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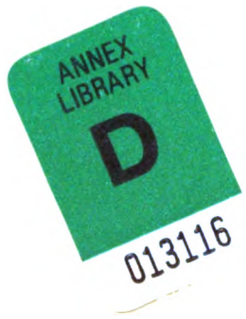
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SUMMARY

A section dealing with the artificial lighting of schoolrooms is included in the report of the Education Committee of the London County Council. This has been written by Mr. B. Harman, who has conducted an experimental enquiry as to the best positions of the sources of light, the best methods of distribution, and what improvements can be effected by suitable shades. (Page 4.)

The new Patent Act, passed last session, came into force yesterday, and a revised set of rules of procedure by patentees and others has been issued by the Patent Office. The chief novelties are the new "Patents of Addition," and the procedure for obtaining compulsory licences and revocation of patents in the event of the patent not being adequately worked in the United Kingdom. Another useful provision is that, after a provisional patent has been applied for and before the time for filing the complete specification is due, an inventor may file a supplementary provisional patent for an improvement or modification of his invention, with a view to the two provisional patents being subsequently embodied in one complete specification, for which a single fee only is chargeable. For the sake of completeness we outline the entire course of procedure for the obtaining of patents, and in the case of other matters with regard to them, as well as the rules that apply to the working of the new provisions of the Act. (Page 5.)

Professor J. T. Morris gave a lecture recently at the East London College, in which he outlined the working of the Griffiths-Bedell surface contact system, which is now being laid down for the L.C.C. tramways in the Mile End Road, and gave the results of some experiments on the magnetic action of the form of stud employed. (Page 7.)

A demonstration of a new system of transmission of pictures was given in Paris on Saturday by M. P. Berjonneau. Experiments were carried out over the telegraph line from Paris to Marseilles, and wireless transmission was also accomplished. The system does not involve the use of selenium, but employs a metallic relief made from the original photograph, over which moves a contact point. In the receiver a moving sensitive film is acted on by a ray of light controlled by a shutter actuated electromagnetically by the line currents. (Page 18.)

The electrical equipment of the "West Shore" Railway, between Utica and Syracuse, forms a good example of the latest American continuous-current traction practice. The main points of interest are the arrangement of the under-running third rail and the 60,000-volt transmission line. (Page 9.)

Mr. J. Erskine-Murray read a Paper recently on wireless communication over sea, in which he dealt

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in a general way with the principles of wireless telegraphy as at present practised, and the relative proportions in which the various systems are in use. (Page 11.)

AN interesting patent, the specification of which was published on December 27th, is by the Westinghouse Metal Filament Lamp Co., Ltd. This covers a method of securing the metallic filaments of electric incandescent lamps, to the leading in conductors, and the principle relied on is the fact that certain metals have the properties of giving out energy when combined with oxygen, and when a metallic oxide is mixed with these metals and the mass is heated, the reaction will continue without further assistance, and the bodies, especially metal ones, if introduced into such a mixture, can be heated to their melting point. (Page 12.)

THE electrical equipment of the Burbacher-Hütte, which is an example of the utilisation of blast-furnace gases in large gas engines for the production of electric power for rolling mill driving, is described in an illustrated article. Continuous current is employed, and the rolling mills are driven by compound-wound motors. (Page 13.)

AN abstract of an illustrated Paper on the design of brake gear for electric railway cars, read before the American Central Electric Railway Association by Mr. FRED. HECKLER, emphasises the importance of adequate attention to this item in the design of trucks, pointing out the commoner defects, and the ways in which they may be avoided. The illustrations show the arrangements on several American trucks, and analyse the merits and demerits of each. (Page 17.)

A DESCRIPTION is given of some of the forms of the Cooper-Hewitt mercury-vapour lamp on the market in this country, together with some notes on the working of the same. (Page 20.)

INVESTIGATIONS by E. P. HYDE and F. E. CADY, at the United States Bureau of Standards, confirm previous conclusions that the method of testing the mean horizontal candle power of incandescent lamps by rotating the lamp is sufficiently accurate for all practical purposes unless the speed of rotation (200 r.p.m.) far exceeds that laid down by the British standards. When, however, the filament touches the glass at the higher speeds, an immediate decrease in candle power takes place. (Page 21.)

REVIEWS of the following books appear in this issue:—"How to Design a Gas Engine," by Horace Allen; "Hints Regarding the Management and Use of X-ray Apparatus," by F. Bruce; "Popular Fallacies," by A. S. E. Ackermann. (Page 22.)

A SUMMARY of heavy traction installations recently completed or in progress in America, forms part of a recent report of a committee of the American Street and Interurban Railway Association. (Page 23.)

A SHORT article deals with the sources of supply of tungsten ores and the methods of preparation of the metal. (Page 23.)

UNDER "Electrical Science," in the British and American Section, is a note on the effect on friction of the passage of an electric current across a surface. In the Papers abstracted in the Continental Section, ERFLE expounds the electron theory of dispersion; BLOCH studies the iodisation of air by bubbling; COTTON and MOUTON describe their discovery of magnetic double-refraction in nitrobenzene and other aromatic compounds; HELM foreshadows the application of statistical methods to all collective forms of energy. (Page 24.)

UNDER "Electro-Chemistry and Electro-Metallurgy" is given an account of some investigations by K. ARNDT on the relation between the viscosity and the electrical conductivity of solutions and fused salts. A method due to R. SCHAAR for obtaining pure gases or mixtures of gases in varying proportions electrolytically is also described, and the relative advantages of continuous and alternating currents for various kinds of electric furnaces are considered. The new works of the British Aluminium Co., at Kinlochleven, started operations on Christmas Day. (Page 25.)

THE applications to the Board of Trade for electric lighting provisional orders during the session of 1908 number 27. In connection with Fleetwood and Oulton Broad, two applications are made for the same area, so that the actual number of orders that may be granted is reduced to 25. We give the complete list. (Page 25.)

AMONG the specifications published this week by the Patent Office is one by the BRITISH THOMSON-HOUSTON Co., relating to signalling on electric railway systems in which the dynamo at the power house is connected in a special manner, and the signals are controlled by rotary motors. The Westinghouse Metal Filament Lamp Co. have a new method of securing the filament to the leading-in wires. This patent is given in full on page 12. A specification by COWPER COLES relates to anodes for electric deposition, in which the anodes are moveable and can be made to approach the cathodes as the anodes are dissolved away. The BRITISH THOMSON-HOUSTON Co. and WOODBRIDGE have a specification for improvements in switches and switch-controlling mechanism for electrical installations. J. C. LINCOLN has a special construction for electric motors, so as to obtain great range of speed, and also to prevent sparking at high speeds, and also adapts the armature to work equally well in either direction of rotation. (Page 26.)

A NEW section of the Accrington tramways has been opened. The Acton Council are holding an electrical exhibition from January 18th to 25th, 1908. The claims of the injured in the Bradford tramway accident have been settled. The Halifax Corporation have entered into a new arrangement with the National Telephone Company, which came into force yesterday. The Board of Trade have approved of the Hammersmith Council supplying the Franco-British Exhibition with electricity, and terms have been arranged between the Council and the exhibition company as regards payment. The Board of Trade have notified the Hanwell District Council, that if it does not take up its lighting order in the next twelve months it will be revoked. The Haslingden Council are electrifying the steam tramway. The Horbury and Wigan electric lighting orders have been revoked by the Board of Trade. (Pages 27-28.)

A REPORT comes from Montreal that a syndicate of British capitalists is prepared to spend £2,000,000 in Canada's electrical development. The London County Council requires 500 tons of steel slot rails and about 190 tons of conductor rails. A loan of £20,000 is being taken up from the London County Council by the Stepney Borough Council for the purpose of its electrical undertaking, and amongst other towns requiring electrical machinery may be mentioned Wimbledon (a 1,000 kw. turbo-alternator, two water-tube boilers and switchboard), and Rotherham (tramway rails, &c.). A fifth order for a 2,500 kw. Curtis turbine generating set has been placed with the British Thomson-Houston Co. by the County of London Electric Supply Co., Ltd., and the Treforest Electrical Consumers Co., Ltd., has ordered a 3,000 kw. turbo-generator running at 1,500 revs. per minute, from the British Westinghouse Electric & Manufacturing Co. A serious position is indicated in the report of the Sunderland District Electric Tramways Co., Ltd., and owing, it is stated, to bad management in the early stages of the undertaking, the only means of avoiding the appointment of a receiver is the issue of £20,000 prior lien debentures. The debenture holders have agreed to this course. Our Stock and Share List shows a tendency to improvement of some of the London electric railway shares. (Pages 28-32.)

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ELECTRICAL engineers form a large proportion of the 20,000 to 30,000 applicants for patents in Great Britain during the year, and we have no hesitation, therefore, in giving prominence to the new rules of procedure that were put into force at the Patent Office yesterday to give effect to the Patents Act passed in the last session of Parliament. Although the chief alterations relate to the new facilities for patenting additions and modifications of patents already applied for, and to the provisions entitling interested persons to claim the revocation of patents or the issue of compulsory licences in the event of a patent not being adequately worked in the United Kingdom, the present occasion is a good one for reviewing the whole patent procedure now in force. A glance through the article which we publish this week will at once create the impression that the procedure has been considerably complicated in recent years. Formerly it was sufficient for the inventor to deposit his specification with the necessary forms and fees, and unless the application was obviously frivolous, or the grant of the patent would be inexpedient for reasons of morality or other good causes, he would be able to obtain a patent in the ordinary course. Now, following the example set by some other countries, a search is instituted by the Patent Office to ascertain whether the invention claimed is novel; but this search extends only to previous British patents and not to other methods of "anticipation," so that the grant of a patent only affords a partial reassurance as to the validity of the patent. On the other hand, it may put the patentee to considerable trouble and expense, for if the Patent Office is of opinion that the patent has in any way been anticipated by a previous one, a sentence calling attention to the fact is added at the end of the complete specification when it is published, although the inventor, it is true, is at first given the opportunity of amending his own specification. If, however, he is convinced that his patent would be a sound one as it stands, and is not inclined to go to the trouble of applying for a "hearing" by the Comptroller, with the possible added expense of appealing to the High Court for a reversal of the Comptroller's decision, he has to submit to the patent being ear-marked as we have mentioned, which obviously may suggest to his business competitors how his own patent may be evaded. Cases are by no means rare in which the inventor, who has applied for this hearing before the Comptroller, is successful in having the opinion of the examiner put aside, and obtains a clean patent without the objectionable added clause. The result is that the services of a patent agent, who is experienced in the "tricks and manners" of the Patent Office, has become an absolute necessity in cases which in former days an intelligent inventor was quite able to tackle for himself. In the rules, the possibility of another hitch is apparent between the application and grant of a patent, but in practice it is one which is of infrequent occurrence. After the acceptance of the patent has been published, it is open to anybody whose interests would be affected to inspect the specification and oppose the grant of the patent. It is somewhat surprising that more advantage is not taken of this facility on the part of rival firms whose interests will possibly be affected by the grant of the patent, for opposition at this stage will cost them far less than a subsequent application for revocation or the defence of an action for infringement. Applications for revocation are rare, however, and those who would be tempted to institute them, as a rule prefer to disregard the patent and leave the *onus* on the patentee of bringing an action for infringement against them subsequently. These actions have always been so costly that the comparatively small number that are heard is in no way a proof that patents are not frequently infringed. Coming now to the new features of the Act, the first is the opportunity given to an inventor of adding improvements to his patent during the period of incubation between the deposit of the provisional and the complete specifications. The inventor who is tempted to improve his patent when drafting his complete specification, and so to risk rendering the patent invalid on account of "disconformity" in order to save the cost of taking out a second patent, will do well to profit by this new facility. On the other hand, the true "patent of addition," which may be taken out at any time and whose cost is lessened by the remission of renewal fees, will probably not be so much in request, for it will bear the same date as the original patent of which it is a modification or addition, and will in consequence expire sooner than if the inventor had taken an ordinary new patent for the improvement. Coming now to the two sections of the new Act for which much commercial importance has been prophesied, we will first take the case in which revocation of a patent may be claimed because the patented article is manufactured mainly or exclusively outside the United Kingdom. At any date not less than four years after the date of the patent, revocation may be claimed on this ground, and although the case may be costly, as the patentee has a right to appeal from the Comptroller's decision, the procedure is fairly simple and straightforward. The effect of this part of the Act will be good, as it will encourage the foreign patentee to start manufacture in this country as soon as possible to avoid the danger of losing his British patent. The case of the metallic filament lamp is one in point. It will be incumbent on many firms owning the British patents for these lamps to start manufacture soon; in fact, the tantalum lamp will have to be made in the United Kingdom before the end of this year if the fundamental patents are to remain valid in this country. We may add that the Act is so worded that the case of an "unrecognised" inventor, who has been unable during the first years of the patent to create a demand for his invention, is not prejudiced, for in such a case the invention would not have been worked outside the United Kingdom any more than it is worked inside. The new provisions with regard to applications for compulsory licences have been welcomed, although they are second in importance to the new law with regard to revocation of patents worked exclusively outside the United Kingdom. Probably advantage of the compulsory licence clauses will first be taken in the chemical industries. Considered as a whole, the new Patent Act will undoubtedly prove beneficial to the industries of this country, and the rules which have been drafted for procedure under it are reasonable and should tend to prevent, so far as is possible, mistakes and misinterpretations.

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THE illustrated paper on brake-gear design, of which we publish an abstract, shows that the importance of this matter in the operation of electric railways is being realised in the United States, much as the same question in relation to tramcars is having attention here. The design of trucks for electric traction, in both the light and heavy branches, has not yet received adequate attention from the manufacturers, either in respect to power economy, cost of maintenance, or convenient arrangement of the necessary gear, including brakes and motors. The patterns now in use have been adapted from steam railway practice, and whilst satisfactory for comparatively light towed vehicles, they are not right for self-propelled cars, carrying great weight, much of which is not spring supported. The remarkable rapidity of rail and flange wear on the London tube railways, and the excessive tractive resistance of electric motor-cars, compared with steam railway bogie-cars, show the defects on the driving side. The difficulty of arranging brake rigging on the usual patterns of tramway trucks, and the expense of its maintenance and adjustment, are well known, especially to the operating staff on narrow gauge lines. Generally speaking, they are regarded as inevitable, owing to the inertia of truck builders and the expense of obtaining variations from their standard patterns, but a start has been made in two or three directions to effect improvements, and the near future will bring into the markets trucks which have been designed from the teachings of experience. Adequate treatment of brake rigging is one of the most important items, and a study of Mr. Heckler's paper will direct attention to the essentials as they appear to the responsible officer of an important American electric railway.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, JANUARY 2ND.

Civil and Mechanical Engineers' Society.

8 p.m. Meeting at Caxton Hall, Westminster, London, when the President, Mr. W. N. Twelvetrees will open a discussion on "Standard Notation for Engineering Formulæ."

Röntgen Society.

8.15 p.m. Ordinary General Meeting at 20 Hanover Square, London. The Standards Committee will present an interim report.

TUESDAY, JANUARY 7TH.

Institution of Electrical Engineers: Manchester Local Section.

7.30 p.m. Meeting at the University. Paper to be read :—"Magnetic Oscillations in Alternators," by G. W. Worrall.

WEDNESDAY, JANUARY 8TH.

Association of Engineers-in-Charge.

7.30 p.m. Meeting at St. Bride's Institute, Fleet Street, London. Paper to be read :—"Electrical Measuring Instruments and Some of their Weaknesses," by K. Edgcumbe.

Junior Institution of Engineers.

8 p.m. Meeting at the Society of Arts, John Street, Adelphi, London. Paper to be read :- "Recent Improvements in Electric Conduit Traction Construction," by Fitz Roy Reese (L.C.C.- Tramways Reconstruction Department).

THURSDAY, JANUARY 9TH.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at 25 Great George Street, Westminster, London. Paper to be read :—"Cost of Electrical Power for Industrial Purposes," by J. F. C. Snell.

FRIDAY, JANUARY 10TH.

Electro Harmonic Society.

8 p.m. Smoking Concert in the King's Hall, Holborn Restaurant.

LIGHTING SCHOOLROOMS

MR. BISHOP HARMAN has recently undertaken, for the London County Council, an inquiry as to the best positions and source of light, and what improvements can be made, in the lighting of schoolrooms. A large number of tests and experiments have been made, and the minimum amount of artificial illumination permissible has been found to be 10 metre-candles. Gas and electricity were the only illuminants used. Most council schools are lighted by gas, burned directly as an illuminant at the jets of fishtail or bats-wing burners, or used as a source of heat to render mantles incandescent. A suitable room was first tested, hung with four point of gas with Bray's No. 4 burner, with a No. 6 regulator. The effect of this gave a steady flame of high illuminating power. The desk lighting was then examined. These burners were then replaced by Welsbach "C" burners and mantles and "Calypso" shades. Although the gas consumed by these burners was no more than the Bray No. 4 burner, the desk illumination was three times greater. The three types of burners examined were the "C," Kern, and Simplex; the last is the latest pattern and the best; it has the advantage of being 2½ inches shorter than the Kern. This burner was found to be the best of the gas method of illumination, when combined with a 90° shade. Electric lighting was found to be the best, handiest, and simplest method of illuminating the rooms, and there was a complete absence of shadow below the lamp, and the possibility of more efficient reflection. Healthiness and freedom from the consumption of air and production of fumes, noiselessness, all make the electric glow lamp the most perfect means now available for school use. Two sorts of opal shades are in use in schools; one subtends 110° in the sides, and has a vertical depth of 3⅛ inches. The other shade has sides subtending at an angle of 80°, with a vertical depth of 5 inches. This shade completely screens the filament from the teacher's eyes, and, in Mr. Harman's opinion, is best for school purposes. He also examined the "tantalum" and "Nernst" lamps, but found the latter was not good for schoolroom purposes. The report continues :—The distribution of the lamps should be as follows. Each classroom should be considered to be divided into two halves—the pupils' half and the teacher's half, and left-hand lighting must be arranged for as far as possible. There must be a clearance of 6 feet 6 inches beneath the pendants, and the lamp must come somewhat to the left side and slightly in front of the pupil, and the space between the lamps from front to back of the room must be smaller than the space from side to side. Refraction and reflection are much to be recommended for school use. The prismatic and holophane globes are the best for this purpose. The "Prismatic" globe has the outer surface of a glass bowl moulded into a series of prisms running round the bowl, and so placed as to throw the light downwards. It is extremely effective, especially when a flattened opal shade closes the mouth of the bowl. Indirect illumination by reflection is a favourite method in Germany, and this is done by the use of powerful electric arc lamps, hung close to the ceilings with metal reflectors below them. The effect is somewhat like daylight of modified brilliance, and is most successfully employed in workshops and show-rooms, but is not a success for desk lighting. The system was employed in the new anatomical laboratories of Cambridge University, but has had to be superseded by direct glow lamp illumination.

The improvement on the unreflected light by the use of shades is great, but the results obtained by increasing the depth of the shade are most striking. The gain is obtained by reflecting the rays that would otherwise be dissipated upon the upper part of the walls of the room, and the teacher's eyes are screened from the dazzling naked light by the depth of the shade, and the general wall illumination does not suffer. The only suggestion as to the type of incandescent electric lamp which is best for use in schools, is that the lamp should be as large as possible, and the filament be twisted in as long a loop as is convenient, and with electricity, the points of light may be more closely distributed than is the case with gas, as there are no noxious fumes given off. With gas the fewest possible number of burners should be used, for the more burners the worse the atmosphere.

Electrical Science. In the paragraph under "Electrical Science," on page 1050 of our last issue, describing the new current balance at the National Physical Laboratory, the name of Prof. Viriamu Jones should have been mentioned amongst those to whom the design of the instrument was due. In the last line of the same paragraph, 14·9928 should have read 14·99928.

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NEW PATENT OFFICE PROCEDURE

THE new Patent Act passed last session, a full *résumé* of which was given in our issue for September 19th, came into force yesterday, and the Patent Office has issued a set of rules for its application. Although the rules have only been altered in some respects, for the sake of completeness we outline the whole procedure that is to be followed when patents are applied for or opposed, when compulsory licences are desired, &c.

APPLICATION FOR A PATENT.

An inventor desiring to acquire a patent has to apply on a form issued for the purpose by the Patent Office. He can either apply for "provisional" protection, or he can hand in a "complete specification" of his invention with his application. In the former case the initial fee is £1, and in the latter case £4. If he has filed a provisional specification in the first instance, he must within six months file a complete specification with an additional fee of £3, so that it costs the same whether he files his complete specification in the first instance or commences with the provisional only. Both the provisional and complete specifications have to be written out in duplicate, and the first sheet of the specification is to be a form provided for the purpose by the Patent Office. Applications may be made by the inventor personally, or through an agent, or may be sent through the post, and the forms must bear a stamp representing the amount of the fee to be paid.

If the Patent Office finds, after examination of the complete specification, that it comprises several distinct inventions, the inventor will be required to amend his application so that it shall include one invention only, but the applicant may apply for separate patents for the other inventions, and if these patents are granted the controller may give these the date of the original application or any later date up to the time they are deposited.

An inventor who has filed a provisional specification, and who has extended or modified his invention before he has left his complete specification, may file a second provisional specification for the addition with a view to the whole being embodied in one complete specification. In this event the patent will bear the date of the first application, except so far as questions of validity and oppositions are concerned. This is one of the additional facilities granted to inventors by the new Act.

At the end of his complete specification the inventor must in all cases state in clear and succinct terms what is the invention claimed, and these claims are to be separate and distinct from the body of the specification.

A month's extension of time is allowed beyond the six months' interval between the filing of the provisional and complete specification, on application on the desired form with payment of a supplementary fee of £2.

In cases where drawings accompany specifications, certain rules are to be observed, and copies of instructions may be had on application at the Patent Office.

EXAMINATION OF PATENT BY THE PATENT OFFICE.

After the complete specification has been deposited an examination is made to ascertain that the invention described in the complete specification is substantially the same as that described in the provisional, and that it has not been anticipated by other British patents published within the previous fifty years. [From a date which will be fixed subsequently by the Board of Trade, this search will also be extended to those specifications which, although already deposited, have not yet been published.] If, after examination, it is considered that there is disconformity between the provisional and complete specification, or if the patent has been wholly or partly anticipated, the inventor will be informed of the facts and will be given the opportunity of renewing his specification within two months of the date of this notice. Should he not be satisfied with the Patent Office decision with regard to the anticipation, he may apply to the Comptroller for "a hearing," and an appointment will be given him with ten days' notice. If the applicant does not apply for a hearing, or does not keep his appointment, or if the Comptroller after the hearing decides against him, the following sentence is added at the end of the complete specification after the claims: "Reference has been directed in pursuance of Section 7, sub-section 4, of the Patents and Designs Act, 1907, to Specification Number .....of....."

The inventor has the right, however, to appeal against this decision to the Law Officer of the Crown, which he must do on a form with a £3 stamp. He must do this within 14 days of the date of the decision, and must address the form to the Chief Clerk, Law Officer's Department, Room 549, Royal Courts of Justice, London. At least seven days' notice will be given of the hearing of the appeal, and no further evidence may be given in addition to that which the inventor gave before the Comptroller, unless special permission is granted. The Law Officer may award costs against the applicant.

In the case of chemical inventions, the Patent Office may require that samples should be deposited, and there are specific directions as to the size of the bottles, the method of labelling, &c.

When the complete specification is accepted, a notice is published in the Official Journal of the Patent Office, and the specification is open to inspection by anyone before it is actually printed and published, on the payment of a fee of 1s.

OPPOSITION TO GRANT OF PATENT.

Any person may, within two months from the date of the above notice in the journal, give notice of opposition to the grant of the patent on certain grounds which are set forth in Section 11 of the Act and published in our previous article above referred to. The opposer must send in his notice on a form prescribed for the purpose, and pay a fee of 10s., and he must give the reasons for his opposition on this form, which is to be accompanied by an unstamped duplicate copy. In certain cases the notice of opposition should be followed in 14 days by a statutory declaration in support of the same (made in the ordinary course before a Justice of the Peace, Commissioner of Oaths, or other qualified official), and the opposer must furnish the applicant for the patent with copies of such declarations. The latter may reply with statutory declarations in support of his case.

When all the evidence has been sent in in this manner, a date is appointed for the hearing, and either party desiring to avail himself of the privilege must notify his intention of attending, on the prescribed form, and pay a fee of £1.

COST OF AN UNOPPOSED PATENT.

If there is no opposition to the grant of the patent, and everything is in order, the patent is "sealed" after acceptance, upon payment of a further fee of £1, together with applications on the proper form.

Assuming that there is no opposition to the grant of the patent, and that there has been no appeal to the Comptroller or to the Law Officer of the Crown, the first cost of a patent, which gives protection for four years, is therefore £5. Before the expiry of the four

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years, the patent may be renewed from year to year on payment of fees on a rising scale: £5 for the fifth year, £6 for the sixth year, £7 for the seventh year, and so on up to £14 for the fourteenth year. Fourteen years is the minimum life of a patent in normal circumstances.

It may be mentioned that these fees are the same as have been in force hitherto, although under the new Act the Patent Office may subsequently raise them at any time. The maximum fees under the Act were published in our previous article, but apparently there is no likelihood of their being enforced in the near future.

A reminder of the renewal fee being due will be sent to the patentee by the Patent Office at least a month before the date when it becomes due. The renewal fee is to be paid by means of a stamped form duly filled in.

RESTORATION OF A LAPSED PATENT.

If a patent has become void on account of the failure of the patentee to pay his renewal fees, he may apply to the Patent Office for the restoration of the patent. To do this he has to pay a fee of £20 and explain the circumstances which led to the omission of the payment of the renewal fee. He is to accompany this with a statutory declaration verifying the statements made in his application. If the Patent Office entertains the application, an advertisement is published in the Official Journal, and it is free to anyone to oppose the restoration of the patent. The opponent must pay a fee of £1, which is in the form of a stamp on a notice stating the reason for his opposition. The rules as to evidence and hearings are the same as those which apply in the case of opposed patents.

In the event of such a patent being restored, persons who have availed themselves of the subject matter of the patent between the date of the announcement in the Journal of the patent being abandoned and the restoration of the patent are held free from prosecution for infringement or actions for damages, and any such person may even make application to the Board of Trade for compensation in respect of money, time, or labour expended in the *bonâ fide* belief that the patent had become void.

AMENDMENT OF A PATENT SPECIFICATION.

If an inventor desires to amend his specification he must apply on the prescribed form and pay a fee which is £1 10s. if the patent has not yet been sealed or £3 after it has been sealed. The application is to be sent in to the Patent Office, together with a certified copy of the original specification and drawings, with the desired alteration marked on in red ink. A small fee is also payable for the certification of the copy. Particulars of the desired amendment are then advertised in the Official Journal. Any person desiring to oppose the amendment may do so on payment of a fee of 10s. and sending in a form in duplicate stating the reason of his opposition; the duplicate copy is sent to the patentee. A statutory declaration in support of his opposition may be sent in also; similar rules hold with regard to counter-declaration, &c., as in the case of an opposed patent. If the amendment is agreed to, the fact is advertised in the Journal.

A request to correct a clerical error is not regarded as an application for amendment. A special form is provided for the purpose, and the fee payable is 5s. before the patent has been sealed, or £1 after.

PATENTS OF ADDITION.

"Patents of Addition" are introduced for the first time in the new Act. By obtaining a Patent of Addition instead of an ordinary patent for an improvement or modification of an invention which he has previously patented, the inventor is relieved of the necessity of paying renewal fees on the second patent. He has, however, to pay the same fees on depositing the additional provisional and complete specification and on the sealing of the patent of addition (£5 in all). Application for patents of addition must be made on special forms provided for the purpose, and not on the ordinary application forms. A disadvantage is that the patent of addition expires at the same date as the fundamental patent. Modifications or improvements in existing patents can, however, be protected by ordinary patents as heretofore, in which case, of course, the supplementary patent runs for its full life, but the full renewal fees are then payable.

COMPULSORY LICENCES.

If a patentee does not manufacture his patented article to an adequate extent, and supply it on reasonable terms, or if, for other reasons specified in the new Act, "the reasonable requirements of the public have not been satisfied," any person interested may apply for a compulsory licence. The application must be made on the proper form, upon which the applicant must state in detail the circumstances of the case and the terms upon which he asks that an order for a compulsory licence should be made, and he must send in with this another form, stamped with a £1 stamp, requesting the Comptroller to place his application before the Board of Trade. It must also be accompanied by affidavits or statutory declarations and other documents in support of his petition, and copies of all of these must also be delivered to the patentee. The patentee, in opposing the application, has also to put in formal declarations and to pay a fee of £1. He must serve copies of his declarations on the petitioner, who may again reply with another batch of declarations in reply. The Board of Trade will dismiss the petition if no case has been made out; if the Board is satisfied that a licence should be granted, it may assist the parties to come to terms; or, finally, it may refer the petition to the High Court, which may fix the terms for the granting of licences or may revoke the patent.

APPLICATION FOR THE REVOCATION OF A PATENT.

Revocation of a patent may be applied for under two different sections of the Act.

In the one case it is in the event of the applicant for the revocation alleging that he himself was the true inventor or that the patent was obtained by fraud. The fee payable in this case is £2, and the procedure is similar to that in the case of opposition to the grant of a patent.

A more interesting reason for demanding revocation of a patent, recognised for the first time in this country in the new Act, is that the patent is not adequately worked in the United Kingdom. If it can be shown (after August 28th, 1908), in the case of a patent which is four years old, that the patented article is manufactured exclusively or mainly outside the United Kingdom, this is sufficient ground for revocation, unless the patentee can give a satisfactory reason for this. The patent may be revoked by the Comptroller forthwith, or he may make an order that it be revoked at the end of a certain time unless manufacture in the United Kingdom is proceeded with to an adequate extent.

Applications for revocation for this cause may be made by any person interested, and although the fee payable in the first instance is but £2, it will probably be a lengthy and costly process. After the usual deposit of statutory declarations on both sides, the Comptroller may hear the case *viva voce*, and may admit witnesses on both sides. Finally, his decision may be appealed against to the High Court.

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THE G.B. SURFACE CONTACT SYSTEM

A LECTURE was given by Professor J. T. Morris at the East London College, University of London, on Thursday, December 19th, in which some details of the working of the G.B. surface contact tramway system were given, with the results of the author's investigations into the working of the stud.

Prof. C. Smith, of the same College, who was in the chair, made a few opening remarks about the line equipped with this system that is being laid along the Mile End Road.

At the commencement of his lecture, Prof. Morris summarised the leading features of the three systems of tramway working. The L.C.C. had adopted a surface contact system in the Mile End Road mainly because the Underground Railway did not leave sufficient depth for their conduit system, and the Borough authorities strongly objected to the overhead system. The only example of the Griffiths-Bedell or "G.B." system is now at work at Lincoln, wher a short line has been in use for nearly two years.

The method of working of the system is roughly as follows :—A magnetised flexible "skate" is carried under the car. As this passes over a stud it is attracted down and makes contact with the stud, and at the same time the magnetic flux causes a switch-piece or plunger to fly out and make contact with the underground live conductor below the stud. This conductor takes the form of a cable constructed largely of iron, and carried on insulators in earthenware pipes. The cable is bare, and therefore liable to electric osmosis. This is guarded against in the following way :—The insulators are reel-shaped, and are threaded on iron spindles. One end of the spindle is made to project outside the pipe. The ends of the spindles are all connected by hoop-iron, with the result that the osmotic action takes place on this instead of on the cable.

The object of the flexible skate is to allow of the studs being flush with the road surface. That the skate rises from the stud quickly enough to clear the road surface when running at high speeds is perhaps doubtful. The skate is made up of a number of cast-iron links, threaded on a flexible cable, and supported by vertical springs in a slot in one pole of a magnet. It is a little over six feet long. Three cores on which the magnetising coils are wound connect to the other pole, which is above. The skate is magnetised normally by current from the underground conductor. A battery of about 25 volts is provided, which is charged when the current is large, and which excites the magnets when the current is cut off. Switches are provided to open the battery circuit when the car is standing.

The stud is made up of a chilled cast-iron plate on top, from which descend two soft iron prongs or cheeks. The plunger or switch-piece is hung up by a spiral spring between these cheeks. The spring is made, in the L.C.C. system, of pianoforte steel wire, heavily coated with copper and covered with a preservative compound. It is insulated, the current being carried by flexible copper conductors. The chances of its breaking and making the stud permanently alive are very small. At Lincoln, from August to December, not a single live stud was found. The plunger is tipped with a carbon block. One of these was shown that had been in use for six months. It showed a slight concavity, but very little roughness.

The distance between the studs is 6 ft. as against 9 ft. at Lincoln. The shorter distance is necessitated by the fact that the cars are required to operate on the conduit system as well as on the surface contact. Only one skate can be used instead of two as at Lincoln, and therefore in order that contact may always be made with one stud, the studs must be much closer.

The theory of the action of the plunger is at first sight not quite clear. Professor Morris attacked the problem, and gave his own ideas on this point. When the cheeks are magnetised, it might be thought that the iron of the plunger would be attracted to them, rather than repelled. But it must be remembered that the plunger is between two N. poles, and is magnetised by lines passing vertically downwards, thus forming a S. pole at the upper end and a N. pole at the lower end. The S. pole is attracted to, and the N. pole repelled by, the two N. poles at the ends of the cheeks, with the result that the plunger moves out. When the cable is in position there is, of course, the additional attraction of the magnetised plunger to the iron of the cable. Professor Morris also looked at the explanation from another aspect, going to fundamental principles. If any part of a magnetic circuit is movable, that part moves into such a position as to allow the maximum number of lines to flow. The magnetism has to leak round from the stud through the air to the upper pole. The area available for leakage is greater with the plunger out than in, especially if the cable is in position to make contact with. It has been proved experimentally that the plunger moves farther with the cable in position than without it. In Fig. 1 a curve is given, showing the total flux through different parts of the stud, and Fig. 2 shows roughly the distribution of the flux. The flux density near the end of the cheeks is about 4,000. The 0·6 ampere curve represents working conditions.

The construction of the cable is ingenious. A centre of jute is surrounded by a ring of copper wires. Then come two layers

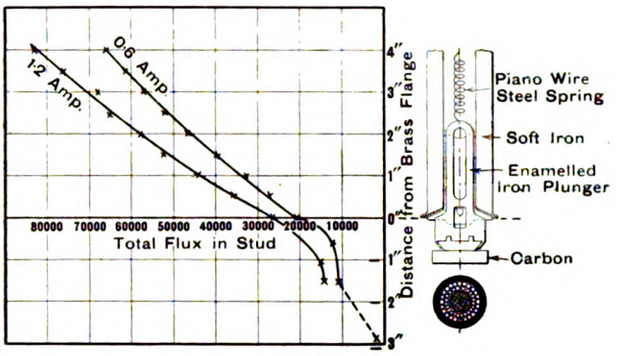


FIG. 1.

of galvanised iron wire, and over all is fitted galvanised iron tubing in 6-in. lengths. The conductivity of the cable is equal to that of a 00 trolley wire. Heavier currents can be carried by a cable of the same diameter (1·2") by putting in more copper and less jute. The iron tubing was not used at Lincoln, but the iron wire did not give a sufficiently good contact.

The joints of the earthenware pipes, which are of an egg-shaped section, are very carefully made. Sticky tape and an iron sheath, filled inside with pitch, is used. The joint is practically water-tight. Any water that may leak in is carried away at drainage pipes fitted at intervals. Every alternate piece of piping has a stalk projecting upwards, into which the stud fits. Two granite blocks which fit round the stud are hollowed out below the road surface. The hollow is filled in with pitch, thus sealing the stud into the pipe. The trench in which the pipes are laid is $16\frac{1}{2}$" deep.

At points, crossings, and other special work, extra precautions have to be taken. It is quite evident that if ordinary iron rails were used when the skate came over the rail it would be attracted and would short-circuit the supply. This is guarded against in two ways. Manganese steel rails are em-

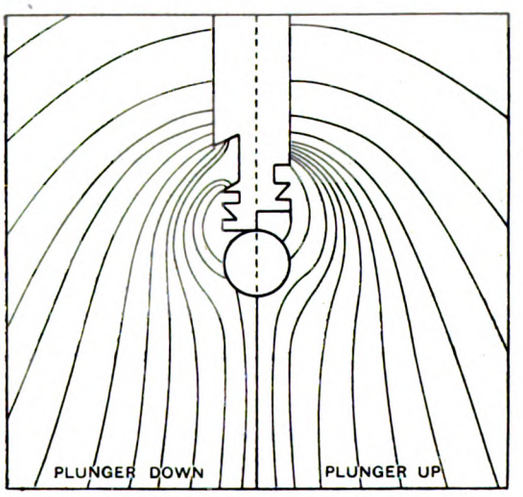


FIG. 2.

ployed. This steel, which consists of 88 parts of iron to 12 parts of manganese, is practically non-magnetic (μ=1·4). Studs of a special type are also used at dangerous positions. In these studs the upper part is insulated from the lower. The two parts are connected through a resistance of 8 ohms, which limits the short-circuit current to 60 amps. (The resistances are placed three or more together in pits under the roadway.) Therefore, should a piece of scrap-iron be picked up by the magnets and trail across a rail and short-circuit the supply, no harm is done.

Every car is fitted with apparatus for detecting a live

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stud that may be left behind. A steel brush passes over the stud after the skate has left it. If the stud is alive, current is collected by the brush, and either rings a bell or passes through a coil in the canopy switch and opens it, thus stopping the car. The latter system is to be used, we believe, in London. When the car is stopped in this way, the driver closes the canopy switch and drives slowly backwards until the switch is opened again. In this way the live stud can be detected.

Fig. 3 shows the actual forces acting on the plunger. It will be observed that the resultant downward force on the plunger is considerably greater at the commencement of its movement than it is later. This is as it should be, as the plunger is then accelerated more quickly than it would be with a uniform force. Prof. Morris concluded by stating his indebtedness to Mr. Bedell for information and specimens and to certain students of the college for their help in various ways.

The CHAIRMAN, in inviting discussion, remarked upon the greatly increasing traffic in London, and also complimented the inventor upon having succeeded in producing a surface contact system that was in a fair way to success.

Mr. HOLMES next spoke, and questioned the efficacy of the carbon contact when in continual use. In reply to this, Mr.

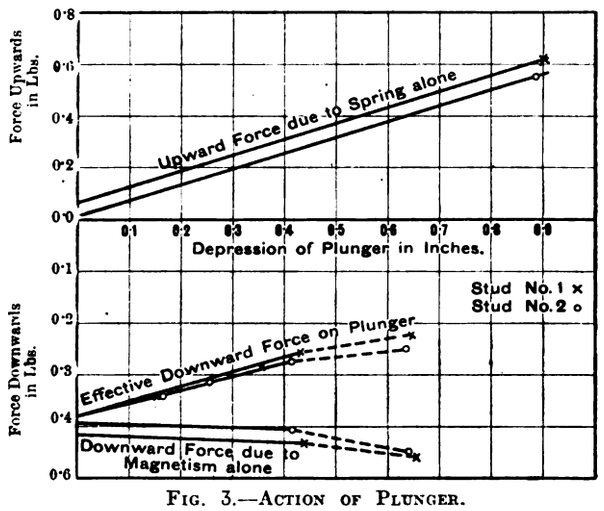


FIG. 3.—ACTION OF PLUNGER.

Bedell produced a block that had been in use for six months. He asked other questions that have been already dealt with.

Mr. MURPHY asked how this surface contact system compared with the overhead and conduit systems as regards cost of installation. He upheld the use of the spring as against gravity. The utilisation of gravity necessitates that the moving part should have considerable mass, which was unfavourable to quick motion. He also asked what was the loss in the magnet winding. He thought it possible that the rubbing of the skate over the studs would have an appreciable braking effect.

Mr. FARMER asked how the skate was insulated from the car. Several other speakers asked questions.

Prof. MORRIS replied that the surface contact system costs, on the average, about 10 per cent. more than the overhead, while the conduit system costs close upon double.

Mr. BEDELL spoke next, and stated that some of the information given that evening was new to him. He said that the actual pull between the skate and the stud had been adjusted to 3 lb. The adjustment was made by varying the ratio of pole face and chain face. The tractive effort required was therefore 7 or 8 oz., and quite negligible. The magnet was attached to the car body by insulating bolts.

Manchester Electrical Exhibition.—We are informed that Mr. H. Talbot, President of the Municipal Electrical Association, has accepted a seat on the Exhibition Committee to represent their interests and those of the Nottingham Corporation, who are supporting the scheme.

Electric Lighting Dispute in Toulon.—We understand, from the *Daily Chronicle* special correspondent, that a conflict between the Socialist municipality of Toulon and the local electric light company threatens to have a serious ending for the city. The municipality at the moment owes the company £16,800 for the lighting of Toulon. For over a year the council has been repeatedly "dunned" by the company, but, for reasons best known to itself, has refused to pay. Now, as a result of legal proceedings, a bailiff has been placed in possession of the town hall, and the plaintiff company has given the mayor and councillors a week in which to find the whole of the debt, failing which the electricity will be cut off, and Toulon will find itself left in darkness.

THE BERJONNEAU SYSTEM OF ELECTRIC TRANSMISSION OF PICTURES

From our Paris Correspondent

LAST Saturday evening a demonstration was given by M. Pascal Berjonneau of his new system of transmission of pictures before a large audience in the hall of the Société des Ingénieurs Civils. After giving a full description of the system, the working of which is outlined below, experiments were conducted under the following conditions. The sending and receiving instruments were first connected to a loop formed of the State telegraph lines from Paris to Marseilles and back, a total distance of 1,726 kilometres, when several pictures, including a portrait of M. Simyan, Under-Secretary of State for Posts and Telegraphs, were successfully sent and received at the rate of one in each fifteen minutes. In the second experiment the apparatus was disconnected from the line and operated by Ducretet wireless telegraph relays. It had been hoped that the "wireless" station on the Eiffel Tower would have been used, but the authorities were unable to grant the necessary permission on account of the Lorient-Paris-Casa Blanca experiments of the French Navy being in progress. The sending and receiving apparatus had therefore to be placed in the same hall, but this in no way detracts from the importance of the experiment, in which it is claimed that pictures were transmitted by wireless methods for the first time.

The system of M. Berjonneau differs fundamentally from that of Prof. Korn (ELECTRICAL ENGINEERING, Vol. II., page 767), in that selenium is not made use of, and may be said to present the following advantages of both the Korn system and that of M. Belin (ELECTRICAL ENGINEERING, Vol. II., page 845):—Greatly reduced size of apparatus and greater robustness of mechanism; the use of the same apparatus for transmission and receiving; the possibility of working over the longest land lines or submarine cables, as the only line current is the very small amount required to actuate relays; and, finally, the possibility of wireless transmission. Roughly speaking, the Berjonneau transmitter is nothing more than a Morse key actuated in a particular manner, sending a series of current impulses which are translated in the proper manner by the receiving apparatus. First of all, a copper relief similar to the blocks used for printing "half-tone" reproductions of photographs is prepared from the original which it is desired to transmit. This is made in the form of a cylinder, and mounted on a travelling revolving drum similar to that of a phonograph, with a feed of 1/6 mm. per revolution. In place of the sapphire "needle" of the phonograph, a suitably insulated platinum point is employed, which makes contact with the portions of the cylinder standing in relief and causes currents depending in duration on their size, but of constant strength, to be sent into the line.

In the receiving apparatus a sensitive film is mounted on a similar cylinder, and a ray of light passing through a very small aperture is caused to fall on it as it rotates. A diminutive shutter, actuated by an electro-magnet, controls the incidence of the ray according to the current received, so that light falls on the film only at points corresponding to those of high relief on the sending cylinder. On development, therefore, a reproduction of the original photograph is formed in fine lines 1/6 mm. apart. It will be seen that the strength of the current does not enter into the question, so that the whole of the working can be done by relays either over a telegraph wire or by "wireless" methods. The main point of importance is the accurate synchronism of the cylinders; but we have not at present information as to how this is obtained.

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TRANSMISSION LINES AND THIRD RAIL EQUIPMENT OF THE WEST SHORE RAILWAY BETWEEN UTICA AND SYRACUSE

THROUGH the courtesy of the British Thomson-Houston Co., Ltd., we are able to give some interesting details of the electrification of the West Shore Railroad of the Oneida Railway Co. between Utica and Syracuse, which forms a good example of the latest American practice in continuous-current traction. To give some idea of the conditions to be met, we may mention, before proceeding to a description of technical detail, that the service to be handled over the length of 44 miles of route is as follows, in addition to the steam freight service still maintained over the line:—(1) The fast limited cars or trains will leave each terminal hourly, and make two stops en route. These will complete the journey in 1 hour and 28 minutes, the 28 minutes being taken on the local lines at each end of the system, the run over the West Shore track proper taking only 60 minutes. (2) Local cars or trains with a schedule speed of 24 miles per hour, which will complete the run in 1 hour and 58 minutes, will also provide an hourly service from each terminal, and will make frequent stops at every highway if necessary.

The general scheme of electrification provides for the generation of current at 2,200 volts at Spiers Falls, where it is stepped up to 60,000 volts, and transmitted to the sub-stations. At the sub-stations, after this pressure is reduced to 370 volts, it is converted to direct current, and fed to the third rail at 600 volts.

The transmission line is of special interest, being operated at so high a pressure as 60,000 volts, and may be described in some detail. The Hudson River Electric Power Co. is erecting a transmission line from Spiers Falls to Clarks' Mills sub-station, the other three sub-stations being supplied with energy by the transmission line constructed by the Oneida Railway Co. The two transmission lines are radically different in details of construction, although they both operate at 60,000 volts, and supply three-phase current at a periodicity of 40 cycles per second. The Hudson River Power Co.'s transmission line, which, when complete, will be in duplicate throughout, extends from Spiers Falls to Utica. It is 100 miles in length, and passes through Ballston Spa., Amsterdam, Johnstown, St. Johnsville, and Little Falls *en route*. The general shape of the towers will be seen in the illustration. They are built of galvanised steel angles. The towers are all of the same general type, but vary in weight according to the requirements of the line, and there are three different arrangements of cross arms and insulators.

The standard towers, used on tangents and in all places where the angle of deflection is less than 20 degrees, weigh 4,200 lb. each, and have an ultimate breaking strength of 8,000 lb. The transposition towers weigh 5,600 lb. each, and are designed to stand the same strain as the standard towers; such transposition towers are placed 2¾ miles apart. The corner towers are of a much more substantial construction, weighing 10,000 lb. each, and have an ultimate breaking strength of 17,000 lb. Such towers are only employed where the angle of deflection is greater than 20 degrees. The normal spacing of the towers is 550 ft., but the distance is variable, depending largely on the contour of the ground, some being placed 750 ft. apart, and others not more than 400 ft. apart. The average number of towers per mile is ten.

The conductors are composed of six copper wires stranded on a hempen centre, forming a cable with a capacity equivalent to that of a No. 000 solid wire, and having a diameter of half an inch. The breaking strain of this cable as shown on test is about 6,100 lb. The conductors are spaced so as to allow a clearance of 6 ft. between them at any point in the span which necessitates the spacing of the insulators always being somewhat greater than 6 ft. A ground wire of the same material and of the same size is strung for the entire length of the line, and is grounded at every fourth tower to a galvanised iron plate 20 in. × 30 in. The insulators are constructed with four petticoats; they stand 15½ in. high, and at their greatest diameter measure 18 in. Each insulator weighs about 45 lb., and when assembled was subjected to a test of 140,000 volts. Both the upper and lower cross arms are built up of 3 × 3 × ⅜ in. angles, and are suitably braced. The upper arm is 11 ft. 9 in. in length, and the lower 17 ft. 9 in. The foundations are built of concrete, and extend to a depth of 5 ft. below surface of the ground. The bases of the towers occupy the four corners of a 17 ft. square.

The Oneida Railway Co.'s transmission line is not in duplicate, but consists essentially of three conductors, each having the capacity of a No. 0 wire; the cables are built up of seven strands of hard drawn copper. No form of lightning protection is used other than that provided in the sub-stations themselves. The cable is strung from tower to tower with a sag of 12 ft. for a span of 480 ft. at 30 degrees Fahrenheit. This corresponds to a normal tension of 300 lb. in the cable, and if the spacing of the towers varies, the sag is altered to bring this tension up to the constant. The Oneida Co.'s towers assume a square lattice structure which is composed of four 3 × 3 × $\frac{5}{16}$ in. angles. The legs of the towers are buried 5 ft. deep in re-enforced concrete footings which have a section of 3 ft. × 10 in. In designing these towers, a side wind pressure amounting to 1¼ lb. per linear foot of cable is allowed. This figure is based on a wind pressure of 30 lb. per linear foot on the flat surfaces, and half of that pressure on the round surfaces when the cable is covered with a coating of sleet equal to its own diameter. A maximum pull of 1,000 lb. per cable is allowed on a single cross arm tower, the ties being designed to break at this tension. The height of the tower is such as to allow a minimum clearance of 10 ft. over buildings or wires that may be crossed by the transmission line. At those points where the transmission line turns through an angle, the towers are provided with a sufficient number of insulators to enable the curvature of the wire at any one insulator being kept within an angle of 7½ degrees.

The insulators are of porcelain, and it is of interest to note that no rigid specifications were prepared by the railway company as to the tests, dimensions and materials which should be adhered to in their design. The manufacturer was simply asked to construct insulators which they could guarantee to operate satisfactorily at 60,000 volts, with the happy result that since the line has been erected and tested, no failures have been recorded. The insulators are spaced 7 ft. apart at the corners of a 7-ft. equilateral triangle, and are mounted on malleable iron pins 18 in. in height by means of cement. The pins are attached to the cross arms by four ⅝-in. bolts, and are designed to withstand a strain of 2,000 lb.

There are in all four sub-stations situated at various points along the line, equipped with transformers, rotary converters, and switchgear, manufactured by the General Electric Co., of Schenectady. The equipment of these is, generally speaking, on what has come to be regarded as standard lines, except for the high voltage of the incoming lines, which necessitate special care being taken to provide the necessary clearance on the high-tension side. The transmission lines enter the building under weather-proof hoods, and the openings in the wall through which the wires pass are 3 ft. in diameter.

The high-tension room is constructed with the required number of compartments isolated from one another by suitable barrier walls; those on the outside wall housing the lightning arresters and choke coils, and those on the inner wall serving as bus-bar compartments and to isolate the oil switches, each leg of which occupies a separate compartment. The bus-bar compartments occupy the lower portion of the inner wall and the oil switches are situated about 16 ft. above the ground floor level; a floor having been built at this height throughout the high-tension compartment to provide a ready means of inspecting the switches and lightning arresters.

The rotary converters are of 800 kw. capacity, and are designed for 40 cycles instead of the more usual 25 cycles. Batteries are not used on the traction circuit, but a few cells are installed in the sub-stations for auxiliary purposes.

The most interesting feature of the railway is the underrunning protected third rail, of which a total length of some 105 miles has been laid. The form of rail employed is of the bull-head underrunning type, and is of the same cross-section as that employed on the electrification section of the New York Central Railway.

The weight of the rail is 70 lb. per yard, and it was supplied in lengths of 33 ft. In the case of the New York Central rail, a special composition was used to secure the highest conductivity possible, but in the present instance this was unnecessary owing to the traffic conditions, which are not of such a nature as to demand so heavy a current. The third rail adopted on the West Shore Road is of the Lackawanna Steel Co.'s standard composition for track rails of from 70 to 80 lb.; that is to say, they consist of carbon 0·45 to 0·55, phosphorus not over 0·10, silicon not over 0·20, and magnesia not over 0·75 to 1·05. A rail of this composition and cross section will give an electrical resistance of 0·0494 ohms per mile, or, in other words, the rail

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has a conductivity equivalent to a copper cable of 1,023,000 c.m. cross section. This conductivity is sufficiently large, so that no D.C. feeders will be required.

The general form of protection and the method of attaching it to the third rail will be seen in the illustrations; part of this protection is in the form of a wooden sheath and part in the form of a fibre sheathing. The wooden protection is of

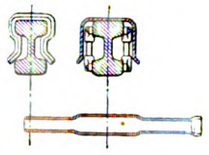


FIG. 1.—FIBRE SHEATHING.

long leaf yellow pine in three parts:—teh top and two base pieces, which are held together by 3½-in. diamond pointed drive screws. The wooden covering is not subjected to any special treatment, but is painted before being applied to the rail. The fibre sheathing is illustrated in Fig. 1. It is moulded in lengths of 43½ in., and it takes three sections of this length to cover the third rail between brackets. The joints on straight track are covered by 2½-in. lap joints, while the joints in the wooden protection are butt joints. On those stretches of track where the fibre covering is used, the rail joints are protected by a fibre covering of wider section, and in this way the bands are very effectually protected, and where the wooden protection is used it is cut away to accommodate the splice bars, bolts, and bonds. The specifications for the fibre sheathing called for an insulation test of 5,000 volts before breakdown. The covering is sufficiently flexible to permit its being pressed into position.

The third rail is normally situated between the tracks, but at all curves this order is reversed, and the third rail is installed alongside the running rail of greater radius. The location of the third rail relative to the track will be seen by reference to the illustration. This position does not conform with the dimensions that have been advised as standards for such work, but it was dictated by the fact that both passenger and freight cars of practically every type in existence are required to be accomodated. The location selected for the third rail will permit the passage of all types of cars with the very limited exception of a special design of coal car which has low truss rods. At each yard a cast-iron tell-tale is provided, which is used to ascertain if there is any projection on the train which would interfere with the third rail.

The brackets for supporting the third rail are of tough grey cast-iron, and the specifications required that a sample piece of

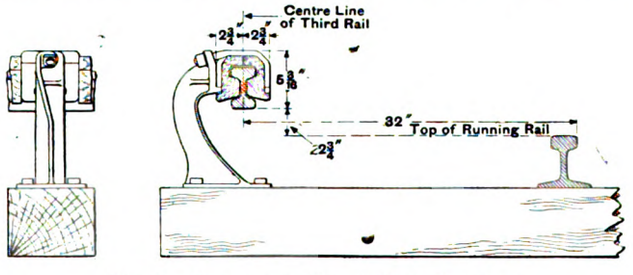


FIG. 2.—DETAILS OF THIRD RAIL BRACKET.

1 sq. in. cross section, cast from the same heat of metal in sand moulds, should be capable of sustaining a central load of not less than 2,500 lb. on a clear span of 12 in., and that such test pieces should deflect 0·15 in. before rupture.

These brackets are shown in detail in Fig. 2, and it will be noticed that they are of the same pattern as that adopted on the New York Central electrification. They are located 10 ft. apart, or on every fifth tie, long ties having been provided in all necessary places along the track, with this exception, that at such points as where switches and other special track construction would involve too much expense in laying new ties under a multiplicity of rails, a length of channel iron is bolted to the end of the tie, and the bracket is bolted to this channel. To insure a standard position of the bracket being adhered to throughout the whole construction a template was used for drilling the holes in the ties, which was held over the running rail and against the tie, while the holes were being marked out. Brackets are held to the ties by means of three lag screws ¾ in. in diameter and 4½ in. long.

The insulators for holding the third rail in the brackets are of semi-porcelain. A great deal of consideration was given as to what material should be used, as to secure good insulating qualities vitrification is necessary, but at the same time a thoroughly vitrified block is necessarily brittle, which makes it unsuitable for third rail construction. The necessary combination of mechanical strength and electrical insulation has been obtained by using a combination of clay and porcelain mixture and by subjecting this composition to special methods of drying and burning. The insulators were required to pass the follow-

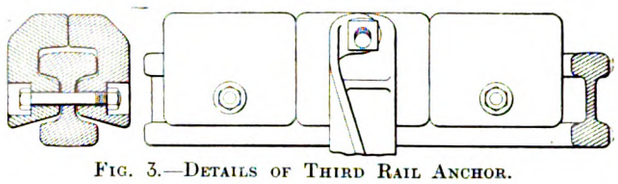


FIG. 3.—DETAILS OF THIRD RAIL ANCHOR.

ing tests:—(A) They should be immersed in water for 72 hours, then removed, and the surface wiped dry, and the resistance of the insulator measured from the hook slot to the rail slot, should not be less than 10 megohms. When subjected to a precipitation of ¾ in. of water per minute the resistance measured as before shall not be less than 0·2 megohms. (B) A compression test with the pressure uniformly distributed should show the insulator capable of withstanding at least 85,000 lb. without showing any indication of fracture. (C) For tensile strength all insulators should be capable of standing a stress not less than 1,400 lb. without showing any indication of fracture. (D) The impact test is of special interest. It provides that 2 per cent. of each batch of insulators shall be selected and subjected to a test consisting of successive blows from a ¾ lb. weight in the form of a spherical steel ball dropped from a height of 50 in. The insulators not showing any signs of fracture after 100 such blows shall be rated as 100. Other insulators shall be rated at the number of blows at which they develop fracture. The average of these ratings must not fall below 25 blows.

The insulators are held in their respective brackets by a steel hook bolt, which passes around the insulator and through a lug on the top of the bracket. This will be seen more clearly by reference to the illustration. The third rail is anchored at frequent intervals. This is accomplished by two wooden insulators bolted to the third rail on either side of a porcelain insulator. The illustration of this will show that the bolt passes through the wooden insulator and the third rail, which effectually prevents any longitudinal movement of the rail. The wooden insulators are of the same general shape as the porcelain insulators.

The third rail approaches or inclines are made of grey cast-iron of the same quality as specified for the third rail brackets, and they are attached to the third rail by a standard two-bolt splice

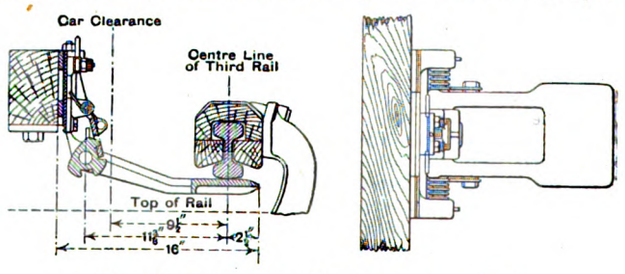


FIG. 4.—DETAILS OF UNDER-RUNNING SHOE.

bar. These inclines are used at all breaks in the third rail, and their general form and the special third rail covering used in their protection are shown in a comprehensive manner by the illustration. The insulators used for their support differ from the standard insulators only in that they are slightly shallower in order to meet the special requirements.

The third rail jumpers are used at all breaks in the third rail to insure a continuous conductor. They are housed in an iron pipe 3 in. in diameter. The cable, before being drawn into the iron pipe, is insulated with 3/32 in. rubber, and is enclosed in lead. The jumpers are brought up to about 2½ in. above the surface of the ties, and the cables, after emerging from the ducts, divide in two twisted arms, commonly known as pigtails, which are attached to the third rail by means of solid copper terminals, which are bolted and soldered. Great care is exercised to protect the terminal at the point where it emerges from the duct; it is tapped and painted, and the end of the duct is also plugged with oakum to prevent dirt from entering, and to avoid any movement of the cable. The third rail joints are made in the ordinary manner by means of two-bolt splice bars secured in position with bolts ⅞ in. in diameter.

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The third rail is bonded throughout with 15″ ribbon bonds, which are soldered to the rail at each side of the upper head and have a large contact surface at each joint. They each have a capacity of 500,000 c.m. As already stated, where the wooden covering is used it is cut away to accommodate the bonds and with the fibre covering a special section is used to cover the joints.

The third rail is continuous throughout under normal operation, the only sectionalisation being at the feeder points opposite each sub-station. This arrangement is of the simplest possible nature, and permits any section between the sub-stations being cut out by means of the switches on the feeder panels at the adjacent sub-stations.

The running rail is bonded throughout with 11 in. bonds with compressed terminals which are located under the fish-plates. There is only one bond at each joint, but they have a section equal to that of a 4/0 trolley wire. The track is cross-bonded at all special work, such as cross-overs and switches.

There are at present fifteen cars, of the interurban type, in operation, each equipped with four 75 h.p. motors, and Sprague-General Electric multiple-unit control. The arrangement of the underrunning shoe is shown in Fig. 4.

WIRELESS COMMUNICATION OVER SEA

MR. J. ERSKINE-MURRAY read a Paper with the above title recently before the Institution of Engineers and Shipbuilders in Scotland. Although the principal subject of the Paper was electrical wireless telegraphy, the introduction contained a short survey of marine communications in general, including systems of signalling by sound transmitted both through air and water and by light.

A technical description of the apparatus used in any system of wireless telegraphy was not attempted, but the author confined his remarks to its application to nautical purposes and to the general principles which define its scope and the advantages and disadvantages of the various systems at present in use. In order to indicate the magnitude of the wireless telegraph system of communications throughout the world, the following data collected from various Government and other reports on the subject were given :—

Commercial land stations	195
Merchant vessels	170
Lighthouses, &c. (Government stations) ...	150
Naval installations	670
Military portable installations	55
Experimental stations	310

These 1,550 stations have been erected by the various companies in approximately the following proportions :—

Telefunken	41 per cent.
Marconi	20 ,,
De Forest	6 ,,
Lodge-Muirhead	3 ,,
Fessenden	3 ,,
Other systems	27 ,,

As regards commercial land stations :—

Marconi	32 per cent.
Other systems	68 ,,

On merchant vessels :—

Marconi	56 per cent.
Other systems	44 ,,

The figures, which are more complete than those given in the American report abstracted on p. 841 of ELECTRICAL ENGINEERING, November 28th, were given to show that the adoption of the Radiotelegraphic Convention by this country was a necessary consequence of the refusal of the Marconi Companies to allow their stations to intercommunicate with those of other companies whether on sea or land. The actual proportions in different regions are, of course, very various. On the North Atlantic the Marconi Company has a greater hold than elsewhere, though it is very far from having a monopoly, even in the British Islands. In South America, the West and East Indies, and on the Continent of Europe, excepting Italy, the Telefunken, Lodge-Muirhead, and De Forest Companies practically do all the business.

The general principles of wireless telegraphy were summed up shortly, as follows :—The energy which transmits the signal is propagated over the earth's surface as an electric wave motion. This wave motion, or alternate current, may be either uniform like an ordinary lighting or power current, or it may be in the form of damped wave trains, *i.e.*, in short series of waves following one another at comparatively long intervals; each series or train commencing strongly and dying out after comparatively few waves. In the first case a high frequency alternate current generator or a vibrating electric arc may be used; in the latter, the intermittent spark discharge of a condenser. In both cases it is necessary that the frequency of the current (number of alternations per second) should be high in order that the amount of electricity set in motion at each wave, and, therefore, the actual dimensions of the apparatus, may not be too large. This will be appreciated when it is recollected that a small quantity of electricity, or any material, when moving very rapidly, may transmit a large amount of energy. (A high speed de Laval steam turbine is a good mechanical instance of this.) A high frequency is thus advantageous from an engineering point of view, though it is not absolutely necessary.

The receiving apparatus must, therefore, be capable of detecting and indicating currents whose frequencies are greater than 100,000 per second. There are now scores, possibly hundreds, of ways in which this may be done. These may be classed as follows :—(*a*) Imperfect electrical contacts, or coherers, whose resistance is changed by the action of the received current; (*b*) Electrolytic detectors, which indicate the received currents by an alteration in polarisation; (*c*) Thermometric detectors which indicate the current through the effects of the change of temperature it causes; (*d*) Magnetic detectors in which the magnetic state of a piece of magnetised iron is altered by the current; (*e*) Electromagnetic detectors on the current balance, or electro-dynamometer principle; (*f*) Valves or rectifiers which, owing to their property of permitting current to pass more easily in one direction than in the other, produce a more or less unidirectional and, therefore, measurable current directly from the alternating current received; (*g*) A miscellaneous class whose methods of action have not yet been explained.

The best known forms of coherer are (1) the Marconi, consisting of a glass tube of about 5 millimetres bore, in which are two silver plugs about 0·5 millimetre apart, between which a small quantity of very fine nickel filings are placed. The gap is usually V-shaped to admit of regulation by merely turning the tube as the filings only occupy about one-third of the space and are, therefore, more or less crowded together according as the wide or narrow end of the V is uppermost. (2) The Lodge-Muirhead, which consists of a razor-edged steel wheel about the diameter of a threepenny bit whose edge dips into mercury covered with oil, and which is kept revolving by clockwork. The Marconi coherer, which, by the way, is a modified form of Branly tube and is also used by the Telefunken Company, requires to be decohered by tapping or shaking it after it has recorded a signal, as it would otherwise remain cohered. This, though apparently a disadvantage, is in reality the essence of its success, for it is owing to this that it was first possible to maintain the effect of the passage of the high frequency current long enough to obtain from it a permanent record of the Morse tape by means of ordinary telegraph instruments. The Lodge-Muirhead coherer is decohered after a small fraction of a second by the movement of the wheel.

The other detectors most in use are Marconi's magnetic detector and the electrolytic or barretter invented by Fessenden. Magnetic detectors are based on the fact that a high frequency current, even if of very short duration, may produce considerable changes in the magnetism of a fine magnetised iron wire. In Marconi's form an endless band of fine iron wires is kept travelling round two pulleys. Surrounding one of the straight pieces between the pulleys is a small glass tube on which are wound two coils of fine insulated wire. One of these is connected to the aerial and earth wires, and the other to a telephone receiver. Two permanent magnets are placed so that their lines of force include part of the travelling iron band in their circuit. The motion of the band draws the lines to one side through the retentiveness of the iron for magnetism. The high frequency current in the aerial wire, on passing through the small coil round the iron band, suddenly demagnetises it, or rather releases the lines of force. These spring back into a position at right angles to the band, and in so doing cut the coil connected to the telephone, induce a current in it, and thus produce an audible click in the instrument. The motion of the band soon draws the lines aside

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again and renders the apparatus ready to indicate a new signal. The Morse "dash" is, of course, represented, as in all systems of wireless telegraphy, by a close succession of dots.

The electrolytic receiver, or barretter, depends on the fact that if a constant voltage be applied between electrodes dipping into an electrolyte, one of which is of very small area, the current is, under certain conditions, unstable, and the sudden superposition of a high frequency current causes a sudden and considerable increase in the constant current. The action is not yet properly understood, though many theories have been stated. A telephone is generally used in connection with this detector which is one of the most sensitive of all.

It is noticeable that in the above list of detectors of high frequency currents there are very few, if any, which give directly an audible or visible indication of the signal. In practically every case it is thus necessary to have some auxiliary instrument to indicate to the operator that the detector has reacted. In some cases a telephone, syphon recorder, or Morse inker, may be used at will, in others the telephone is the only auxiliary suitable, and it is, therefore, not possible to obtain a permanent record of a message.

The waves are propagated outward from the transmitting station, either equally in all directions or with a maximum in one direction according as the aerial wire is vertical or inclined. In the latter case the strongest transmission is in the direction of the lower end of the wire. This method is used at Clifden and Glace Bay, Marconi's transatlantic stations, and at Knockroe, the Poulsen transatlantic station now building.

The lines of electric force are in general attached to the ground and follow it, as they do a wire in ordinary linear conduction. The resistance and dielectric constant of the ground are important factors in determining the distance to which it is possible to signal with any given transmitter and receiver. In general the dielectric constant is the more important of the two, and the chief reason why it is more easy to transmit signals over water than land is that the dielectric constant of water is 80, while for dry sand or rock it is only about 5. Thus it is possible to transmit signals very much further over water with a given power than over land. The actual ratio of the distances is now calculable approximately in cases where the natures of the soil and subsoil are known.

It is now easy to determine with considerable accuracy, in fact within a few degrees, the direction from which a message is coming—a discovery which may in the near future become a great aid to navigation, since any two land stations within range of a ship will be able, by making simultaneous observations, to give their bearings, and thus to fix the actual position of the vessel. In these days of ever-increasing speeds it is becoming more and more essential that the shipmaster should be warned, when still a considerable distance away, of his approach to land. This has been done for some years by wireless telegraphy, but it is only recently that it has become possible to add to the warning a statement of the actual position of the ship at the time of sending.

The speed of transmission at moderate distances, and the reliability of a wireless connection, are now both as good as the same qualities in an ordinary land wire. A proof is given by the abolition of the Post Office wire from Hunstanton to Skegness, since wireless stations have been erected, and the fact that a speed of 90 words per minute has been attained between these stations. The means of preventing interferences between neighbouring stations have been developed to such good effect in the last few years that it is now possible, as experience shows, to construct apparatus which will respond only to waves which do not differ by more than about 4 per cent. from the proper wave length for the station. An even greater sharpness in tuning has indeed been claimed by various workers, and may very probably have been obtained. A margin of 4 per cent. is, however, sufficient to render possible the efficient working of a very large number of stations in a comparatively small area without interference. The actual wave lengths to be used by ships and shore stations have been fixed in some countries; and in all which are parties to the International Convention, the wave lengths from 600 to 1,600 metres are reserved for naval purposes; wave lengths below 600 metres being available for short distance stations, and those above 1,600 metres for long range stations. The usual wave length for short distance stations (*i.e.*, under 100 miles range) is about 400 metres. The German long distance station at Nauen uses wave lengths of 2,000 metres; Poldhu (Marconi) of about 2,500 metres, and Clifden of about 4,300 metres.

The Paper concluded with a short reference to the progress of wireless telephony in the American navy, and a table of wireless telegraph stations in the United Kingdom, similar to that given in ELECTRICAL ENGINEERING, November 28th, page 841, was given in an appendix.

THE WESTINGHOUSE METAL FILAMENT LAMP PATENT

A PATENT of considerable interest, published last Friday by the Patent Office, is No. 18,923 of 1907, taken out by the Westinghouse Metal Filament Lamp Co., Ltd.

The invention relates to improvements in the methods of securing metallic filaments of incandescent electric lamps to their leading-in conductors by the use of a metal alloy serving as solder, produced at the junctions of the filaments with the leading-in conductors, and also involves a novel process for producing the same.

By this method the filament is durably fastened in intimate contact with the leading-in conductor.

The process is based upon the fact that certain metals, such as aluminium, magnesium, calcium, cerium, and the like, have the characteristic property of giving out energy when combined with oxygen, for which they possess a great affinity.

When, therefore, a metallic oxide is mixed with aluminium, magnesium, or other similar metal, and the mass is heated at one point, the reaction is initiated and will then continue without further assistance. Inasmuch as the reaction gives out considerable heat, bodies, especially metallic ones if introduced into such a mixture, can be highly heated, and under proper conditions can even be brought to their melting point.

The invention is carried out in the following manner :—

The ends of the leading-in conductors are provided with hooks or loops, or other suitable means for receiving the filaments, and the filaments are thrust into or secured to these. A mixture is prepared of metal oxides, preferably of such metals as are to be fused together, and to these oxides, aluminium or magnesium, calcium, cerium, &c., is added, as nearly as practicable in equi-molecular proportions, with a suitable liquid or flux, and the connecting points are covered with this mixture, carefully dried and heated to initiate the reaction; this can be effected by means of the electric current or with the help of any other heating source.

The liquid or flux employed should be such as will not exercise an injurious effect upon the material, thus, for example, with calcium instead of water, alcohol, or some other organic compound should be used, and on the other hand with aluminium, a solution of mercuric chloride or some other suitable salt of mercury may be used.

The reaction which takes place proceeds in the well-known manner, and by reason of its positive or exothermic nature, causes the bodies to be combined to fuse together into an alloy which constitutes a reliable contact. In the course of the reaction, oxide of aluminium, magnesium, &c., is also produced, which forms a film on the outside of the joint. This does not in any way affect the conductivity of the joint, and may easily be removed if desired by dipping into hydrochloric acid.

The claims are :

1. A durable conducting connection between the metallic filaments of incandescent electric lamps and the leading-in conductors consisting of a metallic alloy produced at the point of connection.

2. A process for producing a durable conducting connection between the filaments and the leading-in conductors of incandescent electric lamps consisting in covering the junction of the filament and leading-in conductor with a mixture of one or more metallic oxides and metals which combine with oxygen with evolution of heat, with or without the addition of a suitable liquid or flux, then drying, and finally heating the same for the purpose of initiating the reaction.

4. A process for producing a durable conducting connection between the filaments and the leading-in conductors of incandescent electric lamps in which the oxides of those metals of which the filament and the leading-in conductors consist are mixed with aluminium, or magnesium, calcium, cerium, or the like, preferably in equi-molecular proportions, and applied to the joint, being afterwards heated to initiate the reaction.

Wireless Telegraphy.—It is announced that a complete wireless telegraph service will be installed during January between Marseilles and Algiers.

Telephones for Submarines.—A telgram from Cherbourg to the *Eclair* (Paris) states that as the result of experiments carried out in the first Channel flotilla with a view to providing submarines with buoys fitted with telephonic apparatus in order to enable the crews to communicate with the surface in case of accident, the Minister of Marine, after hearing the evidence of the Technical Committee, has ordered the adoption of metallic floats of great buoyancy, and capable of withstanding the pressure of water at a depth of fifty metres. These floats have been experimented with at Cherbourg on the submersible boat Aigrette, and when practicable they will be fitted to all vessels in commission or in the dockyards as speedily as possible.

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THE ELECTRICAL EQUIPMENT OF THE BURBACHER-HÜTTE IRON AND STEEL WORKS

THE introduction of the large gas-engine for the utilisation of blast-furnace gases has, especially in Germany, given a great impetus by the cheapening of power production to the application of electric driving in iron and steel works. An interesting example of an equipment of this nature is found in that of the Burbacher-Hütte, of which, through the courtesy of the Siemens-Schuckert Company, we are able to give some illustrations.

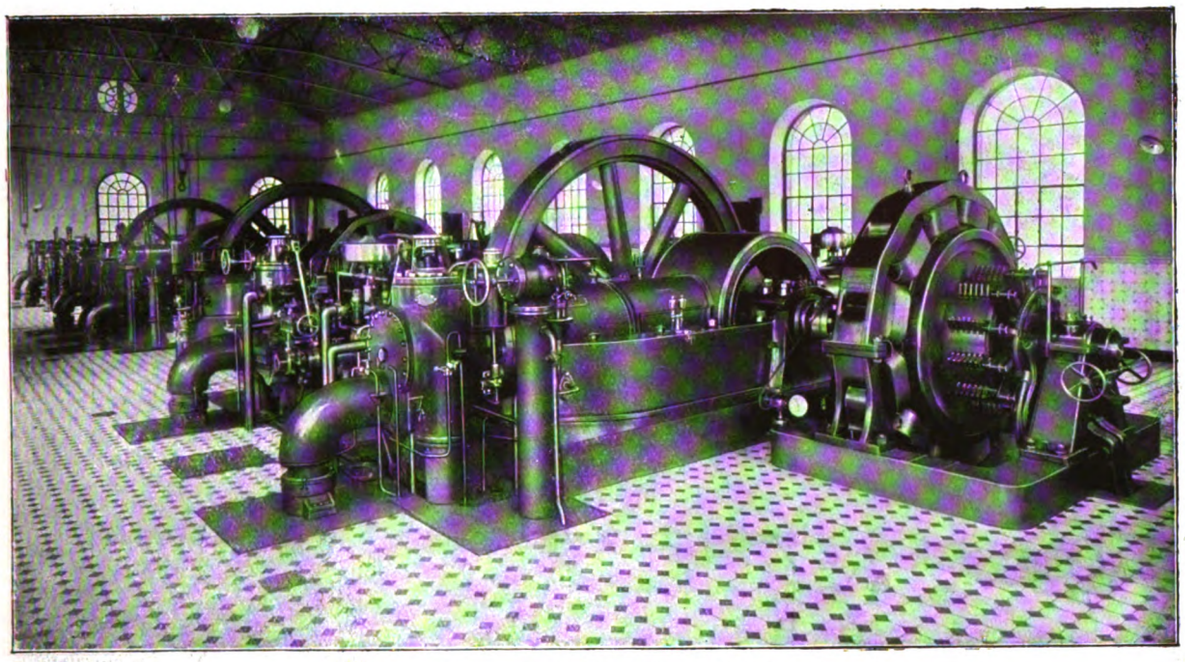


FIG 1.—OLDER GAS-DRIVEN GENERATING STATION.

In Fig. 1 is shown a view of the interior of the older power station, in which are installed three blast-furnace gas-engines of the Deutz type, to each of which is direct coupled a continuous-current dynamo. The output of each set is 1,740 amperes at 240 volts, or about 420 kw., and they run at a speed of 140 r.p.m. The current from these machines is taken through cables placed under the engine-room floor to a four-panel switchboard not shown in the illustrations.

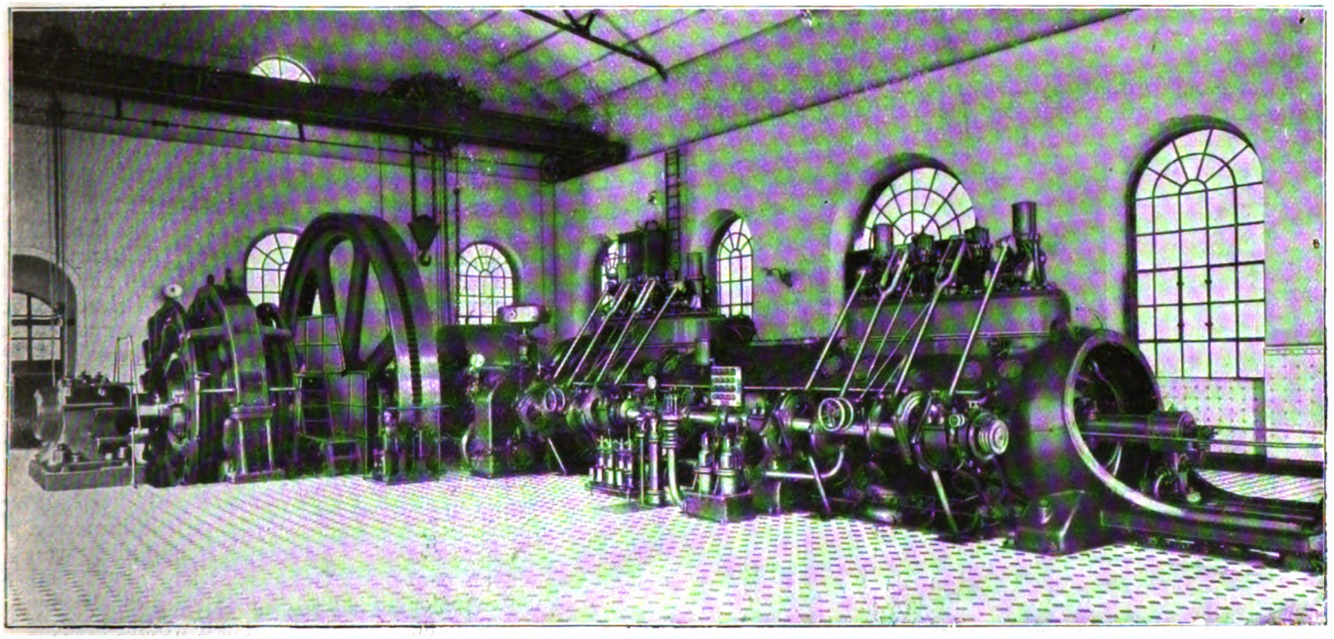


FIG. 2.—NEW GENERATING PLANT.

On account of the extensions in the adoption of electrical driving in the Burbacher Steel Works during 1906, it became necessary to provide further generating plant, and accordingly an entirely new power house

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was built of ample size for dealing with present and future extensions. The new station was, first of all, set to work with a single generating set, consisting of a continuous-current dynamo directly coupled to a large tandem gas engine by the Augsburg-Nurnburg



FIG. 4.—CONTROLLERS FOR MOTORS OF LIVE ROLLS AND TRAVERSING TABLE.

Co., also running on blast-furnace gas. The electrical portion of plant, as in the older station, was supplied by the Siemens-Schuckert Co. An illustration of the set is given in Fig. 2. The dynamo is a two-commutator three-wire machine, following a practice more common on the Continent than in this country. It is designed for 2 × 240 volts and 2 × 2,045 amperes, or 980 kw., and runs at 100 r.p.m., which is about the usual speed of gas engines of this size and type.

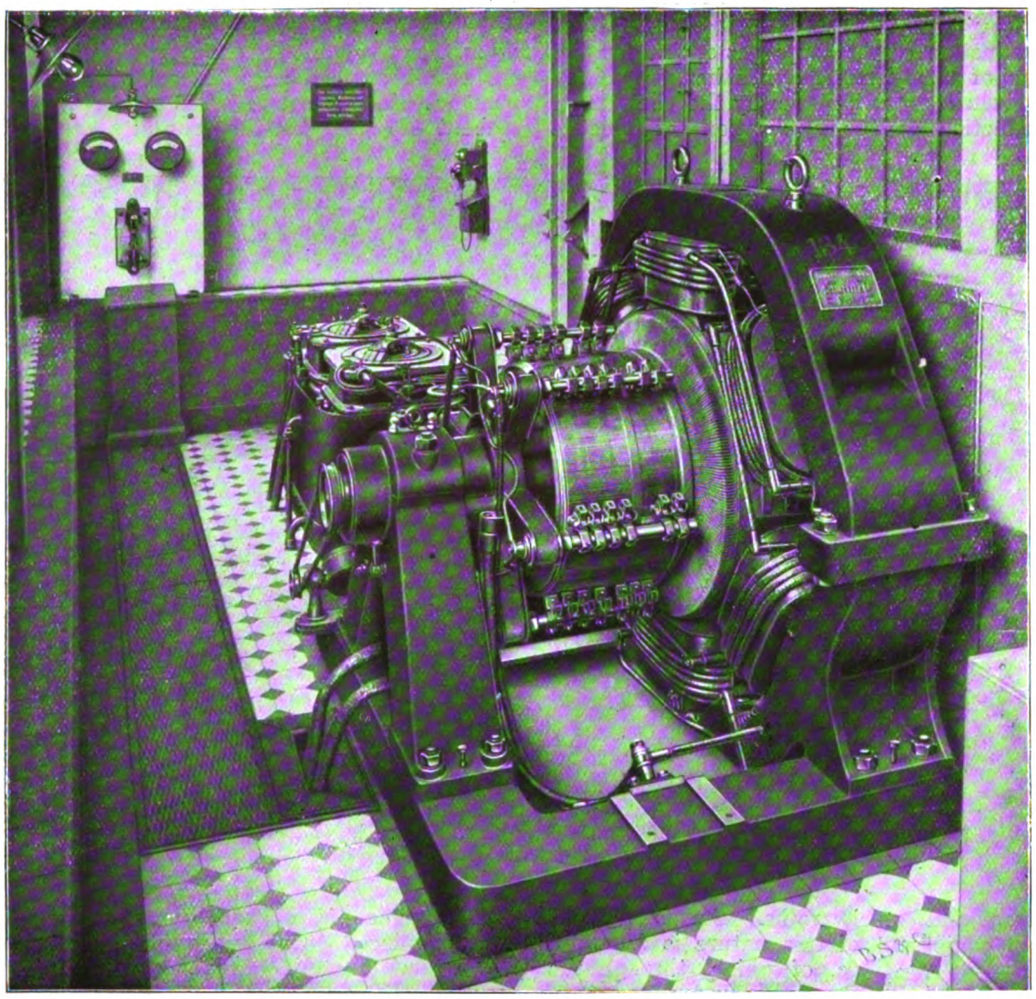


FIG. 3.—MOTOR FOR ROLLING MILL.

In order to further increase the output of this station a set was ordered, to be driven by a steam turbine of the Augsburg-Nurnburg Co.'s manufacture, with a capacity of 1,250 h.p., and running at 1,550 r.p.m. The electrical part of this set, which by this time is probably running, consists of two Siemens-Schuckert generators each for an output of 420 kw., coupled in tandem. These generators, like that of the large gas-driven set, are two-commutator machines for 2 × 240 volts. By means of this arrangement it is possible to supplement to same circuits as supplied by the old 240-volt station, and to also take advantage of the increased economy of the higher voltage between the outers.

The Burbacher-Hütte was one of the first iron and steel works where electrical driving of rolling mills was adopted. As an example of the electrically-equipped mill may be mentioned a set of fine rolls driven by the 6-pole continuous-current compound-wound motor, shown in Fig. 3. This motor has a continuous rating of 410 h.p., but can exert 800 h.p. for short periods to overcome the sudden demands for power often made by the conditions of rolling-mill work. The cycle of operations of this particular mill requires a certain amount of speed variation of the rolls. This is effected entirely by regulation of the current in the shunt

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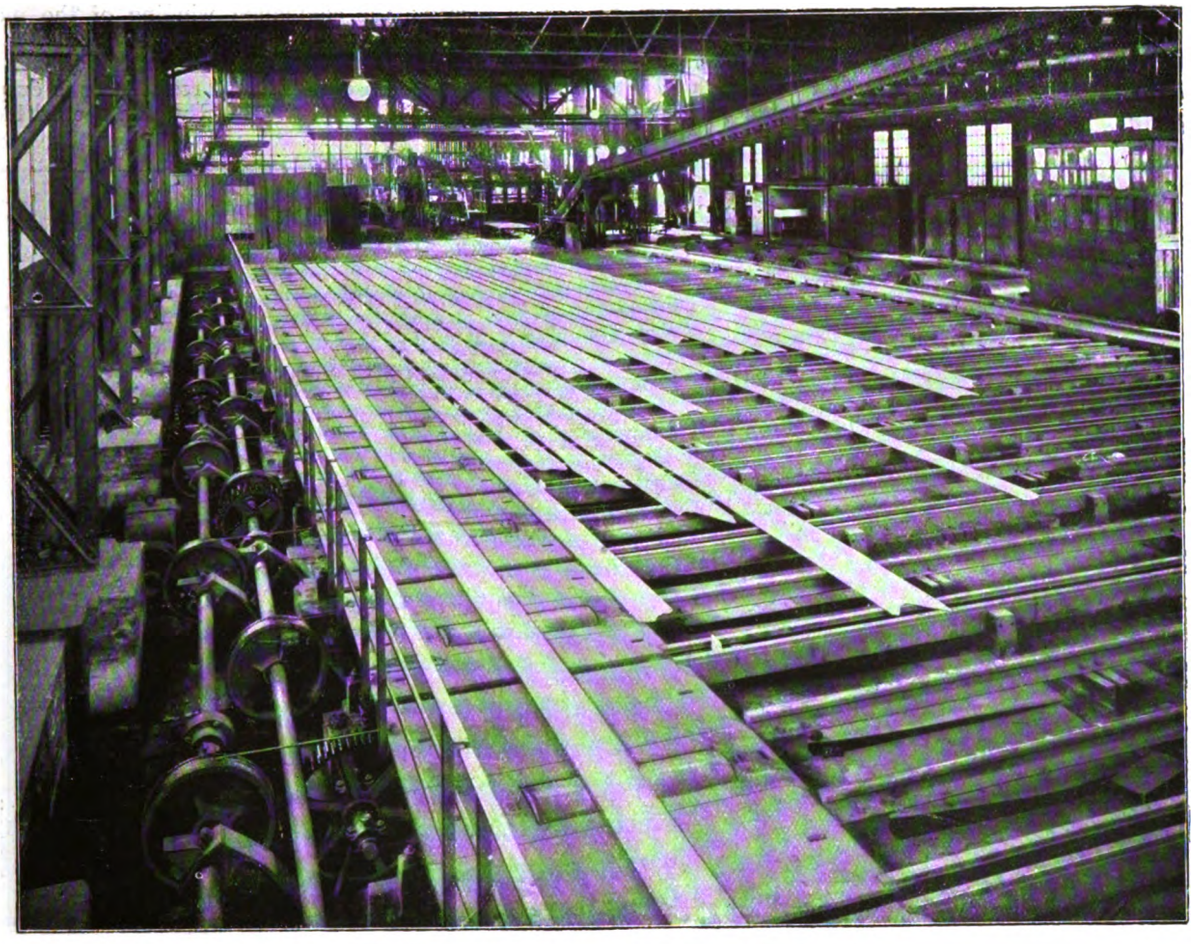


FIG. 5.—LIVE ROLLS AND TRAVERSING TABLE.

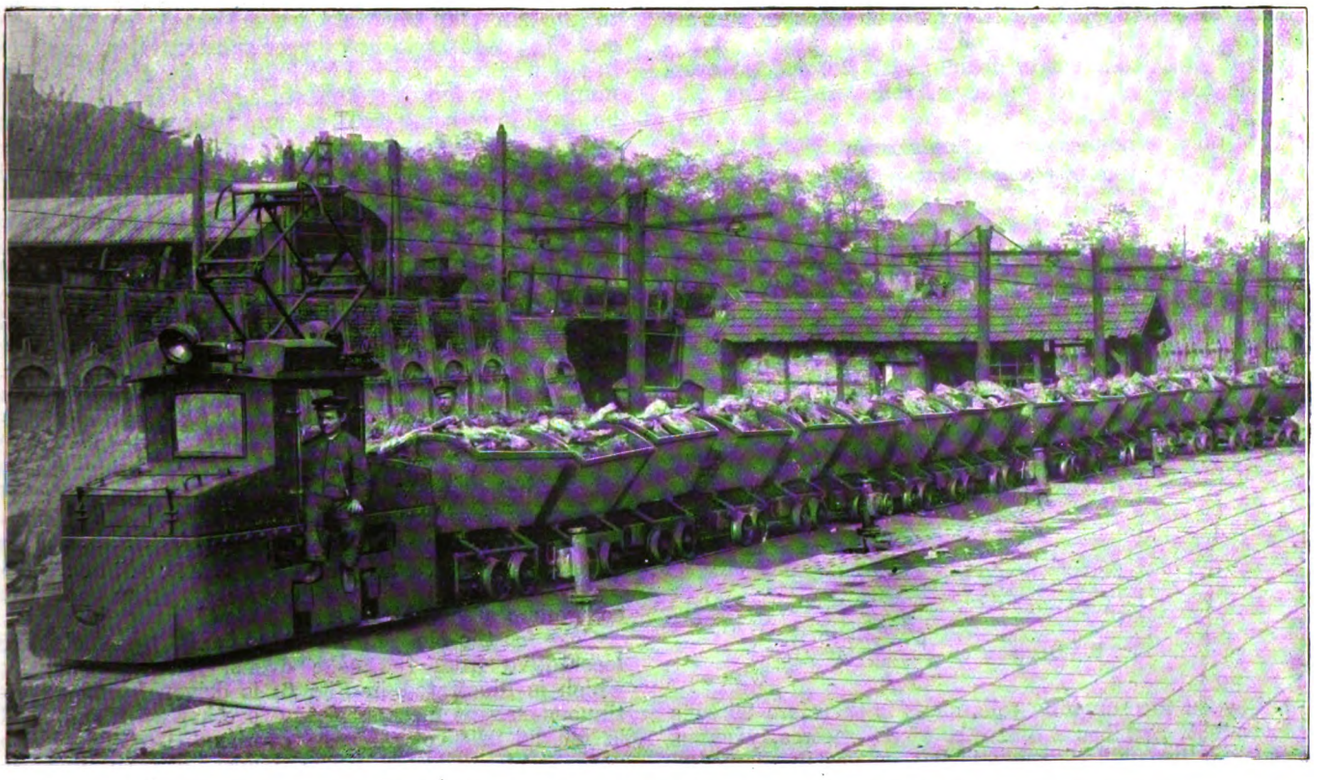


FIG. 6.—ELECTRIC LOCOMOTIVE FOR TRANSPORT OF COKE.

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winding by means of a rheostat of sufficient size to regulate the speed between the limits of 230 and 300 r.p.m. The motor is coupled directly to the high-speed series of finishing rolls through a leather belt flexible coupling of the Zodel-Voith type. The slower-running

this reason: the compound winding of the motor is proportioned so that when running light the speed is about 10 per cent. higher than at full load.

A starter with oil-immersed resistances is employed, the contacts of which are fitted with a special blow-out

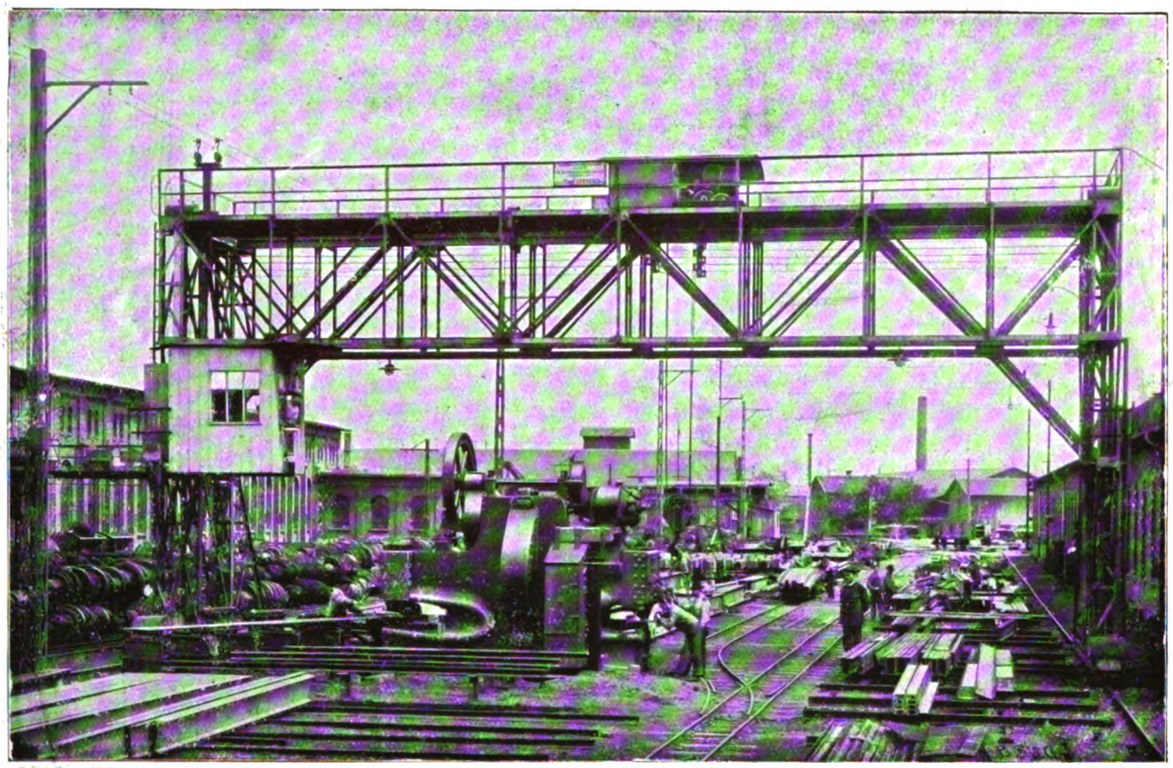


FIG. 7.—PUNCHING AND SHEARING MACHINE AND ELECTRIC CRANE.

roughing rolls are rope driven from the shaft of the finishing rolls by seven 47-mm. ropes of square section. Both the pulleys on which these ropes run are specially heavily built in order to give plenty of fly-wheel effect to assist in dealing with the sudden overloads to which both trains of rolls are liable. The

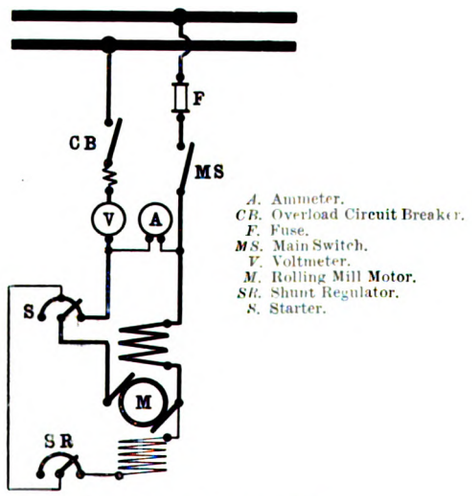


FIG. 8.—DIAGRAM OF CONNECTIONS.

pulley on the roughing rolls shaft is therefore 35 tons in weight, and has a diameter of 6·5 metres, whereas the smaller pulley, which is 2·6 metres in diameter, weighs 7·5 tons. For a satisfactory utilisation of the fly-wheel effect it is necessary that the speed-running light load be higher than when heavily loaded, and for

arrangement. The conditions at starting are, of course, much more severe than in most classes of work, owing to the large masses to be accelerated, so that the starting gear has to be of very substantial proportions in order to carry the full load current for a considerable number of minutes. The starter is also designed to be capable of being used at frequent intervals without overheating. The arrangement of connections of the motor switch gear is shown in Fig. 8. A circuit breaker with overload release is included in one pole of the armature circuit to protect the motor from excessive overloads. Electrically-driven shears between the roughing and finishing rolls cut off the material into convenient lengths. The mill is capable of dealing with billets from 80 to 200 kilogrammes in weight and 130 mm. × 130 mm. section, and is employed to produce round or square bars from 8 mm. to 45 mm. diameter, strip up to 60 mm. in width, and various other profiles such as angle-iron, tee-iron, and channel-iron in the smaller sizes, in quantities from 20 to 50 tons per 12-hour shift. Enclosed reversing series wound motors are used to drive the various trains of live rolls and traversing tables, on account of the high-starting torque required. One of these is shown in Fig. 5. The motors are controlled from a raised platform having a full view of the work. Some of the controllers are shown in Fig. 4.

Coke for the blast furnaces is brought by an electric locomotive from the coke ovens. This locomotive, which is illustrated in Fig. 6, is driven by two continuous-current motors, giving together 25 b.h.p., and is fed at 220 volts by an overhead line through a pantagraph collector. The gauge of the line is 630 mm., and its length is about 1·8 kilometres. A considerable number of these locomotives are in use for the transport of ore, coal, and other materials.

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Further applications of electrical driving are shown in Fig. 7, which illustrates a shearing and punching machine in the open air, driven by a 20-b.h.p. 220-volt compound-wound motor, and served by a travelling electric crane. The total number of motors installed in the works is 290, giving, in the aggregate, 2,550 h.p. For the lighting, over 4,000 incandescent lamps, and 300 arc lamps are employed.

BRAKE GEAR DESIGN

A PAPER by Mr. F. Heckler was read recently before the American Central Electric Railway Association dealing with some mechanical points in the design of brake gear for electric railway and tramway cars, and considering more particularly brakes worked by compressed air. An abstract of the Paper is given in the *Street Railway Journal* (New York).

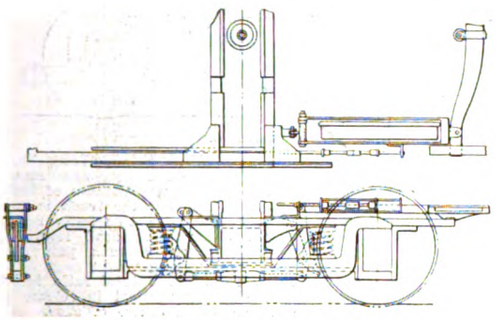


FIG. 1.

Truck and Brake Design. Merits: 1. Inside hung brake shoes. 2. Equalised brake leverage system, so that unequal shoe clearance will not throw all the pressure on one pair of wheels. 3. Radius bar connection to live truck levers. Besides its use on curves the radius bar construction eliminates the great deflection of weak brake beams, due to the truck levers acting at their centre.

Demerits: 1. High truck leverage ratio. The total ratio is 7.22 to 1, and necessitates a large movement of the live truck levers in setting the brake shoes, with consequent danger of fouling something. The multiplication can readily be made in the car-body levers where there is greater clearance room. The total truck lever ratio should not exceed 6 to 1. 2. Angle of live truck levers almost vertical in release position.—If lever is too near vertical in release position, it assumes a bad angle when brake shoes are set up against wheels. 3. Available movement of radius bar too limited. 4. Brake shoes hung slightly too far below the centre of wheels.—This will increase in proportion to the load. 5. Dead lever dimensions not of the same proportion as those of the live truck levers.—One pound applied at the middle of radius bar gives 3.53 pounds pressure at the live lever brake shoes, and 3.69 pounds at the dead lever shoes. This results in unequal shoe wear, and also makes it impossible to use the best percentage of braking power on both pairs of wheels.

The brake is usually looked upon as a safety device only, and it is because of the prevalence of this idea that the installation and maintenance does not receive the consideration it merits. There is no part of the railway equipment that will give greater material returns than the brake when properly installed, operated, and maintained. Its importance would be more fully appreciated if we could eliminate the idea that it is a safety device only, and show that it makes possible the hauling of heavier cars, and faster and more frequent service as much or more than the high-power motor, the signals, and the good roadbed. If given the consideration it should have, it would increase the possibilities of all these things. Therefore, at least the same consideration should be given to its design and installation that is accorded to other parts of railway equipment. The magnitude of the problem can be seen when the thought is kept in mind that the brake has often to do in seconds what it has taken the motive power minutes to accomplish, and that it is far more important to be able to stop a car than to start it. No matter how perfect and well maintained the apparatus may be, a great part of the brake efficiency may be lost by improper design of foundation brake gear, which condition will continue to exist until the brake ceases to be looked upon as a necessary evil. When it is realised that the brake equipment is not merely a necessary expenditure, but a dividend-earning asset, then sufficient pressure will be brought to bear on the car and truck designers and builders to induce them to consider the brake installation before it becomes impossible to put on one that will even merit the name of a brake in the true sense of the word.

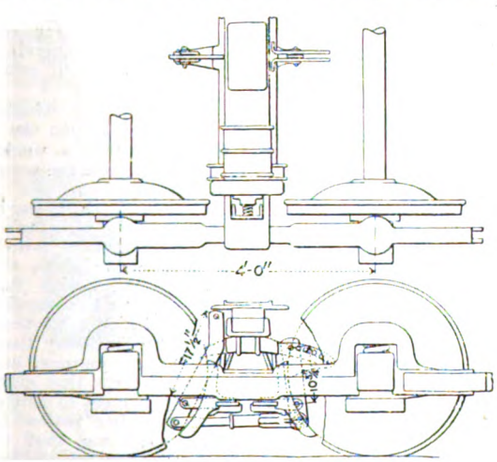


FIG. 2.

Truck and Brake Design. Merits: 1. Inside hung brake shoes. 2. Equalised brake leverage system.

Demerits: 1. Very high leverage ratio. The total ratio is 10.96 to 1. 2. Brake shoes hung somewhat too far below centre of wheels. 3. Dead lever dimensions not of the same proportion as those of the live truck lever.—One pound applied at the top of the live lever gives 5.37 pounds pressure at the live lever brake shoes and 5.59 pounds at the dead lever shoes. 4. Dead lever fulcrum should be horizontal instead of curved. 5. Dead lever is too short, thereby assuming a bad angle with the brakes set, especially with worn shoes. 6. Angle of main truck lever too near the vertical in release position.

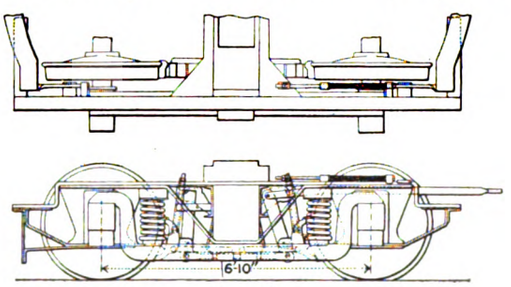


FIG. 3.

Truck and Brake Design. Merits: 1. Inside hung brake shoes. 2. Equalised brake leverage system. 3. Good angle of live lever in release position. 4. Radius bar connection to live truck levers.

Demerits: 1. Very high truck lever ratio. The total ratio is 9.85 to 1. 2. Dead lever dimensions not of the same proportion as those of the live truck lever.—One pound applied at the middle of radius bar gives 5 pounds pressure at the live lever brake shoes and 4.8 pounds at the dead lever shoes. 3. Brake shoes hung somewhat too far below centre of wheels. 4. The suspension is at upper end of shoe instead of at centre of same.

The brakes should be given equal consideration with the other necessary points of design, for at all times much money will be made thereby, and there are times when not money, but life and limb, become the measure of this value.

Coming to the mechanical requirements of the foundation brake gear, the most desirable features in connection with this

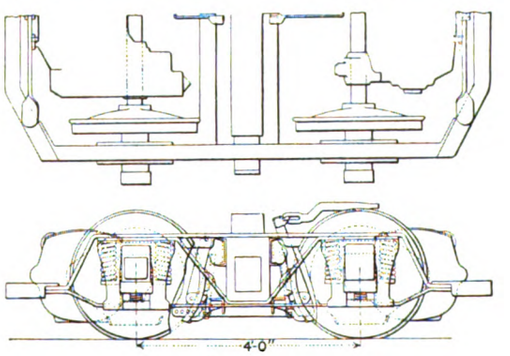


FIG. 4.

Truck and Brake Design. Merits: 1. Inside hung brake shoes. 2. Equalised brake leverage system. 3. Good angle of live lever in release position.

Demerits: 1. Very high leverage ratio.—The total ratio is 10.8 to 1. 2. Brake shoes hung somewhat too far below centre of wheels. 3. Dead lever dimensions not of the same proportion as those of the live truck lever.—One pound applied at the top of the live lever gives 5.33 pounds pressure at the live lever brake shoes and 5.46 pounds at the dead lever shoes. 4. Shoe hangers so straight as to preclude proper release by gravity action when pressure is removed.

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matter are a motor truck that will permit a brake design providing a low truck leverage ratio and a clear movement of the same for the entire wearing out of the brake shoes of, say, 1½ in. thick; also provision in motor truck construction for the best location of the brake shoes on the wheel and the suspension of the brake head or beam hangers at a proper angle, and at such a point on the truck as will maintain a standard location of the shoes on the wheel, regardless of whether the car is light or loaded. These recommendations also apply to the car builders who, in many cases, so design the car body portion of the foundation brake that the harmonious working of the hand and air brakes is not possible. In fact, it is seldom that a car and truck design can be found upon which even a passable brake installation can be made.

To the end that improvement be made in this direction, the following suggestions are offered. In the design of the car and truck ample space should be allowed for the application of the proper brake equipment and a suitable foundation brake gear right down to the brake shoes.

Sufficient clearance should be allowed to permit of the wearing out of the shoe, and, in the event of piston travel adjustment being neglected, the piston should strike the cylinder head before the radius bar or levers foul.

While a total leverage of from 9 to 1 to 12 to 1 is proper, yet

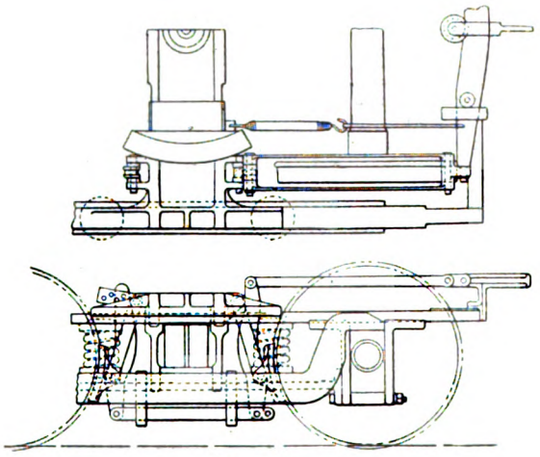


FIG. 5.

Truck and Brake Design. Merits: 1. Inside hung brake shoes. 2. Equalised brake leverage system. 3. Radius bar connection to live truck levers. Demerits: 1. High truck leverage ratio.—The total ratio is 7.5 to 1. 2. Angle of live truck levers too near the vertical in release position. 3. Available movement of radius bar in guide too limited. 4. Brake shoes hung slightly too far below the centre of wheels. 5. Dead lever dimensions not of the same proportion as those of the live truck levers.—One pound applied at the middle of radius bar gives 3.7 pounds pressure at the live lever brake shoes, and 3.8 pounds at the dead lever shoes.

the total truck leverage ratio should not exceed 6 to 1, *i.e.*, one lb. exertion on truck pull rod should not give more than 6 lb. of force distributed at the four wheel shoes. This means a ratio of 3 to 1 for each truck lever, but 2½ to 1, or a total truck leverage ratio of 5 to 1, is preferable. This because when it is exceeded, the travel of the top end of the lever becomes great as compared with shoe wear; also, the shoe has to be placed very low on the wheel, besides the danger of the lever fouling on the shoe; also the lower the ratio the less change of lever angle for a given shoe wear.

Proper provision should be made for maintaining as near a uniform piston travel as practicable, that (1) the air consumption may be kept low; (2) that uniform braking power may always be had; and (3) a brake of full power assured at all times.

All truck levers, brake beams, clevises, pins, and rods for truck should be made strong enough to withstand safely the stresses produced with a total braking power on the shoes equal in lb. to the maximum weight of car for which the truck is suitable. This also applies to car-body pins, rods, and levers.

The following points should also be considered:—Release springs of proper strength; thickness, area, and friction of brake shoes; the ratio of leverage to allow for motor and idle axles, ample provision for take up of shoe wear, slack, &c.; elimination as far as possible of lost motion in journal boxes, pin holes, centre plates, &c.; reasonably long truck centres to admit of proper connection of body levers to truck levers by means of pull rods; the equalisation and gearing ratio of the hand brake, so that a large force can be applied to the hand brake chain with small amount of chain to be wrapped up.

Attached are drawings showing designs for truck with brake rigging. These are intended to give some idea of what should be considered in the design as well as to show that many things have not been considered, and for easy references the defects and merits have been printed thereon. Some of them show that the efficiency of even a good brake may be reduced to a minimum and become a source of trouble and loss. Others show that what the brake is expected to do is more nearly

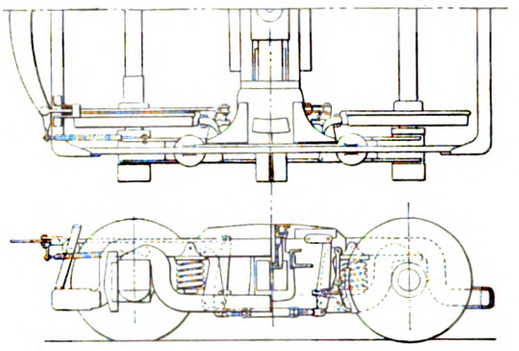


FIG. 6.

Truck and Brake Design. Merits: 1. Brake shoes hung the proper amount below centre of wheels. 2. Brake shoe hanger bracket supported by the equaliser bars.—With this construction the distance of brake shoes below centre of wheel remains constant, whether the truck is supporting the car body and its varying load, or not. 3. Inside hung brake shoes. 4. Equalised brake leverage system. 5. Live and dead levers of same proportion, thus giving same shoe pressure on each pair of wheels. 6. Radius bar connection to live truck levers.

Demerits: 1. High truck leverage ratio.—This total ratio is 7.48 to 1. 2. Angles of live truck levers too near the vertical in release position. 3. Shoe hanger connected above instead of at centre of shoe.

NOTE.—Absence of the thickness and width of truck levers, rods, &c., makes it impossible to figure the strength of the brake rigging, but on electric railway trucks, generally, it is almost invariably too weak, with consequent deflection, and often failure of the brake rigging.

approximated, care and maintenance reduced a minimum, and troubles eliminated.

It is to be regretted that we do not have more desirable truck designs, but they are so scarce as to be practically unobtainable, while undesirable designs can be seen under any car you may care to examine. As these problems are physical, mathematical, and mechanical, it is certainly not beyond the range of possibility that they may be solved in a way that will be satisfactory to the car and truck builders, profitable to the railway companies, and more conducive to the comfort and safety of the public.

The Electrification of the Victorian Railways.—Mail advices received on Saturday state that on November 26th a conference took place in Melbourne between the Federal Postmaster-General, the Chairman of the Victorian Railway Commissioners, and Mr. Merz, the Consulting Electrical Engineer to the Victorian Government. The last named made it clear that the electrification of the suburban railway lines would be begun very soon, and that the effect of the installation of the electric traction plant would render the telephone service, as it at present exists, practically useless, and that an expense of £100,000 would have to be incurred by the postal authorities to instal a complete metallic circuit. Mr. Mauger (the Postmaster-General) stated that he would recommend the Federal Cabinet to consent to the necessary work being carried out.

L.C.C. Tramway Accidents.—Two tramway accidents, fortunately not attended with loss of life, occurred upon the system of the London County Council during Christmas week. The first, and most serious of the two, took place on the evening of Christmas Day, when a covered top deck car got out of control soon after commencing the long descent which starts near the reservoirs in Pentonville Road and ends at King's Cross Station. Pending the Board of Trade inquiry, which will probably be delayed somewhat owing to the holidays, the only reason assigned for the accident is that the brakes failed to act. The work of converting the tramways in Pentonville Road is not completed beyond King's Cross Station, and this point has temporarily formed the terminus. Consequently there was another car there preparing for the return journey, and into this the runaway car crashed with such force that eight passengers were more or less injured, although none so badly as to necessitate lengthy detention in hospital. One reason for the comparative immunity from serious injury was that the car kept the metals, and an extraordinary feature of the collision was that the driver of the runaway car, who stuck to his post, was practically uninjured. All the passengers on the stationary car were warned in time to enable them to get to a place of safety. The other accident referred to above happened on Friday, when an electric car from Stamford Hill to Moorgate Street crashed into a horsedrawn tramcar going to Green Lanes at the junction of City Road and Old Street, and here, again, a few people were injured. In this case the collision appears to have been due to the misjudging of distance by one or both drivers.

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MERCURY-VAPOUR LAMPS FOR CONTINUOUS CURRENTS

THE Cooper-Hewitt mercury vapour lamp is becoming well known in this country since its introduction by the British Westinghouse Company, but a few particulars relating to the working of the latest continuous-current type may be of interest.

All the forms consist essentially of a sealed glass tube containing a small quantity of pure mercury. Normally the lamp-tube is slightly inclined, and the mercury remains in a pocket at the lower end, where contact is made with it by a platinum



FIG. 1.—COMBINED TYPE MERCURY VAPOUR LAMP.

leading in wire connected to the negative side of the circuit. The arc is started, and the lamp lighted by tilting it momentarily to allow a small quantity of mercury to flow along the tube.

The lamps may be arranged for running singly or two, three, or more, according to the voltage of the circuit. The current taken by all sizes is 3½ amperes, and the three standard lengths of tube of 18, 22, and 45 inches give 300, 350, and 700 candle-power respectively. Each lamp is connected in circuit through a combined inductive and non-inductive resistance, this being

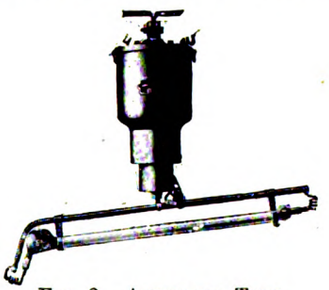


FIG. 2.—AUTOMATIC TYPE.

provided with an automatic shunting device when two or more lamps are to be connected in series, to render each lamp independent of its neighbours. The two chief varieties of lamp are the "combined" and "separate" types. In the former, the resistance coils are contained within the case from which the lamp-holder and lamp are suspended, whereas in the latter type the lamp and resistance are separate.

Another modification is the automatic lamp, in which the tube is tilted automatically by the action of a solenoid when the current

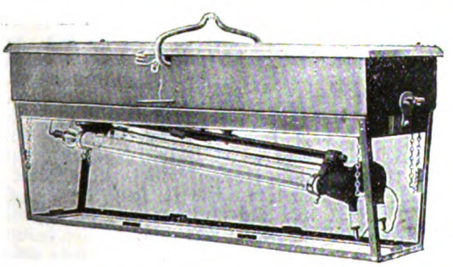


FIG. 3.—AUTOMATIC DOUBLE TUBE TYPE IN LANTERN.

is switched on instead of the lamp having to be tilted by hand. Some of these varieties, including a double tube lamp in a lantern for outdoor use, are shown in Figs. 1 to 4. The three lengths given above, in the case of non-automatic lamps, may be adjusted between the following respective limits of terminal voltage, 50 to 65 volts, 55 to 75 volts, and 100 to 125 volts. The automatic lamps require a slightly higher voltage.

It is of importance in fixing the lamps that the supports should be rigid, so as not to allow of swinging of the lamp, and, of course, care has to be taken to connect the positive and negative poles correctly. Provision is made for adjusting the series resistances so that the lamp takes the current for which it is designed on the particular circuit where it is used. It is well to put an ammeter in circuit and repeat the adjustment whenever a new tube is put into the lamp.

A cross section of the rheostat of a non-automatic lamp suitable for running in series is given in Fig. 5, and a diagram of

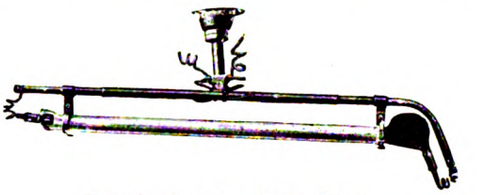


FIG. 4.—SEPARATE TYPE LAMP.

connections of two lamps running in series is shown in Fig. 6. It will be noticed that there are two resistance slides. The one on the right is for the regulation of the shunt current, and is so set that at the normal line voltage the current through the shunt before the lamp is lighted is 3½ amperes. After the lamp is lighted, the adjustment of the main circuit is made by the other slide. The connections of the automatic type of lamp are practically similar with the addition of the solenoid coil for effecting the tilting of the lamp. The shunter contact is arranged to cut the solenoid out of circuit as soon as the lamp lights up. To extinguish the lamp, nothing further has to be done beyond turning off the switch.

The latest pattern of rheostat for use with separate type lamps is shown in Fig. 7, in which the inductance on the left

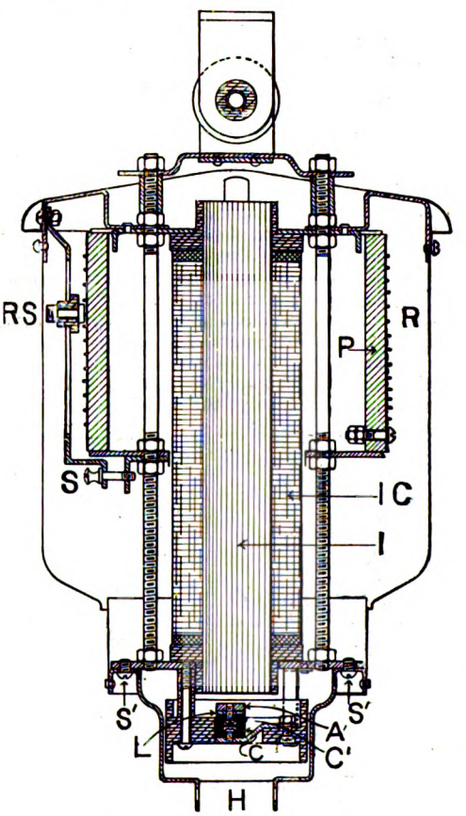


FIG. 5.—CROSS-SECTION OF SERIES RHEOSTAT NON-AUTOMATIC TYPE.

and the resistances with their contact slides on the right are clearly seen together with the shunting mechanism below.

The satisfactory working of these lamps depends very largely on the position of what is known as the "disintegrating point," which is the point at which the current enters the surface of the mercury. This point is continually moving to and fro on the surface of the mercury, and is of very high temperature. The good working of the lamp depends on the purity of the mercury

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vapour contained therein—that is to say, on the absence of all other gases. In the course of manufacture, the foreign gases (air, &c.) are expelled to as great a degree as possible, but a certain small quantity is always retained by the leading-in wires and the positive electrode.

As long as the lamp works under normal conditions, these solid metal parts do not get very hot, and the occluded gases will not be given off from them. Should the lamp be improperly manipulated, however, overheating of these parts is liable to occur, and in such cases the vacuum of the lamp will be impaired by the liberated gases.

Practically the only way in which this overheating of the metal parts can be brought about is by allowing the disintegrat-

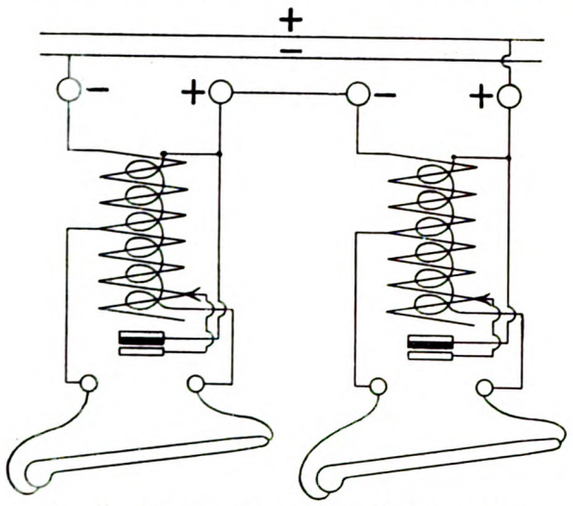


FIG. 6.—CONNECTIONS FOR TWO NON-AUTOMATIC LAMPS IN SERIES.

ing point to attach itself to one of them. The disintegrating point, which—as already mentioned—is at the negative end of the lamp and is of an extremely high temperature, is consequently apt to heat the solid metal very quickly.

To guard against the heating of the lamp electrodes in this way care must be taken that the polarity of the lamp is never reversed, as this would result in the formation of the disintegrating point on the iron electrode at the top end of the lamp. There must also be a sufficient depth of mercury at the negative electrode to ensure its being always covered up, even when the lamp is tilted. For this reason a stop is placed on the holder to prevent the lamp being tilted too far. But, of course, if the lamp is tilted violently, too much mercury may run over.

The disintegrating point enters the surface of the mercury to a depth of about $\frac{3}{64}$ in. In the normal running position there is a protective depth of mercury of about $1\frac{3}{16}$ in., and in the lighting position, that is to say, the position assumed when the

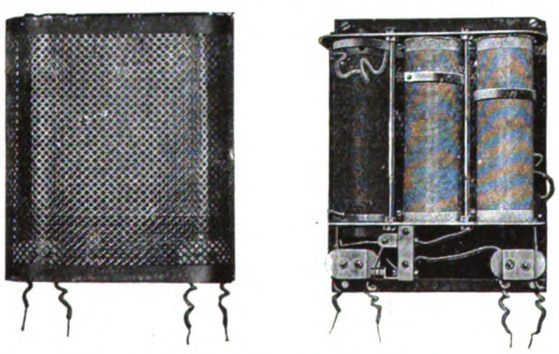


FIG. 7.—SEPARATE TYPE RESISTANCE.

lamp is tilted for starting, there is a protective depth of mercury of about $\frac{5}{8}$ in. If the lamp be kept tilted more than a few seconds, enough mercury will be vaporised to allow the disintegrating point to get down to the top of the platinum wire. This shows how important it is to let the lamp come back to its normal position immediately after it is tilted. If the lamp is shaken violently the mercury is liable to leave the negative electrode exposed, thus allowing the disintegrating point to settle right on the platinum wire. If this occurs only a few times, enough gas will be liberated to spoil the lamp.

In cases where the ordinary lamp tube is fitted in a vertical position, there is a protective depth of only $\frac{3}{16}$ in. of mercury. Under this condition a very slight shifting of the mercury will be enough to allow the disintegrating point to touch the platinum wire. This explains the objection to placing the lamp tubes vertically, as is sometimes done.

The first sign of deterioration is usually that the lamp goes out easily, generally a short time after starting. Another preliminary sign of a bad lamp is that it starts up with a reddish light when cold. This phenomenon is due to the presence of foreign gases in the tube, these gases having been liberated as explained above. When the deterioration of a lamp reaches a more advanced stage, black spots appear on the tube, which finally gets blackened all over.

The normal running of the lamp is secured by :—(*a*) Having a radiating surface to the lamp that is properly proportioned to the current. (*b*) The rheostat.

The rheostat, as previously explained, consists of two essential parts, viz., an inductance or inductive resistance, and an adjustable ohmic resistance. The latter acts primarily as a "buffer" between the lamp and the circuit, in much the same way as the line resistance of an arc lamp, and it enables the current to be adjusted to its proper value. Part of it also acts as a shunt in series lamps.

The function of the *inductance* is to maintain the disintegrating point in an active condition while the lamp is running. This action is reciprocal, inasmuch as the varying resistance of the disintegrating point sets up very rapid variations of the current, with correspondingly rapid variations of voltage in the inductance coil, the effects of which react on the disintegrating point. The interaction of the inductance and the disintegrating point is so rapid that it is considerably affected by *capacity* in the circuit. This explains why it is necessary that the wires running from the rheostat to the lamps, or from lamp to lamp, should be placed at least $1\frac{1}{2}$ in. apart. If the wires are close together their capacity increases sufficiently to annul the above-described action, and the lamp cannot be kept alight.

Paris Metropolitan Railway Accident.—A Reuter telegram from Paris on Tuesday last week stated that an accident occurred on Monday on the Paris Metropolitan Railway at the Rue Lutèce, where a tunnel is being built under the Seine in connection with a new line. The message states that a partition gave way, and the rush of compressed air which resulted hurled the workmen in the caisson under the wall of another caisson, where all five men were drowned.

An Australian Power Plant.—According to the *Australian Mining Standard*, the electrical machinery for the Casilis Gold Mine (Victoria) is being pushed forward very rapidly by the A.E.G. Co., who are endeavouring to have the whole in complete working order before the middle of next year. The plant will consist of a 400 kw. 500 volt. three-phase generator, direct-coupled to a Pelton wheel, of Messrs. Voith's manufacture, capable of developing 670 b.h.p. when running at 500 r.p.m. The set will be capable of withstanding overloads of 25 per cent. The excitation will be carried out by means of a direct-coupled exciter, the voltage of which will be automatically regulated by a Tirrill regulator, so as to maintain constant voltage on the three-phase bus-bars independent of variations in the speed, power factor, or load. As a reserve for the excitation and the lighting, a small continuous-current generator of 10 kw. capacity is provided, driven by a separate Pelton wheel. The governing of these turbines will be carried out hydraulically. With the system of governing adopted, a very high efficiency will be secured at all loads, so that no waste of water will take place during periods of light load, when a storage reservoir will accumulate the surplus water. The water for driving the turbine will be taken from the Victoria River, about four miles above its junction with the Cobungra River, by means of a race about three and a half miles long, sufficiently large to carry water capable of developing 1,200 h.p. at the generating station, which is connected with the race by means of a pipe line 1,650 ft. long, composed of equal lengths of 34 in., 31 in., and 28 in. pipes, giving an effective head of slightly over 400 ft. at the inlet to the turbines. The discharge from the turbines flows immediately into the Cobungra River, at the side of which the generating station is situated. The mine and works of the Cassilis Co. are about 16 miles from the power station; the voltage is raised by means of stationary transformers to 12,000 volts, so that a transmission efficiency of about 90 per cent. is obtained. The energy transmitted from the power station will be conducted to two receiving stations—one at the works equipped with four 125 kw. single-phase transformers, and the other at the mine, with four 35 kw. transformers of the same type. The line voltage will be reduced to 500 for motors. The lighting throughout the mine and works will be carried out by special lighting transformers. The Cassilis installation is of special interest as possessing the longest transmission line in the Commonwealth, carrying the highest voltage.

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DETERMINATION OF THE MEAN HORIZONTAL CANDLE-POWER OF INCANDESCENT LAMPS

IN a Paper "On the Determination of the Mean Horizontal Intensity of Incandescent Lamps by the Rotating Lamp Method," published in the United States about a year ago (*The Electrical World*, November 17th, 1906), E. P. Hyde and F. E. Cady described an investigation, undertaken at the Bureau of Standards, of the possible errors of the rotating lamp method. This method is the one in almost universal use in the United States. Another Paper, published by Uppenborn in Munich (*Elektrotechnische Zeitschrift*, February 14th and 21st, 1907), gave results at variance with those obtained at the Bureau of Standards, and this has incited Messrs. Hyde and Cady to return to the subject and carry out further tests.

In the investigation at the Bureau a substitution method was employed, which did not necessitate a determination of the actual candle-power of the lamps studied. Any change in candle-power, due either to the bending of the filament or to the flicker could be detected and measured separately. For most of the types of filaments the effect of bending was to decrease the mean horizontal intensity, but for one type the effect was to increase it by about 1 per cent.

In Uppenborn's investigation the lamps were measured for actual mean horizontal candle-power, by taking the mean of 36 readings made every 10° in the horizontal plane. The values obtained in this way were taken as the true values, and a comparison of the candle-power values obtained by other methods with these standard values gave the errors incident to the several methods studied. In this way eight lamps of different sizes, types, and voltages were measured for mean horizontal candle-power, first by the point-to-point method, and subsequently by the rotating lamp method. A comparison of the results indicated that the values obtained by the rotating lamp method were uniformly too low, the amount of the error ranging from 3·3 to 9·9 per cent. Uppenborn attributed the errors to the distortion of the filament on rotation; but since the experiments at the Bureau had shown in no case an error much over 1 per cent. due to this cause, it seemed desirable to make some further experiments by a different method, and using lamps of other types than those previously investigated. The differences in the results obtained at the two laboratories could not have been due to differences in speed used, for in the experiments at the Bureau various speeds were employed up to 550 or 600 r.p.m., whereas in Uppenborn's work the speed of 450 or 500 r.p.m. was employed.

In the new method the lamp was placed in a universal lamp-holder which could be set at different angles, but which also could be rotated. In general, readings were made first with the lamp spinning, then at every 10° in the horizontal plane with the lamp at rest, and again with the lamp spinning. The speed was then gradually increased, in some experiments until the filament touched the bulb.

The first lamp studied was a 110-volt 16-c.p. oval anchored filament lamp, which was first rotated at about 420 r.p.m., and readings were taken. Then measurements were made every 10° in the horizontal plane with the lamp stationary, and finally the lamp was rotated again at 420 r.p.m. The results obtained by the two methods agreed to within 0·2 or 0·3 per cent., which is within the range of experimental error.

In the type of lamp which was next studied the filament consisted of two long, slender loops, entirely unsupported except at the leading-in wires. Denoting by 1·000 the value of mean horizontal candle-power obtained at the beginning at a speed of 350 r.p.m., the value found by the point-to-point method every 10° was 1·005, and the value obtained at the end at a speed of 350 r.p.m. was 0·999. This decrease of 0·5 per cent. at a speed of 350 r.p.m. was in very good agreement with that obtained in the previous investigation using the rotating mirror method. The mean of a number of determinations using this method indicated a decrease of 0·9 per cent. at a speed of 500 or 600 r.p.m.

Another lamp of the double filament type gave the following results: Mean horizontal intensity at 180 r.p.m., 1·000 at the beginning of the set of measurements, 1·003 in the middle of the set, and 0·998 at the end; by the point-to-point method 1·002, or an average decrease of 0·2 per cent., which also agreed with the values previously obtained for this type of lamp.

Having thus shown that the error at a speed of 180 r.p.m. for this type of filament is negligibly small, the two lamps were mounted successively in the rotator, and the speed was increased until the filaments touched the bulb, in order to see how large a decrease in mean horizontal intensity could be obtained with this type of lamp, and what the speed must be in order to accomplish this maximum reduction.

The maximum decrease in mean horizontal intensity obtained under any condition was about 5 per cent., when at a speed of 750 or 800 r.p.m., the two loops of the filament were each separately touching the bulb, one at one side and one at the other. In no case did the decrease amount to more than 1·5 per cent. so long as the filament did not touch the bulb, but as each loop touched, a decrease in candle-power resulted. The investigators point out that on touching the bulb the filament is cooled, and so a decrease in candle-power is to be expected. Moreover, the amount of the cooling, and, consequently, the decrease in candle-power, depends upon whether the filament touches in only one point, or whether it lies against the glass for an appreciable part of its length, so that the decrease in candle-power is not always the same when a filament touches the bulb.

The double filament lamp seemed to represent one of the worst cases for high-speed rotation, but the large errors found by Uppenborn were obtained with filaments having a turn in them somewhat similar to the common oval anchored filament. It was, therefore, thought desirable to make some tests with lamps of this type.

The maximum error which Uppenborn obtained—9·3 per cent.—was found for a 32-c.p., 110-volt, 1½-turn oval filament with no anchor. The authors obtained two special lamps, which were identical in every respect with the regular 32-c.p., 110-volt, oval anchored lamp, except that the anchor wire was omitted, in order that the filament might be left as unstable as possible. The dimensions of the filament agreed approximately with those given by Uppenborn, the total height of the filament used at the Bureau being about 75 mm. instead of 65 mm., and the vertical axis of the oval being 50 mm. instead of 40 mm.

These two lamps were studied in the same way as the double filament lamps described above, except that the readings by the point-to-point method were made every 15° instead of every 10° as in the preceding determinations. The first lamp was first measured at different speeds up to 600 r.p.m., and the greatest change in mean horizontal candle-power, as compared with the value determined by the point-to-point method, was only 1 per cent. In these determinations the filament did not touch the bulb, although it approached close to it. Subsequently the lamp was kept at a speed of 600 r.p.m. for some minutes, and though at first the filament was separate from the bulb, it gradually spread and ultimately came into contact with the glass. Just before the filament reached the bulb the mean horizontal intensity was about 1 or 1·5 per cent. low; but after coming into contact the intensity decreased to a value 3 or 4 per cent. lower than that determined by the point-to-point method. The current also underwent a very appreciable change when the filament touched the bulb. The speed was now increased to 800 r.p.m., at which both loops were in contact with the glass. The mean horizontal intensity was found to be about 7 per cent. low, and the current to have undergone another change in the same direction as before. While rotating at the high speed of 800 r.p.m. a star crack developed and the filament burned out so that it is possible that a part of the observed 7 per cent. change in candle-power may have been due to the constantly deteriorating vacuum.

The other special 110-volt, 32-c.p. lamp showed approximately the same characteristics as the former, except that the filament touched the bulb first in one point and then in a second point, the mean horizontal intensity decreasing to about 97 per cent. of its original value as determined by the point-to-point method. The current also showed a marked change due to the cooling of the filament.

In addition to the two special 32-c.p., 110-volt lamps, two special 32-c.p., 220-volt lamps without anchors were used. The filaments were of the 2½-turn type, such as are usually provided with two anchors. Without the anchors the filaments were quite unstable and entirely unsuited for high-speed rotation. Consequently, they were forced against the bulb at the comparatively low speed of 400 or 500 r.p.m.

At speeds of 600 or 700 r.p.m., when the filaments were well over against the glass, the decrease in candle-power reached a value as high as 4 per cent. for one of the lamps; but whenever the change in candle-power was large, there was always a very appreciable change in resistance, indicating that the change in candle-power was due probably, to a large extent, to a cooling of parts of the filament. At the high speed of 675

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r.p.m. one loop was short-circuited by the next, and the filament burned out at the point of contact.

All the data obtained showed, therefore, that the maximum error observed, due to a bending of the filament was not in any case greater than 1·5 per cent., provided the filament did not actually touch the bulb. The speed of rotation necessary to force the filament against the bulb was not less than 600 r.p.m., except for the special 32-c.p., 220-volt lamps without anchors, and for these it was about 400-450 r.p.m. For most common types of lamps the speed would be much higher than 600 r.p.m. and it is probable that for some types a rupture of the filament would occur before the filament would touch the bulb. When the filament touches the bulb changes in candle-power of as much as 6 or 7 per cent. may take place, but as these large changes are always accompanied by relatively large changes in resistance, it is probable that they are due to a cooling of the filament owing to the contact with the glass.

REVIEWS OF BOOKS

How to Design a Gas Engine: with full working drawings for a 7 b.h.p. gas engine. By Horace Allen. 39 pp. 7½ in. by 10 in. 20 illustrations. (Manchester: Scientific Publishing Co.). 2s. 6d.

THIS little work describes the process followed by the author, Mr. Allen, in designing a gas engine to give 7 b.h.p. Full working drawings are given of the engine, and the various parts and calculations are made for all the essential features. The engine produced would work quite well, although there are points in detail which one would like to have seen altered. It is not very good practice, for example, to make the liner shown on page 19 with a contracted part at the breech end. It is always desirable to make a liner so that the boring-bar can be put straight through. Apart from that, it is easier to prevent the accumulation of charred matter at the bottom of the cylinder when the lower line of the cylinder runs clear to the level of the exhaust-valve. This is a small point, but it is important in practice. The construction shown for the gudgeon-pin end of the connecting-rod, too, is not by any means the best in common use. It is very unusual also to make a removable exhaust-valve seating for an engine of such small dimensions. For an engine of this size it would have been better to adhere to the ordinary practice of seating the exhaust-valve directly upon the casting. The construction of separate exhaust-valve seating is not a very good one. In the case of a larger engine it would have been better to allow greater freedom of exhaust discharge. The construction adopted is liable to distortion. Although the engine designed is not quite the best possible from a commercial point of view, it is a good little engine, and Mr. Allen's book contains many interesting discussions on practical points which will be useful to the amateur.

Hints regarding the Management and Use of X-ray Apparatus. By Lieutenant F. Bruce. 50 pp. 6 illustrations. (London: H.M. Stationary Office.) 3d.

THIS little work is a reprint of a series of papers on X-ray apparatus and its management, which have already appeared in the *Journal* of the Royal Army Medical Corps. It is composed of six chapters, the first dealing with the sources of current, the second with the details of induction coils, and so on. The development of the exposed plate and the management of Mackenzie Davidson's localising apparatus are also described. The book is written in a clear and systematic manner, and conveys a large amount of correct information in a small compass. It fills its purpose as a primer for X-ray workers, especially for work under Service conditions. We think there are better forms of mercury jet interruptor than the one chosen for description. With occasional revision to keep pace with new inventions and adaptations, this little work should be valuable for a long time to come.

Popular Fallacies. By A. S. E. Ackermann. 312 pp. 8 in. by 5½ in. Eight full-page plates. (London: Cassell and Co.) 6s.

IT is never too late to learn, and Mr. Ackermann has produced a work which we think few will look through without learning something. Although written by one who is well known in electrical engineering circles, the book is addressed to everybody, and we may almost say its subject is everything. Briefly, the writer's object has been to collect together a number of matters of a miscellaneous nature, about which misconceptions commonly exist, and point out in simple language the correct facts of each case. It should be said at once that only questions of fact are dealt with, matters of opinion do not, as a rule, come within the range, and popular beliefs in any way involving the supernatural are avoided except in a very readable appendix, in which the dividing line between ignorance and superstition is discussed. Here and there, however, as in a paragraph relating to vegetarianism, the author has allowed himself to wander on to debatable ground. The general scheme divides the book into sections according to subject-matter, but otherwise there is fascinating and often humorous incongruity in the sudden changes of theme. Dipping at random among the pages to show the wide range covered, we find the view commonly held in England that more beer is drunk per head in Germany than in the United Kingdom most effectually disproved by statistics, and a few pages later a diagram is given to dispel the popular belief that the human heart is well to the left side of the body instead of, as it really is, nearly in the centre. A brave attempt is made to teach the housewife that sunshine does not put out the fire, and in the historical section the beliefs which we have held from our childhood, that William Tell shot an apple from his son's head, and Lady Godiva rode naked through the streets of Coventry, are rudely shaken. Passing on to the fallacies connected with technical and scientific matters, subjects on which the author is well qualified to speak, there is a great deal to interest and to amuse. The technical reader will naturally find much that is obvious, but the crispness of the explanations and the evidences of the author's fine sense of humour which pervade the whole book prevent any portion becoming wearisome. We are glad to see the absurdity of the conventional zigzag representation of lightning pointed out (although this paragraph is hardly included in its right section), and due credit given to the great Turner for the accuracy of his delineation of the lightning flash. The explanation of the formation of the vitreous mass sometimes termed a thunderbolt, which, of course, is formed by the action of the discharge on the earth and does not fall from the "blue," is also misplaced in the classification. The technical Press is quoted to show that the belief that beech trees afford protection from lightning is unfounded, and the unimpeachable authority of the *Daily Mail* is brought forward to give an example of persons sheltering beneath beech trees who have been killed by lightning. This is, perhaps, a case where the subject has been dismissed too readily, for although the statement that beech trees afford protection from lightning is an exaggeration, statistical researches by Prof. A. G. McAdie, of the United States Weather Bureau, published last year, have shown that some trees are much more liable to be struck by lightning than others, although a satisfactory explanation for this has not yet been arrived at. The oak, for example, was found to be specially liable to injury, but the beech is recorded as being only infrequently affected. Before leaving the subject of thunder and lightning, it is gravely pointed out that "putting cold iron bars on barrels of beer" is of no avail to prevent "the beer being turned sour by thunder." Space does not permit of our referring to all the paragraphs upon which we should like to comment in this section, but we may express our pleasure that the deceptions (possibly of themselves and certainly of others) of the wielders of "divining rods" for finding water are exposed, and our sympathy with those who learn for the first time that Egyptian cigarettes are not made of tobacco grown in Egypt. It may appear a little ungrateful after the enjoyable half hours we have spent with this fascinating work to point out misprints, but we should like to ask Mr. Ackermann for the address of the man mentioned on page 36, who weighed only 12lb. 12oz. before lunch, and to point out that on page 10, in the title of the fallacy as to the invisibility of steam, the word invisible has been inadvertently printed instead of visible.

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HEAVY ELECTRIC TRACTION IN AMERICA

THE following summary of heavy electric traction installations recently completed or in progress in America, taken from the report of a committee of the American Street and Interurban Railway Association, and published in the *Street Railway Journal* (New York), is of interest as showing the directions in which electric traction is tending in America.

CONTINUOUS CURRENT 500 TO 600-VOLT INSTALLATIONS.

New York Central & Hudson River Railroad.—This installation, which has been in progress for some years, and which comprises 35 100-ton locomotives, and 131 multiple-unit cars, has been practically completed and is in successful operation.

Detroit River Tunnel Co.—Six 100-ton locomotives.

United Railways, Portland, Ore.—One 35-ton locomotive.

Boston Elevated Railway Co.—This company, which has operated heavy elevated service for a number of years, has under construction 308 160-h.p. motors for use as double equipments.

Metropolitan West Side Railway Co., Chicago.—Two hundred and twenty-eight 160-h.p. power motors have been added to the previous equipment of this company's motor power for use with multiple-unit control as double equipments.

Philadelphia & Western Railroad.—One hundred cars, each equipped with four 125-h.p. power motors.

Brooklyn Rapid Transit Co.—This company has added to its rolling stock 100 elevated cars, each equipped with two 200-h.p. motors with multiple-unit control.

West Jersey and Seashore Railway.—Eighty cars, each equipped with two 200-h.p. motors.

Philadelphia Rapid Transit Co.—This company has added to its equipment 170 125-h.p. motors for use in two-motor equipments.

The Hudson Cos., New York.—Fifty cars, each equipped with two 170-h.p. power motors.

Buffalo, Lockport, & Rochester Railroad.—Nineteen cars, equipped with four 75-h.p. motors each.

Texas Traction Co.—Fifteen cars, each equipped with four 75-h.p. motors.

West Shore Railroad Co. (Oneida Railway Co.), Utica.—Fifteen cars, each equipped with four 75 h.p. motors.

Pittsburg, Harmony, Butler & Newcastle Railway Co.—Twelve cars, each equipped with four 75-h.p. motors. This equipment is noteworthy as contemplating the use of 1,200 volts on the trolley, two 600-volt motors being connected in series.

Buffalo & Lake Erie Traction Co., Buffalo, N.Y.—Eight cars, each equipped with four 100-h.p. motors.

SINGLE-PHASE ALTERNATING-CURRENT INSTALLATIONS.

New York, New Haven & Hartford Railway Co.—This installation, which has been in progress for the past two years, has been practically completed, and is in successful operation. It comprises 35 90-ton locomotives operating both from 11,000-volt, single-phase trolley and a 650-volt continuous current supplied from the third rail.

Spokane & Inland Railway.—This installation comprises 14 locomotives, six equipped each with four 100-h.p. motors and eight equipped each with four 75-h.p. motors; also 21 passenger cars, each equipped with four 100-h.p. motors. This road is operating partly from 6,600-volt trolley and partly from a continuous current. Length of track, 146 miles.

Sarnia Tunnel.—Five 62-ton locomotives; trolley voltage, 3,300 volts.

Illinois Traction System.—One 50-ton locomotive and eleven cars, each equipped with four 75-h.p. motors; trolley voltage, 3,300.

Erie Railroad, Northern New York.—Six cars, each equipped with four 100-h.p. motors; trolley voltage, 11,000. Length of track, 34 miles.

Washington, Baltimore & Annapolis Railway Co., Baltimore, Md.—This equipment comprises 21 cars, each equipped with four 125-h.p. motors; also four cars each equipped with two 125-h.p. motors; trolley voltage, 6,600.

Richmond & Chesapeake Bay Railway Co., Richmond, Va.—Four cars, each equipped with four 125-h.p. motors; trolley voltage, 6,600.

POLYPHASE INSTALLATIONS.

Great Northern Railroad, Cascade Tunnel, Washington.—This equipment will comprise four locomotives, each of 100 tons, to be operated on a 3,000-volt, three-phase alternating current.

CONTINUOUS CURRENT 1,200-VOLT INSTALLATIONS.

Southern Pacific Co., Oakland, Cal.—This equipment will comprise 44 cars, each to be equipped with 125-h.p. motors, to be run permanently two in series on 1,200 volts. There are also to be 40 trailer equipments.

Indianopolis and Louisville Railway.—Ten cars, each to be equipped with four 75 h.p. motors, connected two in series for 1,200-volt working.

Experiments are also being made on Pennsylvania Railroad, who are preparing to equip their new New York terminus and the tunnels connecting Manhattan Island with New Jersey and Long Island for electric traction, an experimental 140-ton, 15-cycle, single-phase, 11,000-volt locomotive has been constructed.

THE SUPPLY OF TUNGSTEN

IN view of the rapidly growing demand for the metal tungsten principally for the manufacture of filaments for incandescent lamps, and the difficulty which firms requiring large quantities of that material have in obtaining supplies, the following particulars, taken from the *Journal of the Society of Arts*, are of interest.

The market for tungsten ore is still expanding, and according to a recent bulletin of the United States Geological Survey, seems now to be almost as sure as the market for copper and other staple ores. Prices during the past year have varied from 21s. to over 50s. (depending on quality) per unit for ore containing tungsten acid.

The chief ores of commercial importance are wolframite and scheelite, the former a tungstate of iron and manganese, containing up to 76 per cent. tungstic acid, the latter tungstate of lime containing up to 80 per cent. tungstic acid. The greatest producing locality in the United States is Boulder County, Colorado, where the ore occurs as a wolframite breccia. An analysis of the crude ore from the most important deposit yet discovered in the United States near Crescent City, Colorado, gave tungstic acid 39·7 per cent., FeO 12·8 per cent., MnO 6 per cent., insoluble matter 42·3 per cent. In commercial working, it would be easy to produce a 60 to 65 per cent. tungstic acid concentrate from this deposit.

It has long been known that wolfram was associated with tin ores in Cornwall, but until recent years it has not been separated to any extent. Magnetic separation was introduced some years ago, and some measure of success in the separation has been attained in various mines. Tungsten is feebly magnetic, and requires higher magnetic power than some other ores. The magnetic separation is, however, not complete, and there is still room for considerable improvement in the treatment of Cornish ores. Some discussion has recently taken place regarding the genesis of magnetic separation in Cornwall. The credit for its introduction, according to the Cornish correspondent of a leading mining journal, is due to Professor Bauerman and Mr. W. Thomas. Moissan has shown that it is an easy matter to prepare crude tungsten in the electric furnace, and that this might be refined by remelting the metal in presence of an excess of tungstic acid.

Faraday House.—As a result of a recent examination the following awards have been made:—Bertie Travers Alston, Bedford Grammar School, an exhibition of twenty-five guineas, tenable for two years. Joseph Herbert Shannon, the Royal School, Dungannon, Ireland, an exhibition of twenty guineas, tenable for two years.

A Large Vertical Shaft Rotary Converter.—A description is given in the *Western Electrician* of a 2,000 kw. rotary converter, with a vertical shaft running at 167 r.p.m., which has been installed in one of the sub-stations in Chicago. Electrically, the characteristics of the new machine are identical with those of the older horizontal type of rotary made by the General Electric Co., the features of the vertical rotary being in economy in various points, simplicity and accessibility. Some of the points of advantage are apparent from a comparison of figures. The floor space required for a horizontal rotary of 1,000-kilowatt capacity is 11 ft. 2 in. by 11 ft. 7 in.; for the vertical machine of this size the floor space measures 9 ft. 8 in. in diameter. For the 2,000-kilowatt machines the horizontal type takes up a space measuring 16 ft. 6 in. by 16 ft. 8 in., while the space required for the vertical rotary measures 15 ft. 3 in. in diameter. In many instances clearance is an important matter, and here the vertical type of rotary shows to advantage also. The 1,000-kilowatt horizontal machine measures 9 ft. 7 in. above the floor, against 7 ft. 3½ in. for the vertical. The height above the floor of the 2,000-kilowatt machines is 12 ft. 11 in. for the horizontal and 9 ft. 3 in. for the vertical. The vertical type of rotary also shows a gain of approximately 40 per cent. in speed, and there is a saving of about 17 per cent. in weight for machines of similar capacity. The armature is supported from the top of the shaft, and revolves on oil step bearings. The shaft is 23 in. in diameter, or nearly one-half its height. Sleeve bearings on the sides of the shaft are provided for keeping the armature in alignment.

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ELECTRICAL SCIENCE

British and American

Friction at Surfaces Traversed by Electric Current.—An article in the December *Physical Review*, by P. R. Heyl, describes some experiments on the effect on the friction coefficient of passing a current across the contact. The matter is of some interest in view of the fact that sliding contacts are common in practice; but in the present article the author confines his attention to the friction between iron and mercury and between carbon and mercury. The iron or the carbon was used in the form of two vertical cylindrical electrodes. Two electrodes of the same material were attached to two axial points of a heavy copper rectangle, so that they were in line, and the whole was suspended so that the electrodes dipped slightly into separate mercury cups at different levels. The suspension was a wire, which gave torsional vibrations to the rectangle and electrodes about the common axis of the electrodes. The current was led in at one mercury cup and out at the other. The electrodes were about 3 mm. in diameter, and the surface of contact in each cup was about 0·075 sq. cm. Thus with a current of 6 amperes the current density was about 80 amperes per sq. cm. at each place of friction. Greater currents than this could not be used for fear of forming an arc. The experiments consisted of finding the damping of the torsional oscillations, first, when no current was running, and then when the current was switched on. The effect of heat on the viscosity of mercury was eliminated by alternating these two sets of observations. Using iron electrodes, it was thus found that with a current density of 80 amperes per sq. cm. there is no change in friction as great as 1 per cent. For carbon, with about the same current density, there is an apparent change of about 14 per cent. But with carbon rods there was a considerable development of heat; probably the film of mercury in contact with the rod of carbon was heated rather intensely. Making allowances for this, the author concludes that practically all the difference of damping in the case of carbon electrodes is due, as in the case of iron electrodes, to the reduction of the viscosity of the mercury by warming.

Continental

Electron Theory of Dispersion.—An important advance in the explanation of optical dispersion has been made by H. Erfle, who contributes the results of an elaborate investigation to No. 14 of the *Annalen der Physik*. He used Abbe's spectrometer, and arranged it so that the beam returned upon itself. He examined benzol, methyl iodide, and alpha-monobromonaphthalene, determining from the dispersion curve the constants of Drude's dispersion formula and the number p of optically effective electrons attached to each molecule. He found that the constants deduced accounted completely for the ultra-violet and infra-red absorption bands. Another consequence of the theory is that for an infinitesimal wave-length both the deviation and the absorption of the beam become infinitesimal. Most organic compounds have more than one proper vibration in the ultra-violet. The number p of electrons per molecule is independent of the temperature, but the number affected by light increases as the wave-length of the light increases. Double linking reduces p, but does not halve it. Treble linking also reduces p, but not so much as doubling. The number p is extremely sensitive to impurities, and can, indeed, like Brühl's molecular dispersion, be used for detecting impurities.

Ionisation by Bubbling.—Lord Kelvin showed in 1894 that air bubbled through water possesses an electric charge. The charge is negative when the water is pure, but positive when the water is saline or acidulated. L. Bloch describes, in Bulletin No. 268 of the French Physical Society, some experiments in bubbling dust-free air through distilled water. He finds that though the air has a negative charge, this charge represents only the difference between negative and positive ions contained in it, both kinds being undoubtedly present. Moreover, they have a fairly high mobility of the order of 1 mm., or only ten times less the ions produced by radium or X-rays. They are therefore of quite a different order from the heavy ions found in flames and near waterfalls. The negative ions are about twice as mobile as the positive ions. All this is changed when the water is acidulated. The air is then charged positively. The ions become heavy ions. The mobilities of positive and negative ions are the same, and are of the order of $\frac{1}{10}$ mm. The concentration at which the sign of the total charge is reversed is $\frac{1}{14}$ normal in the case of sulphuric acid. Heating increases the proportion of heavy ions present, and the effect is very sensitive to changes of temperature. Alcohol shows similar effects, but not vaseline oil or mercury. It seems to be greatly a matter of surface tension.

Majorana Effect.—The magnetic double refraction of liquids discovered by Majorana requires very intense magnetic fields for its demonstration. Cotton and Mouton have shown that this effect, when observed in certain colloidal liquids, may be explained as due to the ultra-microscopic particles suspended in them. In Bulletin No. 268 of the French Physical Society the same authors report an important advance in the observation of the same effect, now for the first time found in pure liquids. They worked with the great electromagnet of the Zurich Polytechnic, which gives a field of 30,000 units over several cm. The effect was first observed in nitrobenzene, already notorious for its pronounced Kerr effect. The effect was found to be proportioned to the square of the magnetic field, and, unlike colloidal iron hydroxide, it showed no signs of saturation in the strongest fields. Benzene itself showed an effect amounting to one-fourth of that in nitrobenzene. But all the liquids of the aromatic series show it more or less. The fatty series does not show this effect, so that we have here a new criterium for distinguishing the two series. But the phenomenon is not confined to the aromatic liquids, as CS_2 shows it also. It is not due to suspended particles, but possibly to molecular aggregations invisible in the ultramicroscope.

Collective Forms of Energy.—The analysis of sound and light into periodic motions forms the foundation of optical and acoustic science. In the kinetic theory of gases, and latterly in the electron theory of electricity and magnetism, the analysis has been concerned with irregular motions treated statistically. This method is likely to become increasingly necessary and useful in physics. Some general principles concerning it are laid down by G. Helm in the *Physikalische Zeitschrift* for November 15th. If a body receives an increment of energy dE, and is thereby endowed with an intensity of energy i, then the ratio dE/i always increases from one body to another when dE is positive and is transferred from one to another. In other words, the energy loses in "intensity" by transfer, and is only transferred when it can lose in intensity. Now the sum of such quantities dE/i is strictly equivalent to what in thermodynamics is called entropy, and it also has the property of always growing when energy is transferred. This property is, therefore, not limited to heat. It applies to all "collective" forms of energy, and all irreversible phenomena are characterised by the occurrence of collective energy. Disordered motions have already been thoroughly investigated by Gibbs, but Planck's treatment of radiation shows that the method is not confined to mechanical quantities.

Japanese Exhibition, 1912.—This exhibition, which will be known as the Grand Exhibition of Japan, 1912, will be opened in Tokio on April 1st, 1912, and will be closed on October 31st. Foreign exhibits will be divided into five classes, of which one will relate to electricity. All materials for exhibition purposes will be admitted free of duty. The exhibition site will comprise about 292 acres.

Lord Kelvin's Will.—Under the will of the late Lord Kelvin, the whole of his property and means pass absolutely to Lady Kelvin, with the exception of a legacy of £5,000 to Glasgow University, which is to be applied by the Senate in promoting research and teaching physical science in connection with the chair of natural philosophy. The executors are Lady Kelvin, Dr. J. T. Bottomley, and Dr. J. F. Bottomley, nephew and grand-nephew respectively, and Lord Kelvin's solicitor, Mr. T. Warren, of Glasgow. The total amount of the will has not yet been lodged, but it is understood to be several hundred thousand pounds.

Power Developments in South Carolina.—A considerable development in electrical cotton-mill driving is taking place in South Carolina, U.S.A., where the spread of electrical driving since its introduction in 1894 has been rapid enough already to account for more than one-third of the total 300,000 h.p. used in cotton-mill driving in this region. Ther are in the neighbourhood of Charlotte, N.C., two principal water-power schemes, that of the Whitney Co. on the Yadkin river, and the Southern Power Co.'s undertaking on the Catawba river. The former scheme was originated by Mr. C. C. B. Hambley, an Englishman, and the hydraulic works started in 1904 have made considerable progress. According to a Chicago newspaper a dam 60 ft. wide and 47 ft. high has been constructed, which renders an enormous storage area available. On one side of the dam a canal 130 ft. wide and 30 ft. deep has been constructed, which carries the water about 4½ miles to the pressure pipes to the power-house, where turbines aggregating 40,000 h.p. will be installed. Two other stations in the same neighbourhood are projected, which are to produce a further 90,000 h.p. The Southern Power Co. already distribute power to a large manufacturing district from a 10,000 h.p. Catawba station and a 40,000 h.p. station known as the Great Falls plant. A further 40,000 h.p. plant is under construction at Rocky Creek, and another of 24,000 h.p. capacity at "Ninety-nine Islands," near Spartanbury, and additional power-houses aggregating some 200,000 h.p. are projected at other points on the Catawba river.

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ELECTROCHEMISTRY AND ELECTROMETALLURGY

IN the *Zeitschrift für Elektrochemie* of December 20th, Kurt Arndt publishes an article upon viscosity and conductivity. It has been shown by a number of workers that there is a more or less constant difference between viscosity of a solution or of a fused salt and electrical conductivity. That is to say, with increase in viscosity there is a decrease in the conductivity, and *vice versa*, this being due to the increased or decreased fluid friction upon the passage of the ions. Walden, who has recently worked with a normal electrolyte, tetraethyl-ammonium iodide, which he dissolved in a large variety of organic liquids, stated that the product of the equivalent conductivity and the internal friction of the fluid is a constant, which is independent of the temperature or the nature of the solvent. A practically similar conclusion was come to by Jones, Lindsay, and Carrol, working with mixtures of methyl alcohol and water. A good deal of work has also been carried out with fused electrolytes, but the agreement in this case is by no means constant. Arndt has now carried out experiments with fused salts at different temperatures. With increase of temperature the viscosity decreases, but the conductivity increases. But the product x.n, i.e., the conductivity by the viscosity is not constant. In the case mentioned a fused mixture of B_2O_3 $NaPO_3$ showed the rather remarkable result when the equivalent conductivity was reduced to the same viscosity, that the conductivity was independent of the quantity of added sodium metaphosphate. In other words, the sodium meta-phosphate is completely ionised. Another interesting point brought out is that in the fused condition sodium nitrate conducts half as well again as the potassium salt, but in aqueous solutions the conductivity is in the reverse order, the potassium salt conducting better than the sodium salt. This may be due to a film of the solution moving with the ions. If, then, the $Na^{\cdot}$ ion has a thicker film than the $K^{\cdot}$ ion, the friction will be greater, and consequently the conductivity less.

In the *German Patent* 181,656, Rudolf Schaar describes a method for obtaining either pure gases or mixtures of gases in varying proportions by electrolysis. The process consists in altering the size and position of the electrodes and of having a portion between the electrodes, which, however, does not reach to the bottom of the bath, and can be raised or lowered at will. When the solution is electrolysed with insoluble electrodes, oxygen is given off at the anode and hydrogen at the cathode. The gas causes eddy streams, and if one electrode be small and the other large, and the portion be raised to a certain position, the eddies can be caused to carry the bulk of, say, the cathode gas under the portion and up into the anode compartment, so that a mixture of the two gases is obtained. If pure hydrogen and oxygen are required, then the cathode is made double the size of the anode.

In the *Zeitschrift für Elektrochemie*, 1907, 701, H. Lee and A. Baezen compare the relative value of continuous and alternating currents for heating air or for working a resistance furnace. They have compared the yields of nitric acid with arc flames in air, using electrodes of iron, or platinum and oxide electrodes. With the same energy in each case, practically concordant results were obtained with continuous and with alternating currents. The conditions must, however, be such that the same form of arc flame is produced in every case. The authors conclude that variations of yield are not due to any difference between the continuous and alternating current, but may be caused by differences in the subsequent manner in which the reaction products are cooled. Generally speaking, a higher voltage is required with alternating currents for the same energy consumption than for continuous currents; this may, perhaps, be due to the cooling of the electrodes between the alternations. The most important influence in obtaining high yields is the condition of the arc flame, and also upon the way in which the products are removed from the sphere of action. For the production of calcium carbide and for heating crucibles, both continuous and alternating currents required practically the same voltage and the same current.

The British Aluminium Co. have more than realised their anticipation of being able to commence manufacturing aluminium at Kinlochleven in the beginning of the New Year, as work was commenced on Christmas Day, and the machinery was in full operation by the end of the week. The temporary factory now being operated is situated between the new village and the great dam. A special dam has been constructed for operating the present plant, and turbines capable of developing 3,000 electrical h.p. have been installed. The principal works are being actively pushed forward, but some time will elapse before they are completed.

ELECTRIC LIGHTING PROVISIONAL ORDERS

WE give below a complete list of applications for Provisional Orders deposited with the Board of Trade, under the provisions of the Electric Lighting Acts, 1882 to 1890, for the Session of 1908. In cases where the name of the promoter is not given, the local authority has lodged the application :—

Barrhead, Strathclyde Electricity Supply Co., Ltd.; Barton-upon-Irwell; Bath (Rural) (Amendment); Bispham-with-Norbreck; Bridgend (Extension); Caldy Manor, Caldy Manor Estate, Ltd.; Carmarthen, Messrs. J. B. Saunders & Co.; Clydebank (Amendment), Clyde Valley Electrical Power Co.; Dundee (Extension), Dundee Gas Commissioners; Fleetwood; Fleetwood, Broadstone, Ltd.; Halesowen (Rural), George Balfour; Hendon (Amendment), Messrs. Crompton & Co., Ltd.; Heswall (Rural); Johnstone, Strathclyde Electricity Supply Co., Ltd.; Llandaff and Dinas Powis (Rural), (Amendment); Llansamlet, Rural District Council of Swansea; Lowestoft (Oulton Broad Extension); Lymington (Extension), Lymington Electric Light and Power Co., Ltd.; Macclesfield (Amendment); Oulton Broad; Portsmouth; Rutherglen (Amendment); Southampton; Sowerby Bridge; Tewkesbury; Woking, Woking Electric Supply Co., Ltd.

CATALOGUES AND PAMPHLETS RECEIVED

ELECTRIC LIGHTING PLANT AND ACCESSORIES.—The large bound catalogue of some 300 pages, issued by Messrs. Drake & Gorham, forms a useful work of reference for those laying out electric light installations, and deals in some detail with boilers, producer gas plant, steam, gas, and oil engines, turbines and engine-room stores, shafting, pulleys, and belting, dynamos, motors, switchgear, measuring instruments and accessories, storage batteries, wires, cables, &c., for lighting, power, telephones and bells, and lightning conductors. Incandescent lamps of the carbon filament, tantalum, and Nernst types, arc lamps, switches, wall plugs, lamp-holders, steel tubing, casing, &c. Electric bells, telephones, heating appliances, and fans. Various types of machinery and appliances for domestic, dairy, and farming purposes, and motor-cars and accessories.

INTERCOMMUNICATION TELEPHONES.—A leaflet from the Sterling Telephone & Electric Co. gives particulars of several patterns of intercommunication telephone of the wall and table types. An automatic replacement instrument is tested with only a single lever, and calls may be made irrespective of its position, in addition to the "Era" multiple lever type, of which very large numbers are in use. In all the single-lever instruments the contacts are enclosed in the instrument case.

POCKET-BOOKS, DIARIES, ETC., FOR 1908

The General Electric Co. have presented some of their friends with an exceptionally fine and well-made blotting-book with flexible leather cover, fitted with capacious pockets.

This year's wall calendar of the D.P. Battery Co. fully maintains the high artistic standard set by its predecessors. The principal feature is a coloured view of part of the company's works in Derbyshire, showing the large water wheels and chimney shafts of the auxiliary steam plant by which the works is driven.

We have received from the Electric Construction Co. a neatly made pocket-case with memorandum pad and transparent window for season tickets, &c., and a pair of light and convenient penholders.

Messrs. Johnson & Phillips have sent us a miniature calendar and diary for 1908, neatly bound in crocodile skin.

Messrs. Siemens Brothers & Co., Ltd., conjointly with Messrs. Siemens Brothers Dynamo Works, Ltd., are distributing this year to their friends a somewhat enlarged edition of their well-known diary, which contains a number of useful tables, &c., and some interesting illustrations showing the wide range covered by the activities of the group of Siemens companies.

A neat waistcoat pocket diary and notebook for 1908, bound in Russia leather, is being issued by the Brush Electrical Engineering Co.

A very artistic wall calendar is being distributed by Messrs. T. W. Broadbent, of Huddersfield, to their friends, which contains a three-colour reproduction of a painting entitled "Harvesting in Hertfordshire," by Alfred Elias.

An ingeniously arranged calendar in the shape of a large incandescent lamp with revolving discs for the days of the week, month, &c., has been issued by the Pope Electric Lamp Co.

Telegraph Traffic.—The past week has been fairly free from derangements of telegraphic communication, the only cable which has given out being the one between Bathurst and Bissao, on Christmas Day. The *via* Fao route was again interrupted between Bagdad and Bassorah on the 26th ult., and some inconvenience was caused by interruptions to landlines, owing to the recent storms.

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"ELECTRICAL ENGINEERING" PATENT RECORD

(This Patent Record is compiled by our own Editorial Staff and is Strictly Copyright.)

Specifications Published Dec. 27th

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from abroad.

1906 Patents

19,737, BRITISH THOMSON-HOUSTON. This specification relates to improvements in signalling on electric railway systems, and utilises a power-house dynamo having one of its poles connected directly to an insulated conductor or feeder extending over the route; the other pole is connected to both track rails, which are bonded together, and a series of sectional track-controlling conductors, or rails parallel to them, with semaphores or signals controlled in their operation in one direction by the use of rotary electric motors, and in the reverse direction by the application of a constantly acting force, such as gravity or a spring, the arrangement being such that the signals are held locked at safety against the influence of the constantly acting force, and with the source of electrical energy normally disconnected therefrom. It also combines a system of such signals with sectional third rails, local sources of electrical energy therefor, and switching devices connected in circuit with the sectional track-controlling conductors or rails in such a manner that when any sectional third rail is made alive the corresponding signal or signals are displayed at danger or caution through the agency of the constantly-acting force. Three claims, two figures.

26,212A, COWPER-COLES. Improvements in anodes for electric deposition. It is proposed in this specification to provide an improved means for causing the anode to gradually move towards the cathode surfaces, as the former is gradually dissolved away, by means of screw threaded rods carrying the anodes in section, and each working in a nut, and cams adapted to be turned through the medium of bevel gear, so as to bear against the back of the anode sections. Two claims, two figures.

28,112. BRITISH THOMSON-HOUSTON & WOODBRIDGE. This specification relates to improvements in switch-controlling mechanism for electrical installations, and consists of an arrangement of interlocked levers and switches capable of home and remote control, whereby a switch can be opened or closed by hand-operated means near the switch, or from a distance. The line switch mechanism also controls the opening and closing of an earthing switch, so that the latter may not be closed except when the line switch is open, or *vice versa*. Four claims, three figures.

1907 Patents

880. J. C. LINCOLN. The object of this invention is to construct electric motors so as to secure an unusual range in the speed variation, whilst avoiding harmful sparking at the brushes of the motor, particularly at high speeds, and also to adapt the motor for working equally well in either direction of the armature. The motor consists of the usual field structure, within which the motor is designed to rotate. In connection with the armature are means for withdrawing it laterally from the field structure. The chief feature is the means for affording a commutating field during the high-speed positions of adjustment for the armature, which consists of an electro-magnet laterally positioned beyond the field structure of the motor adjacent to the armature when withdrawn therefrom to the high-speed position. This electro-magnet is connected in series with the armature of the motor. Three claims, six figures.

2,759, PAGE, AND THE U.S.A. LIGHTING & HEATING CO. This specification relates to an improved system for transmitting power to dynamo electric machines suspended from trucks. The object of the invention is to prevent the wear upon the axle of the dynamo and the consequent destruction of the armature which occurs with the usual power transmitting mechanism. The driving pulley is mounted on the frame of the dynamo, the armature shaft being connected to the pulley by a lost motion connection, such as a "dog" or "spider," which is loosely connected to the pulley. There may be relative movement between the driving pulley and the armature shaft, and all the transverse strains due to the movements of the dynamo and the pull of the belting are thrown on the field frame of the dynamo instead of on the armature shaft. The axle is provided with a suitable driving pulley, connected to a belt with a pulley connected to drive the shaft of the dynamo. Suitable belt-tightening springs are provided, and downwardly depending rods are secured to the outer ends of the beams, the lower ends of these rods being connected by cross rods. The field of the dynamo is provided with downwardly depending lugs or ears, to which is secured a cross rod provided with apertures at its ends for the hooked rods. A cross rod connects the two pivot bars, and suitable bearings are provided on the frame of the dynamo. Two claims, three figures.

18,923, WESTINGHOUSE METAL FILAMENT LAMP CO. Method of fixing metallic filaments of incandescent lamps. The patent is published in full on page 12.

Specifications Published To-day

The following Patent Specifications will be published to-morrow, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Summaries of the more important of these patents will appear in our next issue.

1906 Patents

13,126A, COWPER-COLES. Manufacture of metal articles by electro-deposition.

25,050, DAIMLER-MOTOREN GES. Transmission gear for motor-driven vehicles.

28,319, STRECKER-AUFERMANN. Process for preparing printing plates by means of electrolytic etching.

28,739, BABB, CHAPMAN, & COCKSHOTT. Methods or means of electric braking.

28,775, DEUTSCHE GASGLÜHLICHT AKT.-GES. (*Auerges.*). Method of and means or apparatus for producing metallic incandescence bodies for electric glow lamps.

28,846, CROSSLEY & JACKSON. Electric ignition for internal-combustion engines.

28,897A, COWPER-COLES. Electro-deposition of iron.

1907 Patents

316, RHODES & RHODES MOTORS, LTD. Commutators for dynamo-electric machines.

1,358, AMBLER. Electric switches.

1,945. CUNYNGHAME & HOPE-JONES. Gravity escapements and electric clocks.

2,227, SIEMENS BROTHERS DYNAMO WORKS & PALAIRET. Overload electric circuit breakers and the like.

3,724, LORING. Electrical generators for flour-bleaching and subsidiary purposes.

4,172, WUILLOT & FERON. Electrical distribution systems with the aid of storage batteries.

6,280. KITSEE. Electric telegraphy.

6,849, GROSE. Electric fuse boxes and fuse holders therefor.

8,838, RUHL. Electro-mechanical toys.

9,176, LAND-UND SEEKABELWERKE AKT.-GES. Safety electric cable.

9,833. TURNER. Telephone systems and apparatus therefor.

11,123. HUNGERFORD. Electric conductors.

13,074, ALLGEMEINE ELEKTRICITÄTS GES. End pivots for the spindles of electric meters.

16,514, MACGAHAN. Synchronising apparatus for dynamo-electric machines.

18,463, FORD & WASSAM. Combined cross-ties and rail-fastenings.

18,498, BÖHM. Operative system electric locomotives.

18,793, VON KANDO. Double wire overhead electric trolly systems.

22,404, ALLGEMEINE ELEKTRICITÄTS GES. Dynamo-electric machines.

25,722, WESTINGHOUSE. Yielding resistance devices.

The following complete Specifications are open to Public Inspection at the Patent Office, but are not yet published for sale.

1907 Patents

21,535, MAICHE. Electric transformers.

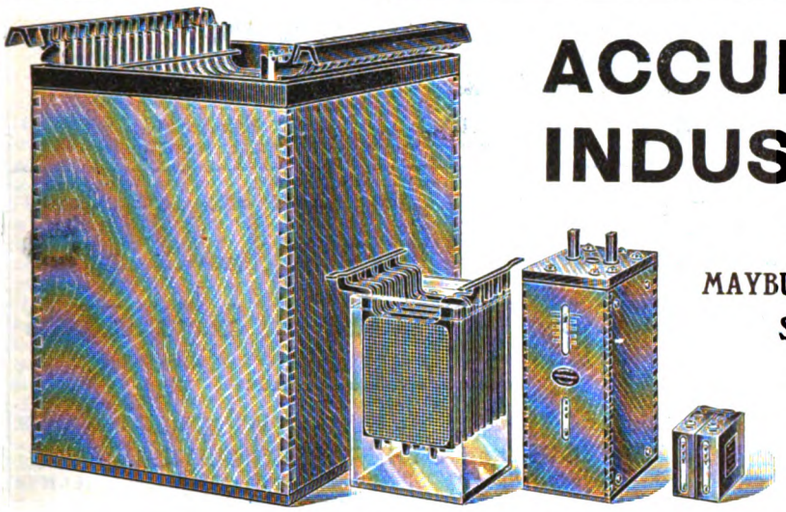
26,607, FELTEN & GUILLEAUME-LAHMEYERWERKE AKT.-GES. Direct current electrical machinery.

26,846, ALLGEMEINE ELEKTRICITÄTS-GES. Arc-lamps.

27,073. SIEMENS-SCHUCKERT WERKE GES. Electrical systems or arrangements for driving machinery subject to variable loads.

For LOCAL NOTES, &c. see pp. 27 to 32

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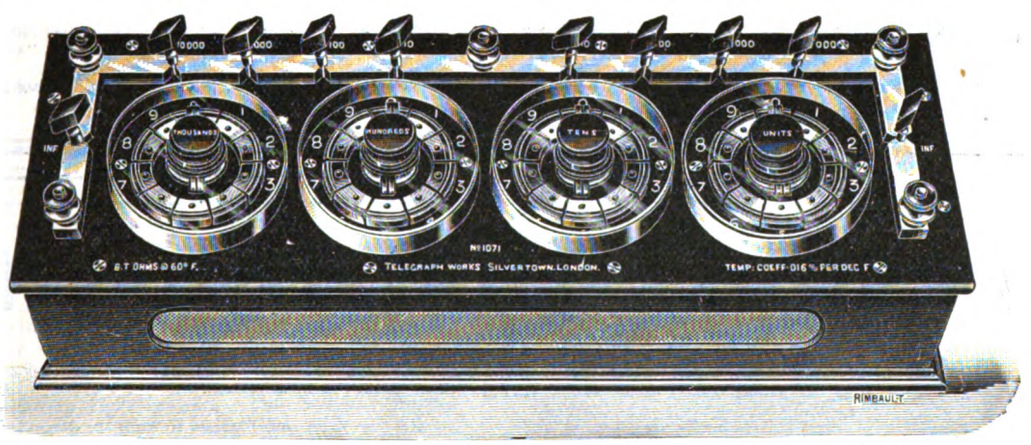
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(*Continued on page* ix.)

For LOCAL NOTES, &c.—See pp. 27 to 32

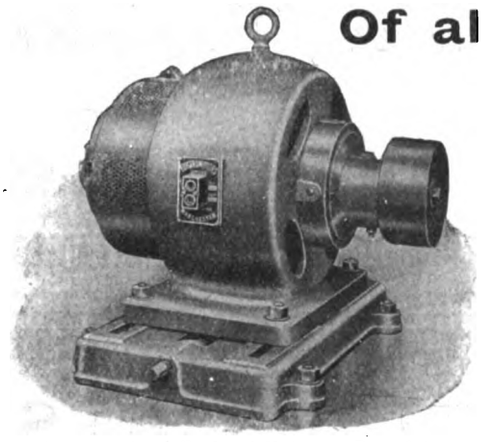
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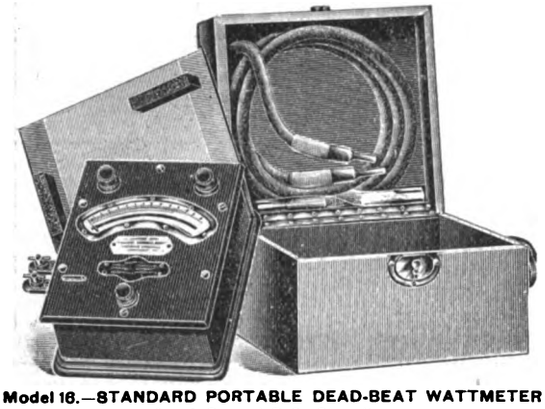
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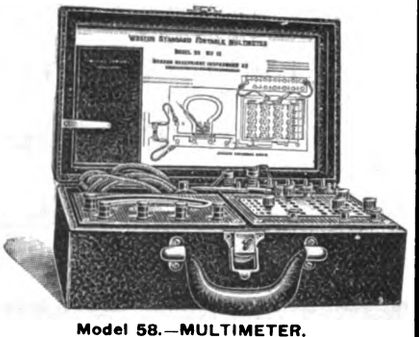
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LOCAL NOTES

ACCRINGTON: *Electric Tramways.*—The new section of the tramways as far as St. John's Church, Baxenden, was formally opened for public traffic last week end. The rest of the lines to the boundaries are now practically completed.

ACTON: *Electrical Exhibition.*—It has been decided by the Acton Council to hold an exhibition of electrical goods in the Public Baths from January 18th to 25th. £82 has already been guaranteed by the stallholders, and it is estimated that the receipts will be £152.

BELFAST: *Tramway Receipts.*—In spite of the rough weather during Christmas, the receipts from the Belfast Corporation electric tramway traffic show a decided increase over last year. The figures last year were: Christmas Eve, £719; Christmas Day, £591; Boxing Day, £488; day after Boxing day, £488; total, £2,246. This year the receipts were: Christmas Eve, £782; Christmas Day, £559; Boxing Day, £594; day following Boxing Day, £531; total, £2,466, showing an increase of £220 for 1907 over 1906.

BISPHAM: *Electric Lighting Order.*—The Parliamentary agent of the Council has reported that all the preliminary stages, with regard to the Council's application for an electric lighting order are now completed.

BRADFORD: *The Church Bank Accident.*—The Bradford tramways accident on Church Bank, the steepest gradient in the city, some months ago, has led to prolonged negotiations with injured passengers. These are now completed, and it is officially announced that all claims have been settled for £2,000, plus doctors' bills. Fourteen persons were injured, and though the Corporation has always held that it was not legally liable, as the car ran away owing to pure accident, liability has not been evaded. The cost of the accident is equivalent to the gross takings on the whole system for half a week.

CASTLEFORD: *The Normanton, Castleford, and Pontefract Tramways.*—Mr. England, the tramways manager, reports as follows:—"The tramways were opened for public traffic on October 29th, 1906, and comprise 7·112 miles of track, and 10·22 miles of line reckoned as single track. At the depôt in Castleford, where the power-station and repair-shops are also situate, there are 16 cars in stock, seven of which are used on the ordinary week-day service, and all of them each week-end. During the year under review it is estimated that approximately 2,500,000 passengers have been carried. Since November 4th last cars have not run into Pontefract, owing to the Board of Trade having refused to grant a certificate authorising the running through Front Street until the required clearance of 15 inches at one particular point is obtained. At the time of writing there seems no prospect of a settlement being arrived at, as the Corporation of Pontefract will not agree to a slight narrowing of the footpath to enable the company to get the clearance. There is no likelihood of any extension to Featherstone or Knottingley being carried out for some time to come.

DUNDEE: *Electricity Developments.*—The Dundee Electric Lighting Committee made a tour of inspection, with a view of finding suitable sites for two sub-stations, which will be situated one at Lochee, and the other in the Maryfield district. Concerning the former it has been decided that ground belonging to the Tramways Department, adjoining the car sheds, shall be utilised, and at Maryfield ground between Dura Street, and Clepington has been chosen.

Electric Lighting Order.—A special meeting of Dundee Town Council was held on Friday last, when the Town Clerk reported that when the late Provisional Order for the extension of the burgh boundaries was promoted, it contained clauses referring to electric lighting, but as the Secretary for Scotland had no power to deal with that question, the clauses had to be deleted. Mr. Don, convener of the Electricity Committee, moved that steps be taken to obtain an Order from the Board of Trade to extend the area for the supply of electricity to make it co-extensive with the new burgh boundaries. This was agreed to.

EALING: *Noisy Tramcars.*—A conference has been held at Ealing by several of the councils through whose districts the London United Co.'s tramways run, and it was decided that the matter could only be dealt with by the Councils individually, and that the Councils follow the course adopted by the Acton Council, that the Middlesex County Council put in force the Act of Parliament which provides that where the tramway company did not do work which was necessary, the authority could give the company seven days' notice, and then do the work itself, and charge the cost to the company. Several members of the conference are approaching Mr. Lloyd George to see what could be done through the Board of Trade in the matter.

FINCHLEY: *Extension of Tramways.*—Negotiations are proceeding between the District Council and the County Council with regard to the proposed tramways in Regent's Park Road, Ballards Lane, and Woodhouse Lane. A number of points have been settled, but six objections raised by the local authority have not yet been satisfactorily met by the County Council.

GLASGOW: *Tramway Extensions.*—The Tramways Committee of Glasgow Corporation have had under consideration a report by Mr. James Dalrymple, the manager of the Tramways Department, regarding the proposal to carry out the powers contained in the Glasgow Coporation (Tramways Consolidation) Order, 1905, to make tramways from Great Western Road to Gairbraid Street—7 furlongs, 26 yards; and from Gairbraid Street to Possil Park—1 mile, 1 furlong, 177 yards. The total length of these sections measures 2 miles, 203 yards, and it would be necessary to double the present single line in two places, which would measure 5 furlongs, 169 yards, making the total length nearly three miles, the cost of equipping which would be £43,000. A census was taken on ten days between September 24th and October 4th, and showed that some 800 people used the route each way every day. An estimate for this route for receipts per car mile would be 5d., and taking the expenses at 9¾d.—last year's figures—there was a loss of 6¾d. on every car mile run. If a five minutes' service were given, the annual car mileage would amount to 481,593, which at 6¾d. per mile would mean a total loss of £15,600 per annum. The Committee decided not to proceed with the work of construction at present.

HALESOWEN: *Light Railways Order.*—The Light Railways Commissioners have submitted to the Board of Trade for confirmation an order made by them transferring to a company the powers conferred on the Rural District Council of Halesowen by the Halesowen Light Railway Order of 1901, and the Extensions Order of 1902, and amending those orders.

HALIFAX: *Telephone Charges.*—The Halifax Corporation Telephone (Wayleaves) Committee have resolved to recommend the Town Council to accept the undermentioned terms:—5s. per annum to be paid by the company to the Corporation for each subscriber through the local exchange up to and including 1,000 subscribers; 2s. 6d. per annum for each subscriber beyond 1,000; 2s. 6d. per annum to be paid by the company to the Corporation for each pole and bracket; a rebate of 20 per cent. per annum to be allowed by the company off the tariff rates for telephones supplied to the Corporation. The new arrangement to commence on January 1st, 1908. Except as varied by the foregoing suggestions, the existing agreement will continue in force.

HANWELL: *Electric Lighting Order.*—At the last meeting of the District Council a letter was read from the Board of Trade stating that unless the Council could show that it intended to take action in regard to the Electric Lighting Order in the course of the next twelve months, the Order would have to be revoked. At the same meeting the General Purposes Committee reported as to the terms upon which the Metropolitan Electric Supply Co. were willing to take over the Council's Lighting Order. The company desired (1) modification of the list of streets in which mains are to be laid, and to this the committee saw no objection; (2), the Council to take the supply of electricity for the offices of the Free Library at 4d. per unit; (3), the company to fix on seventy of the existing lamp-posts in certain streets new lanterns, each containing 250 c.p. Osram, or other high efficiency lamps, to renew these lamps when necessary, and supply them with energy for 3,640 hours pere annum for an inclusive payment by the Council of £4 per post per annum; (4), the company to erect twelve flame arc lamps in the Uxbridge Road, and ten in Boston Road, with the necessary standards, to carbon and clean, renew the globes, repaint the standards, and supply energy for 3,640 hours per annum, for an inclusive payment of £21 per lamp per annum, this price being subject to revision at the end of ten years: (5), the company to repay to the Council the sum of £550 expended by the latter in obtaining the Provisional Order; (6), the Council to have the right of re-acquiring the undertaking in 42 years. The committee pointed out that the company made no condition in their first offer as to street lighting. The committee could not agree to the terms now proposed, and recommended that the agreement should be on the lines of that originally proposed, with the proviso that the Council would be willing to consider the question of street lighting when the supply of electricity was available. The report of the committee was adopted, and the surveyor was instructed to obtain details of the present cost of public lighting.

HASLINGDEN: *Electricity Scheme.*—An animated controversy is proceeding in the Haslingden district, and the part taken by the Lancashire Electric Power Co. is being adversely criticised. On the one side it is claimed that Accrington could have provided for Haslingden in their recent Bill, but for the action taken by the company. However, the borough will now take up the undertaking itself, and the Corporation has decided to electrify the present steam tramway system within the borough, which falls into their hands at the commencement of the New Year. The work is being carried out by the Corporation under the Borough Engineer Mr. J. Singleton Green. Messrs. Handcock & Dykes, 1 Victoria Street, Westminster, S.W., being retained as advising engineers.

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HORBURY: *Electric Lighting Order.*—The Board of Trade give notice that they have revoked the Horbury Electric Lighting Order of 1905, as to the whole area of supply, from the 19th of December, 1907, and the revocation takes place from that date.

HUDDERSFIELD: *Electricity Accounts.*—Orders for additional plant at the generating station have been given. During November the number of consumers was 2,611, against 2,584 in October, and the lamps connected, 192,169, as against 190,174. In reference to the extensions to Linthwaite and Golcar of electrical energy, the approval of the Board of Trade has been received.

KIRKALDY: *New Tramway Arrangement.*—At a meeting of the Tramway Committee of Kirkcaldy Town Council a report was submitted by Mr. Francis, Burgh Electrical Engineer, on the running of the tramway cars during the past four weeks under the system for the joint running of the Kirkcaldy and Wemyss cars, as suggested by the arbiter. He points out that, as compared with the same period of last year, the cars have run 5,016 less car miles, and have taken £26 14s. 4½d. more in receipts, while they have also carried 4,254 more passengers, so that there has been a net gain for the period mentioned of £120, which is at the rate of £1,560 per annum. From these figures it was apparent that the new system was giving greater convenience to the travelling public than the old system, since they were carrying a larger number of passengers. He recommended the Committee to give the present system a trial during all the various seasons of the year. There was no doubt that if the present receipts were maintained throughout the year the Kirkcaldy tramway and electric lighting undertakings would both be paying concerns.

LIVERPOOL: *An Improved Sanding Device.*—The sanding device described in ELECTRICAL ENGINEERING, Vol. I., p. 585, has been fitted to about 300 cars of the Liverpool Corporation. A test of the apparatus was recently demonstrated in Prescot Street, which is one of the steepest gradients in the city. The car was driven to the top, and then allowed to run back, but the sanding device so facilitated the work of pulling up, that the car was brought to a standstill in an extremely short distance. The same result was obtained when the car was driven down the hill at a speed of about eighteen miles per hour.

LONDON: *Hammersmith Electricity for Franco-British Exhibition.*—The Board of Trade have approved of the Hammersmith Borough Council supplying the Franco-British Exhibition with electrical energy, subject to the regulations for securing the safety of the public, and for ensuring a proper and sufficient supply of energy, and to the Board's regulations with respect to supply at extra high pressure. The terms between the Council and the Franco-British Exhibition Co. are as follows. The period within which the guaranteed minimum payment of £10,000 has to be made is from May 1st to October, 1908. The Council guarantees to supply 100 kilowatts on January 1st, 1908, and make a progressive increase in supply from that date up to 500 kw. to May 1st as the work advanced.

Marylebone: The Electric Lighting Accounts.—In reply to the criticisms on the local electricity undertaking, the chairman states, that instead of having only £8,000 at the end of the working year, ending March 31st, 1908, with which to meet £100,000 interest and sinking fund, as alleged in some of the criticisms, at the end of December 31st, 1907, £67,792 will have been paid on this account. There will be an estimated profit, after paying interest and sinking fund charges, of £11,000 at the end of the working year, but if there is any reduction in price per unit this will not be fully realised. The overdraft at the banker's is estimated to be at the end of December 31st £58,048, against which there is due from consumers £44,000. Expenditure on capital account is set down approximately at £1,991,500. Loans received total £1,974,920. An estimated increase of the sales for the year of 7·5 has actually been increased to 7·9.

MAIDSTONE: *Electricity Works Extensions.*—Considerable extensions have been made at Maidstone to the boiler-house and generating plant, and a complete installation of mechanical stokers has been put in, with new water purifiers. A new steam-dynamo set of 500 kw. capacity has been installed, the engine being a 940 i.h.p. Belliss & Morcom high speed triple-expansion, and the dynamo by Dick, Kerr & Co., and a new switchboard by Drake & Gorham.

NEWPORT: *Electricity Loan Granted.*—At a meeting of the Newport Electricity and Tramways Committee on Tuesday, it was reported, in regard to the conditional refusal on the part of the Local Government Board of sanction to borrow £30,000, applied for fifteen months ago, that the Board had now issued sanction for the greater portion of the loan, withholding for the present sanction for sums of between £4,000 and £5,000 upon expenditure, concerning which more information is required. The Town Clerk will furnish this, and it is anticipated that the full loan will then be agreed to, though the adverse balance of £2,600 brought forward on the revenue account must be paid off, and not further brought up from year to year.

OXFORD: *The Dolter System Tramways.*—A report has been submitted by Mr. Sellon, and adopted by the General Purposes Committee of the Oxford Corporation, to the effect that the Dolter system had not yet been working satisfactorily in any town in Great Britain for six months. According to the agreement which the Council entered into with the Dolter Co., an inspection was to be made by the Corporation of some tramway run on the Dolter system for six months, and a definite answer as to whether they considered it satisfactory for Oxford, was to be given to-day. With this object in view the Corporation were invited by the company to visit Hastings last week. After luncheon at the Queen's Hotel an inspection was made of the whole of the line laid upon the Dolter system, extending to the western end of St. Leonards along the sea front for about 1¾ miles. The greater part of this is double line. The party rode on the cars to the further end of the line, and then dismounted and walked back along the track from end to end. After dark the party again walked along the line, in order the better to observe the flashing of the studs, and the alleged interference with the lights in the cars, about which so much has been said. Since the track was first laid in Hastings many improvements have been effected. The studs, which at first were raised above the level of the track to an average extent of about five-eighths of an inch, have now been considerably worn down to about a quarter of an inch. When the cars first started to run a horse received a shock from a live stud, but since that time no accidents have occurred. The fact that the Board of Trade now considers the system quite satisfactory is revealed by the fact that a full licence has been granted. At the first application a licence for six months was granted, and on the second occasion another licence for a similar period was allowed. The conditions of this line are very different from those prevailing at Oxford. The sea front is a wide thoroughfare, on which the track is laid at one side, whilst considerable space is left on the other for vehicular traffic. For this reason it is comparatively seldom that the tram track is used by the ordinary traffic. Only perhaps about three hundred yards traverse a business street, and that is fairly wide. The conditions at Torquay more nearly approach those at Oxford, so that it is quite possible that the Corporation may still decide to visit Torquay also.

PONTYPRIDD: *Rhondda Tramway Route.*—Colonel Druitt, of the Board of Trade, conducted an inspection on Friday last of the new viaduct at Pontypridd, connecting the tramways of that town with the Rhondda Valley. The inspector expressed himself satisfied with the structural arrangements, and the electric tramcars of the District Council commenced running on Saturday last.

SPALDING: *Urban Council Surcharged.*—The district auditor (Mr. J. A. Cole) has surcharged members of the Spalding Urban Council with £66, being amount incurred in opposing an electric lighting scheme, powers for which were being applied for by an outside company. The ground of the surcharge is that the Local Government Board were not notified of the action the Council were taking in the matter. The Council are appealing to the Local Government Board against the decision.

TORQUAY: *Tramway Progress.*—At Torquay the demand of the Tramways Company for current has increased so considerably that extensions will have to be carried out at the electricity station, which is now taxed to the utmost capacity.

WIGAN: *Electricity in Collieries.*—We learn officially that Messrs. Pearson & Knowles, Coal and Iron Co., Ltd., one of the largest concerns of the kind in the country, are having powerful electrical plant put down for haulage, driving, and other purposes at their extensive collieries at Abram, near Wigan.

Electric Lighting Order.—The Board of Trade give notice that they have revoked the Wigan Rural District Electric Lighting Order, 1903, as to the whole area of supply, from the 30th of November last, and the revocation takes effect from that date.

WIMBLEDON: *Electric Lighting Extensions.*—The Electrical Engineer reports that the actual cost of erecting 33 flame arc lamps in Worple Road, Kingston Road, and Haydon's Road, was £639. The Electric Lighting Committee have decided in favour of a sum of £639 8s. 10d., in addition to the £1,500 already voted in relief of rates, being transferred from the electric lighting account to the general district fund. The Electrical Engineer has submitted a report upon the relative cost and efficiency of tantalum lamps, osram, and carbon filament lamps, now in use, for street lighting purposes, and acting upon the report, the Electric Lighting Committee has decided that no extensive alteration should be made at present in the existing system, but that one 32 c.p. carbon filament lamp be gradually substituted in the street lamps for each pair of 16 c.p. lamps now used. Complaints of defective lighting having been received, eight of the carbon filament lamps in Kingston Road are to be replaced by osram lamps, and a 32 c.p. carbon filament lamp substituted for each pair of 16 c.p. lamps in Quicks Road, and Barghley Road. An additional lamp-post, fitted with

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a 32 c.p. carbon filament lamp, is to be placed in Stanton Road. Failures of the electric supply occurred in the district during December, caused, on one occasion, by the breakdown of a 75 kw. transformer, and on another by a pick being driven into a supply cable. Two 100 kw. transformers were hired for £10 and 10s. each per day when used, in view of the breakdown mentioned above.

WINNIPEG: *Electric Progress.*—It is estimated by experts that by their completion of the water-power plant the Winnipeg Electric Co. will save quite $100,000 a year in working costs, which would in all probability equalise any reduction in traffic in Winnipeg that may result from any easing off in business at that centre of Western activities. It is asserted that the company has 22,000 h.p. available, 15,000 of which are sufficient to satisfy its own requirement, while the balance can be disposed of to local users. Rapid progress is being made with the extension of the suburban lines, and the electrification of the section from Winnipeg to Selkirk, some 22 miles in length, at present being operated by steam, is being proceeded with. The financial position of the company has made rapid progress during the last year or two, and the stock at about 120 is regarded as an attractive investment.

TENDERS INVITED AND PROSPECTIVE BUSINESS

AUSTRALIA.—In reference to the notice on page 953 of our issue for December 19th, Mr. J. Cresswell, the Board of Trade correspondent at Adelaide, has forwarded a copy of the specification and conditions relating to the supply and delivery to the Municipal Tramways Trust, Adelaide, of special work, points and crossings for tramways. Sealed tenders, endorsed "Tender for Special Work," must reach the Chairman, Municipal Tramways Trust, 8 King William Street, Adelaide, by noon on February 11th, 1908. Tenders must be accompanied by a preliminary deposit equal to one per cent. of the total amount of the tender. The specification and conditions may be examined by British manufacturers at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, E.C.

The Victorian Postmaster-General's department invites tenders by May 26th, 1908, for the supply of one common battery switchboard of thirty sections, complete with frames, racks, power plant, and parts; also for 3,000 telephone wall sets; 1,000 telephone table sets; 150 extension switches, complete; 10 switchboards, for 2 and 6 lines; 50 switchboards, for 5 and 10 lines; 10 switchboards, for 6 and 20 lines; 10 switchboards, for 8 and 50 lines; 200 telephone wall sets, for party lines; and 100 telephone wall sets, for party lines.

BARNES.—The Council invite tenders for the delivery and erection at the Council's depôt, High Street, Mortlake, London, S.W., of a two-ton electric locomotive crane. Full particulars from the Engineer's and Surveyor's office, High Street, Mortlake, to whom tenders should be sent by January 15th.

BULGARIA.—A British Consular report states that besides Government requirements, there are various municipal enterprises in Bulgaria in which British contractors and manufacturers should obtain a share, including electric lighting and traction.

BUENOS AYRES.—The *Review of the River Plate* states that the Buenos Ayres Municipality are calling for tenders for a period of six months—May 1st, 1908—for the construction of two tube railways, and also for the renting and working of same when built. Full particulars can be obtained in the Argentine Legation in the following cities:—London, Paris, Berlin, Brussels, Rome, and New York.

CANADA.—*The Financier* states that from Montreal comes the report that a syndicate of British capitalists is prepared to spend £2,000,000 in Canada's electrical development. The scope of the enterprise will, according to Mr. Rodolphe Forget, M.P., who has been an active promoter of the scheme, include the improvement of existing electric railways, the construction of others—especially in the rural districts of Quebec Province—and the development of water powers for industrial purposes in Ontario and Quebec. One of the engineers employed by the syndicate has been in Canada for two months making a careful inspection, and one of the leading members of the syndicate is now on his way to Canada.

FINCHLEY.—Tenders are invited for the supply and erection of a 350 kw. high speed engine and dynamo combined, together with spare parts. Particulars from the Electrical Engineer (Mr. E. Calvert), Electricity Works, Squire's Lane, Finchley, N. (fee £2 2s., returnable); and tenders to the Town Clerk by January 20th.

GLASGOW.—The Corporation invite tenders for the supply of a 4,000 kw. turbo-alternator running at 750 r.p.m. Copies of the specification and form of tender may be obtained on application to Mr. W. W. Lackie, engineer, 75, Waterloo Street, Glasgow (fee two guineas, returnable), and tenders to the Town Clerk by January 14th. (See advertisement this week.)

GUISBOROUGH.—The question of electric lighting is under consideration by the Town Council, and a special meeting is to be held.

ILFORD.—The Council are to erect larger tantalum lamps down Ilford Lane from the termination of the arc lights to Loxford Bridge. Extensions of arc lighting are also to be considered shortly.

INDIA.—Tenders are invited by the Bengal and North-Western Railway Co. for 15,000 incandescent lamps. Specifications may be obtained at the company's London offices, price 10s. (not returnable), and tenders should be addressed to the Managing Director, 237 Gresham House, Old Broad Street, E.C.

KILKENNY.—The Joint Committee of Management of the Kilkenny and District Lunatic Asylum invite tenders for (1) suction gas plant, gas engines, and generators; (2) accumulators, switchboard, mains, &c. Plans may be inspected by appointment at the Asylum or at the office of the consulting engineer, Mr. L. J. Lawless, 27 Castlewood Avenue, Rathmines, Dublin, from whom copies of the general conditions, &c. may be obtained (fee, three guineas, returnable). Tenders to the Resident Medical Superintendent by January 18th.

LONDON: *London County Council.*—Tenders are invited for the supply and delivery of about 500 tons of steel slot rails and about 190 tons of conductor rails, required for the reconstruction on the underground conduit system of electric traction of certain sections of the Council's tramways. The rails must be of British manufacture. Full particulars, forms of tenders, &c., from the Chief Engineer to the Council, Mr. Maurice Fitzmaurice (fee £2, returnable), and tenders to the Clerk to the Council by January 21st.

Fulham.—The Board of Guardians has instructed the engineer to revise the telephone system at the infirmary at an estimated cost of £70 6s.

Poplar.—The Guardians invite tenders by January 8th for electrical supplies, among other stores. Tenders to the Clerk to the Guardians, 45 Upper North Street, Poplar.

Stepney.—A loan of £20,000 is being taken up from the London County Council in connection with the electricity undertaking upon the terms that such amount is taken up at once and repaid by equal annual instalments as to the sum of £10,000 within the last thirty-nine years of a term of forty-two years, and as to the sum of £10,000 within a period of thirty years, at 4 per cent. per annum.

METROPOLITAN ASYLUMS BOARD.—The Metropolitan Asylums Board invite Tenders for installation of electric lighting, &c., in the motor workshops and yard at the Mead Ambulance Station, Carnwathe Road, Fulham, S.W., in accordance with drawing and specification prepared by Mr. W. T. Hatch, M.Inst.C.E., M.I.Mech.E., Engineer-in-Chief. The drawings, conditions of contract, &c., may be inspected at the office of the Board, Embankment, London, E.C., where they can be obtained upon the payment of a deposit of £2 (returnable). Tenders to the Clerk by January 8th, 1908.

OSSETT.—An application is to be made by the Council to the Local Government Board for sanction to a loan of £23,000 in connection with the Dewsbury and Ossett tramways.

ROTHERHAM.—The Corporation invite tenders for the supply of tramway rails, fish-plates, tie-bars, bolts and nuts, and special trackwork, to be delivered in Rotherham. Specifications, &c. (fee one guinea, returnable), from the Borough Engineer, and tenders to the Town Clerk by January 17th.

RUSSIA.—The St. Petersburg Municipality have passed a resolution granting to the Tramway Committee a sum of 2,067,000 roubles (about £296,000) for the purchase of 57 new motor-cars and 210 trailer cars for the municipal tramways.

SHERINGHAM.—The Urban District Council have instructed their surveyor to report upon the cost of an electric lighting scheme.

TASMANIA.—The Town Council of Zeeham propose to borrow £3,000 for the purpose of additions to the generating plant at the electric power station.

WILLESDEN.—Application is to be made to the Local Government Board for sanction to borrow further sums for the purposes of the electricity undertaking, amounting to £14,727.

WIMBLEDON.—Tenders are to be invited for the supply and installation of a 1,000 kw. turbo-alternator with condenser, and two water-tube boilers with economisers, pipe-work, and feed-pumps, for the Council's electricity works, also for a remote control main high tension switchboard, and for the annual supply of flame arc lamp carbons from March 31st, 1908.

WORCESTER.—The Corporation invite tenders for the supply, delivery, and erection of the following plant:—A 400 kw. continuous-current steam generator; balancing dynamo; surface condenser. Copies of specification, &c. (fee one guinea, returnable), from the City Electrical Engineer, Mr. C. M. Shaw, to whom tenders by January 6th

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TENDERS RECEIVED AND ACCEPTED

ARGENTINE.—The Lacroze Tramway Co. has ordered 22 electric tramcars from the J. G. Brill Co. to replace those destroyed by fire early this year.

AUSTRALIA.—Tenders for the supply of telegraph, telephone, and electric light material for the year 1908 have been accepted from the following firms by the New South Wales Postmaster-General's Department:—British Insulated & Helsby Cables, Ltd.; India Rubber, Gutta Percha, and Telegraph Works Co., Ltd.; International Electric Co.; Vacuum Oil Co., Ltd.; and Siemens Bros. & Co., Ltd.

BAHAMAS.—It is stated that the contract for the municipal electric lighting plant at Nassau has been given to an American firm.

BLACKBURN.—The Board of Guardians has accepted the tender of Mr. H. Garstang, electrical engineer, for electrical repairs and the maintenance of fire alarms in the Union for the ensuing quarter.

BUENOS AYRES.—A contract has been let for supplying Government House with electric lifts.

COUNTY OF LONDON ELECTRIC SUPPLY CO.—An order has been placed with the British Thomson-Houston Co. for a Curtis turbo-generator set of 2,500 kw. capacity, complete with sub-base condensing plant, for the City Road Station (London) of the County of London Electric Supply Co. This is the fifth contract, and the sixth Curtis turbo-generator set ordered by the County Co. from the British Thomson-Houston Co., Ltd., aggregating 10,000 kw. in capacity.

ERITH.—The tender of the Woodville Electric Co. has been accepted for the installation of electric light at 48 municipal cottages in Brook Street, Belvedere.

FAVERSHAM.—An offer by Messrs. Drake & Gorham to supply "Hoadley" attachments to all the Nernst lamps in Faversham at 2s. 6d. each if the firm did the fitting, or 2s. 3d. if the Council did the fitting, has been received. It has been resolved that 50 of the attachments be obtained if they could be supplied at 2s. 3d. each, the electrical engineer to do the fitting.

SOUTH WALES.—The Treforest Electrical Consumers' Co., Ltd. (South Wales Power Co.), having decided to extend its plant, has placed an order with the British Westinghouse Electric and Manufacturing Co., Ltd., for one 3,000-kw. turbo-generator, 1,500 r.p.m., and complete high-vacuum surface-condensing plant fitted with the Westinghouse-Leblanc dry air pump.

STOKE-UPON-TRENT.—Subject to the sanction of the Local Government Board to the necessary loan, the following tenders have been accepted for plant in connection with the supply of electrical energy to Fenton:—Phœnix Dynamo Co., balancer and booster, £267 10s.; Switchgear Co., switching apparatus, £93 17s. 6d.

URUGUAY.—The tender of Messrs. Felten & Guilleaume for the supply of 39 km. of cable to the Monte Video electric supply works has been accepted.

WALTHAMSTOW. The tender of Messrs. Johnson & Phillips, Ltd., at £19 2s. 3d. for the supply of slate panels, in connection with the rearrangement of feeder cables at the generating station, has been accepted. The contract of Messrs. Chamberlain & Hookham, Ltd., for the supply of meters has been renewed on the same terms as previously.

The following tenders for the supply of paints and varnishes in connection with the tramway undertaking have also been accepted: R. F. Coulston, whitelead in oil; S. Mason, white lead, dry, ground pumice stone, lump pumice stone, turpentine; Docker Bros., blacklead, oil, black-brown; L. Berger, purple-brown, L.B. light Indian red, vermilion real dry, peacock-blue, olive green, chrome yellow, drop jet black, shellac brown, shellac white; Kearsley & Son, raw sienna, crimson lake, raw linseed oil; Kearsley & Son and Docker Bros., body varnish, best finishing body V, gold size, terebene; Everett's Stores, methylated spirit, benzoline.

The West Hampstead Accident.—At the conclusion of the police court proceedings at Marylebone on Saturday, against Signalman Hollis, who was on duty at the time of the collision between two electric trains in West Hampstead station in October, Mr. Plowden committed him for trial on a charge of manslaughter. He stated that the case was of great importance, and raised many points which could only be cleared up by a judge and jury, and it was for this reason, without prejudging the case, that he committed the accused signalman for trial.

Wireless Telegraphy in the French Navy.—A *Reuter's* telegram states that experiments with the Tissot system of wireless telegraphy have been made at Lorient on the Bay of Biscay, on board the cruiser *Kléber*. An attempt was made to open communication between the Eiffel Tower and the *Kléber* and the battleship *République*, which is at Toulon. The results were not quite satisfactory as no reply was received from the *République*. In the evening, however, communication was established with the battleship, and the telegraphists then tried to get into touch with Casa Blanca. The instruments on the *Kléber* were affected slightly, but ordinary communication was found to be impossible.

COMPANIES' MEETINGS AND REPORTS

SOUTH AMERICAN LIGHT AND POWER.—The annual meeting was held on Tuesday, when it was explained that the holding of the meeting had been delayed on account of the non-arrival of the auditor's figures from Bahia Blanca. The balance-sheet figures, which were on their way over, showed a small balance, which would have been greater but for the expense incurred in transferring all the overhead wires underground. The report was adopted conditionally upon the figures being subsequently certified. At an extraordinary meeting held later, the issue of 50,000 ordinary shares at £1 each was sanctioned.

SUNDERLAND DISTRICT ELECTRIC TRAMWAYS.—The report for the year ended October 31st last states that there is a loss on the year's working of £4,723, after deducting debenture interest, bringing the loss to date up to £12,056. This will be slightly reduced by a payment by the Durham Collieries Electric Power Co., Ltd., being royalties for current sold during the twelve months under their agreement with the tramway company. The actual amount has been referred to arbitration. Compared with last year the traffic receipts at Sunderland show an increase of £2,594. The cost of working to receipts comes out at 75·41 per cent. as against 75·76 per cent. last year. In view of the necessity for raising further capital, the Board has for some weeks been engaged in formulating a scheme which would be acceptable to the debenture holders and shareholders and after consultation with the trustees for the debenture holders and some of the largest preference and ordinary shareholders, they have decided that the best way would be to create prior lien bonds up to £20,000, with a currency of ten years, to issue £5,000 at once, and £10,000 as and when required during the next twelve months, holding £5,000 in reserve for contingencies. It is thought that with the judicious expenditure of this further capital on the undertaking the traffics will show a considerable expansion. When the receipts grow so as to show a surplus profit it will then be necessary to readjust the capital of the company, as without some such readjustment a distribution of dividends would appear to be impracticable.

At the meeting on Monday, the report and accounts were adopted, after a lengthy speech by the chairman, Mr. C. S. Cockburn, J.P. The chairman stated that he felt relieved the position was not worse, and that a receiver was not in possession. Even this would still be necessary if the debenture holders did not agree to the proposals of the Board in regard to raising new capital. When he joined the Board in the spring he found that of the £20,000 second debentures authorised at the last annual meeting, it had only been possible to issue some £14,000, and that there were debts and liabilities totalling about £10,000. He had to take £5,000 of these second debentures himself, and to get some of the creditors to take a portion of their debts in these second debentures instead of insisting on cash. He was glad of this opportunity of thanking those creditors who thus assisted the company. It was not an enviable position to assume—to travel round the city of London and the town of Sunderland to persuade irate and insistent creditors to reduce their just claims for payment for work done and then to ask them to accept second debentures instead of cash in part payment of those claims. It was a *rôle* he had never had to assume on his own behalf and in view of his experiences it was a position he would take very good care never again to take up for any company. They now owed to tradesmen and others the sum of £2,885, and were short of the debenture interest on January 1st by £2,100; hence the Board's decision to ask the shareholders to sanction the borrowing of £5,000 at once.

In enumerating the causes which have led up to the present position, the chairman mentioned the installation of the gas plant, which had been a constant source of trouble, the two serious accidents upon the system, the issue of miners' tickets, which it was ultimately found were being worked at a loss, the bad weather during the past year, and the purchase of fifteen French cars which, he said, had he the capital, he would scrap at once. Again, there were the track subsidences due to the colliery working, which was a danger they would always be exposed to. The directors, however, were quite convinced that the poulation was there to be carried. Dealing with the details of the working expenses he pointed out that for the year from November 1st, 1906, to October 31st, 1907, the receipts per car mile come out at 7·608d., and the power costs 0·790d. per unit. The total works costs showed 6·174d., and the net revenue came out at 1·434d. The units per car mile worked out at 1·685. On a car mileage of 758,532, the passengers carried were 3,741,096. The receipts per passenger were 1·542d. and the costs per passenger 1·251d. Other details having been referred to, the report and accounts were adopted as stated above. At a subsequent meeting of the debenture holders, the chairman stated he believed the company had turned the corner, but at the same time, in connection with the expenditure of the new £20,000 capital, the Board would welcome a committee to co-operate. He also stated that the company's bankers had agreed to lend up to £2,500 at once, if wanted, on his personal guarantee, which, if the scheme went through, he had

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no hesitation in giving. An extraordinary general meeting of the company followed, at which the scheme was also sanctioned.

UNDERGROUND ELECTRIC RAILWAYS COMPANY OF LONDON.—At the annual meeting on Monday last week the report given in full in our issue for December 19th was adopted. Sir Edgar Speyer, who presided, made no speech, but stated that, in view of the fact that the directors hoped early in the new year to put before the shareholders a scheme dealing with the finances of the company, he thought it better to reserve his remarks until then.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Son, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f., port of arrival, quoted on Tuesday night was £63 10s. to £64 10s. per ton.

ARMORDUCT MANUFACTURING CO., LTD.—Mr. F. Smart, who for many years was connected with the General Electric Co.'s Newcastle branch as assistant manager, has been appointed manager of the Newcastle branch of the Armorduct Manufacturing Co., Ltd.

DINNERS, &c.—The annual dinner of the engineering staff of the Croydon Corporation Tramways was held on Saturday, December 14th, Mr. Harris, the tramways engineer, presiding.

On Saturday, December 21st, the employees of Messrs. A. Reyrolle & Co., Ltd., Hebburn, held their fifth annual dinner. Mr. Reyrolle took the chair, and stated that although many other electrical firms had experienced a slackening of orders, he was glad to say that they had had an extremely busy year.

The second annual fancy dress ball of the Robertson Social and Athletic Club was held at the Brook Green Works, Hammersmith, on December 21st.

DISSOLUTION OF PARTNERSHIP.—The partnership between F. J. Robinson and W. J. Silvester, Electrical and General Engineers, 21 Collingwood-street, Newcastle-upon-Tyne, has been dissolved by mutual consent. All debts by F. J. Robinson, who continues.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—A meeting of the Premier Accumulator Co., Ltd., will be held at 10 Ironmonger Lane, London, E.C., on January 27th at 12 noon, to hear the liquidator's account of the winding up.

Creditors in the bankruptcy of T. A. Cotton, carrying on business as an electrical engineer as Cotton Bros., 78 King Street, Manchester, are requested to send particulars of their claims to Mr. Arthur Nicholas, 63 Bridge Street, Manchester, by January 10th.

The re-examination of W. D. Palmer, electrical engineer, 50 Wellington Street, Glasgow, was heard last week and adjourned. The statement of affairs shows a deficiency of £5,952.

WESTINGHOUSE-BREMER PATENTS.—The British Westinghouse Electric & Manufacturing Co., Ltd., inform us that they have now received the decision of the Comptroller-General of Patents, and have, therefore, issued a writ against Messrs. D. Santoni & Co. (1906), Ltd., for infringement of the Westinghouse-Bremer flame arc-lamp patent.

MISCELLANEOUS CITY NOTES

AMERICAN WESTINGHOUSE COS.—The Washington correspondent of *The Times* states that an important industrial fact made public is that arrangements are nearing completion to put Mr. George Westinghouse's concerns on a sound basis again, and to discharge the receivers. Official reports indicate that the concerns are entirely solvent and were doing a profitable business at the time of, and for years before, the receivership.

HAVANA TELEPHONE CO.—The half-year's interest, due January 1st, on the 5 per cent. first mortgage debentures, will be paid on and after that date by the company's bankers, Messrs. Frederick J. Benson & Co., 11 and 12 Blomfield-court, London, E.C., on the production of provisional scrip certificates, which must be left four clear days for verification.

COMPANIES TO BE STRUCK OFF REGISTER.—The following are among the companies which will be struck off the register within three months from December 24th, and dissolved, unless cause is shown to the contrary. Electrical Inkless Printing Syndicate, Ltd.; Electric Printing and Publishing Co., Ltd., Electrophone, Ltd.; Medical Electrical Institute, Ltd. The Electric Printing and Publishing Co. was registered in 1894 with a capital of £6,000, to work a reproduction process, and has no connection with any electrical journal. The Electrophone, Ltd., was registered in 1894. Another company of this name is now carrying on business.

NEW PUBLICATIONS

Proceedings of the American Institute of Electrical Engineers. December, 1907. (New York: The Institute.) 50c.

"The Science Year Book, 1908." (London: King, Sell & Olding). 5s.

APPOINTMENTS AND PERSONAL NOTES

MR. E. P. BARFIELD, who has filled the position of lamp manager to the General Electric Co., Ltd., for the past eight years, has resigned in order to take up a similar position with Messrs. Siemens Bros. Dynamo Works, Ltd.

For the positions of traffic superintendent and rolling-stock superintendent at Halifax, the following have been selected for final decision:—Traffic superintendent: R. F. Rogers, Leeds; James D. Caird, Aberdeen; E. Cloney, London; Thomas Tate, Wakefield; E. Lafferty, Preston; and H. H. Saunders, Lowestoft. Rolling-stock superintendent: H. Hartley, Darlaston; Thomas Wilkinson, Haydock; E. Sidgwick, Stalybridge; J. W. Galloway, Rochdale; J. H. Burton, Wakefield; and E. Metcalfe, London.

MR. ARTHUR JACOB informs us that he has undertaken the control of the commercial organisation of The British Aluminium Co., Ltd., 109 Queen Victoria Street London, E.C., and has, in consequence, severed his connection with Messrs. Siemens Brothers Dynamo Works, Ltd., London.

NEW COMPANIES

ELECTRICAL APPARATUS CO.—This company was registered on December 23rd, with a capital of £3,500 in £1 shares, to acquire the business of electrical engineers carried on by E. Schattner, F. H. Epstein, R. Amberton, and R. Behrens, at Caxton House, Westminster, as the Electrical Apparatus Co., and to carry on the same and the business of electricians, suppliers of electricity, manufacturers of, and dealers in, motors, dynamos, accumulators, storage cells, insulators, lamps, and other electrical apparatus and appliances, &c. The subscribers are:—F. Epstein, electrical engineer; Miss C. Amberton; R. Behrens, electrical engineer; R. Amberton, electrical engineer; J. H. Epstein; E. Schattner, electrical engineer; Mrs. K. Schattner; T. A. Hargreaves. No initial public issue.

GASOL ENGINEERING CO.—This company was registered on December 24th, with a capital of £500 in £1 shares, to carry on the business of mechanical, electrical, and marine engineers, millwrights, ironmasters, iron and brassfounders, manufacturers of steam engines, boilers, gas and electric generating appliances, gas and electric engines, motors and machinery, &c. No initial public issue.

LAMINATED GEARS.—This company was registered on December 21st, with a capital of £10,000 in £1 shares, to adopt an agreement with S. W. B. McGregor, and to carry on the business of ironfounders, mechanical and electrical engineers, electricians, manufacturers of engines, boilers, and machinery, tool makers, &c. No initial public issue. Registered office: 9-10 St. Mary-at-Hill, Eastcheap, E.C.

MITCHAM ELECTRIC FAN CO.—This company was registered on December 20th, with a capital of £10,000 in £1 shares, to acquire and turn to account inventions relating to the production, storage, application, distribution, and use of electricity, to adopt an agreement with the Dynamic Syndicate, Ltd., and to carry on the business of manufacturers of and dealers in electric fans, electric tools, induction coils, &c. No initial public issue. Registered office, 6 Broad Street Place, E.C.

RELIANCE INCANDESCENT CO.—This company was registered on December 24th, with a capital of £6,700 in £1 shares, to carry on the business of ironmongers, electric lighting and heating, and general engineers, gasfitters, manufacturers of and dealers in glassware, and lighting and heating accessories, &c., and to adopt an agreement with A. Gross and a deed of covenant between the said A. Gross of the first part, A. Weiss of the second part, A. C. H. Raetsch, and C. H. Thoem of the third part, and the company of the fourth part. No initial public issue. Registered office, 50 Rye Lane, Peckham, S.E.

SHEFFIELD SHERARDISING CO.—This company was registered on December 21st, with a capital of £20,000 in £1 shares, to acquire the sole and exclusive licence for Sheffield and the surrounding district under certain patents for the depositing of metals on metals known as the "Sherardising and analogous process;" to adopt agreements (1) with P. Dawson, and (2) between the Sherardising Syndicate, Ltd., of the first part, P. Dawson of the second part, and this company of the third part, and to carry on the business of galvanisers, zinc workers, steel and ironmasters, founders, manufacturers, and blenders of alloys, electro-platers, engineers, &c. No initial public issue. The number of directors is not to be less than three nor more than five.

WM. WHITEHOUSE & CO.—This company was registered on December 24th, with a capital of £50,000 in £1 shares, to take over as from December 31st, 1906 the business carried on by W. Whitehouse and H. Pinnell (trading as "Wm. Whitehouse & Co."), at Empire Works, Brueton Street, and Lawrence Street, Birmingham, and to carry on the business of gas and electric fittings, manufacturers, brassfounders, art metal workers, &c. No initial public issue. Registered office: Empire Works, Brueton Street, and Lawrence Street, Birmingham.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906 %	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£				
Bournemouth & Poole E. S. Co. Ld.	10	7	5/-*	9½—10½	
Do. 4½% Cum. Pref.	10	4½	4½*	9½—10	
Do. 6% Cum. Second Pref.	10	6	6*	9¾—10¾	
Do. 4½% Debenture, Red.	Stock	4½	4½	98—101 xd	-2
Bromley (Kent) E.L.& Power Co., Ld.	5	5½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	95—98	
Brompton & Kensington E. S. Co., Ld.	5	10	4½*	7—8	
Do. 7% Cum. Pref.	5	7	7*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4*	96—99	
Ch. Cross, W. E. & City E. S. Co.	5	5	5*	3⅞—4⅛	
Do. 4½% Cum. Pref.	5	4½	2½*	3¾—4⅛	
Do. 4% Deb. Red	Stock	4	4*	95—98 xd	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½*	3¾—4⅛	
Chelsea Electric Supply Co., Ltd.	5	4½	2/-*	3¼—4¼	
Do. 4½% Deb. Red	Stock	4½	4½	100—103 xd	-2
City of London Elec. Lt. Co., Ltd.	10	6	5%*	9½—10½	
Do. 6% Cum. Pref.	10	6	6%*	11—12	
Do. 5% Deb. Red	Stock	5	5%	120—123 xd	-2
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	93—96 xd	-2
City of Durham E. P. Dis. Co.	5	4	2/1%*	3½—4½	
Do. 5% Pref.	5	5	5%*	4⅜—4⅝	
County of London Elect. Sup. Co. Ld.	10	5	4%*	6½—7½	
Do. 6% Cum. Pref.	10	6	6%*	10¼—11	
Do. 4½% Deb. Red	Stock	4½	4½%	105—106 xd	-2
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	95—98	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅜—⅝	
Do. 6% Cum. Pref.	5	3½	—	¾—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	75—80	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4½—5	
Do. 5% Cum. Pref.	5	5	2/6*	4⅝—5⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	96—99	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6⅜—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%	95—98	
Kens & N't'ng Hill E.L. Cos. Db. Rd.	Stock	4	4%	98—102	
London Electric Supply Corporation	3	4	2/1½d*	1¼—1⅜	
Do. 6% Pref.	5	6	6%*	4—4½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	87—91 xd	
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	5⅜—5⅝	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—4⅝ xd	-¼
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	100—104 xd	-2
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90 xd	-2
Midland E.Corp.for P.Dist.1stMt.D.	100 & 500	4½	4½%*	96½—99½	
Newcastle & Dist. E. L. Co., £9 paid	10	5	3/7½d.*	8½—9½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99 xd	-2
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6½—6⅝	
Do. £2 Pm.	5	8	1/4⅞d*	6¼—6⅝	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5⅛	
Do. 10/- Pm.	5	5	1/4⅞d	5—5⅛	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	6%*	10½—11½	
Oxford Electric Co., Ltd.	5	7	2/6*	5½—6	
Do. 4% Deb. Red	Stock	4	4%*	95—97	
St. James and Pall Mall E. L. Co. Ld.	5	10	5/-*	7¼—8½	
Do. 7% Non-Cum. Pref.	5	7	3/6*	6½—7½	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90 xd	-2
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	½—1½	
Do. 4% Deb. Red	Stock	4	4/-*	71—75	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2½—3	
South Metropolitan E. L. & P. Co.	1	2½	6d*	⅝—⅞	
Do. 7% Cum. Pref.	1	7	8⅜d.*	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1½—2¼	
Do. 5% Cum. Pref.	5	5	2/6*	1⅝—2⅝	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	5%*	7⅜—8⅜	
Do. 4½% Cum. Pref.	5	4½	4½%	4½—5 xd	-⅛
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%*	89—92	+1
Central London	Stock	4	3%*	62—65	
Do. 4% Preferred	Stock	4	4%*	83—85	
Do. Deferred	Stock	4	—	41—44	
Do. 4% Debentures	Stock	4	4%*	101—104	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	72—76 xd	-2
City and South London Cons.	Stock	2⅝	2¼	43—45	
Do. 4% Perp. Deb.	Stock	4	4%	100—103	
Do. 5% Perp. Pref. 1891	Stock	5	5%*	116—119	
Do. 5% Perp. Pref. 1896	Stock	5	5%*	113—116	
Do. 5% Perp. Pref. 1901	Stock	5	5%*	113—116	
Great Northern & City Pref. "A"	10	4	11½d.	1¼—1⅜	
Gt. Northern, Piccadilly & Brompton	10	4	4/-	4—5	
Do. 4% Perp. Deb.	Stock	4	4%	78—82 xd	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1½*	38½—39½	+2½
Do. 3½% Preference	Stock	3½	3½%*	85—88	
Do. 3½% "A" Pref.	Stock	3½	3½%*	75—80	
Do. 3½% Convertible Pref.	Stock	3½	3½%*	70—75	
Metropolitan District	Stock	nil	—	8½—9½	+⅛
Do. 6% Perp. Deb.	Stock	6	6%	100—105 xd	-2
Do. 4% Pref. Deb.	Stock	4	4%	68—73 xd	-2
Do. Extension Pref. (5%)	Stock	nil	—	10—20	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	—	47—52	
Underground Elec. Railways Co of London 5% Profit Shg. Sec. Notes	Various	5	5%	35—39	
Whitechapel and Bow 4% Deb.	Stock	4	4%	102—105 xd	-1
ELECTRIC TRAMWAYS.					
Batu Electric Tramways, Ltd.	1	5	1/-*	1⅛—1⅜	
Do. 5% Cum. Pref.	1	5	5%	1⅜—1⅝ xd	
Do. 4½% Deb. Red.	Stock	4½	4½%	91—95	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	90—93 xd	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	5—5½	
Do. 5% Perp. Deb.	Stock	5	5%	90—93	
Do. 4½% 2nd Deb.	Stock	4½	4½%	70—75	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4¼—4⅜	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	96—99	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906 %	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£				
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%*	12¾—13¾	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	92—95 xd	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅞—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63 xd	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	92—95 xd	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7½—8½ xd	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	79—83 xd	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	95—98	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—3/16	
Do. 5% Cum. Pref.	1	5	6d*	⅛—⅜	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	91—94 xd	
National Elec. Construction Co. Ltd.	1	10	2/-	1⅛—1⅞	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	¾—1¼	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅝—⅞	
Do. 3½% Mort. Deb.	100	3½	3½%*	90—93	
Potteries Electric Traction Co. Ltd.	1	4	9⅞d*	15/16—1	
Do. 5% Cum. Pref.	1	5	5%*	⅛—¾	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4⅝—5¼	
Do. 6% Cum. Pref.	10	6	6%	10—11 xd	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	6⅞d.*	⅞—1⅛	
Do. 4% Deb. Red	Stock	—	4%	78—82 xd	
Sunderland Dst. E.Trs. 1st Mt. Db. Rd.	100	5	5%*	77—81	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1½	
Do. 6% Cum. Pref.	5	nil	—	3¼—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	78—81 xd	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅜	30/-	55—58	
Do. 6% Pref. Ord.	Stock	6	3%	99—101	
Do. Def. Ord.	Stock	1⅜	—	16—16½	+1
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	80—84 xd	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3½	
Do. 10% Cum. Pref.	5	10	5/-*	8½—8¾	
Do. 4½% Debs.	50	4½	4½%	98—101	
Direct United States Cable Co. Ltd.	20	4¼	4⅜%	13¼—13¾	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	100—102	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	98¼—100¼	
Eastern Ext. Australasia & China	10	7	5/-	12⅜—12⅝	
Do. 4% Mort. Deb. Perp.	Stock	4	4%*	99½—102½	
Eastern Telegraph Co.	Stock	5⅜	3⅜%	130—135	+1
Do. 3½% Pref.	Stock	3½	17/6	83—86	
Do. 4% Mort. Deb.	Stock	4	4%	99—102	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	30½—32½	
Indo-European Telegraph Co. Ltd.	25	13	65/-	52—55	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	1⅛—1⅜	
National Telephone Co., Ltd., Pref.	Stock	6	6%*	109—111	+1
Do. Deferred	Stock	5½	6%*	106½—108½	+½
Do. 6% Cum. 1st Pref.	10	6	6%*	10½—12½	
Do. 6% Cum. 2nd Pref.	10	6	6%*	10—12	
Do. 5% 3rd Pref.	5	5	5%*	5⅝—5⅞	
Do. 3½% Deb. Red	Stock	3½	3½%	96—98 xd	
Do. 4% Deb. Red.	Stock	4	4%	98—100 xd	
West African Telegraph Co. Ltd.	10	4	4/-	10—10¼	
Western Telegraph Co., Ltd.	10	7	6%	12⅝—13⅛	
Do. 4% Deb.	Stock	4	4%	97—100 xd	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	7½d	9/16—11/16	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅛—3⅜	
Do. 6% Pref.	1	6	7½d	1 7/16—1 9/16	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6⅛—6¾	
Do. 6% Cum. Pref.	5	6	3/-*	5⅝—6⅛	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	100—103 xd	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%*	85—89	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	¾—1½	
Do. 4% Mort. Deb. Red.	Stock	4	4%	40—50 xd	
Brush Electrical Engineering Co.	2	nil	—	0—¼	
Do. 6% Pref.	2	nil	—	¼—⅝	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	83—86	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66 xd	
Callender's Cable and Const. Co., Ld.	5	15	15/-	9½—10½	
Do. 5% Cum. Pref.	5	5	5%	5½—5⅞	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	104—106 xd	
Consolidated Electrical Co., Ltd.	1	3	8⅞d*	15/16—1	
Crompton & Co., Ltd.	3	5	5%	1 1/16—1 1/8	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%*	96—99	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1⅛—1⅜	
Do. 6% Cum. Pref.	1	6	7½d	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	99—102 xd	
Edison & Swan United "A." £3 paid	5	4½	2/6	⅝—1⅛	
Do. do. (fully paid)	5	4½	4/2	1⅛—2⅛	
Do. 4% Deb. Red.	Stock	4	4%	78—81 xd	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	⅛—⅜	
Do. 7% Cum. Pref.	2	7	—	⅝—1⅛	
Do. 4% 1st Mort. Deb.	Stock	4	4%*	59—64	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8½ xd	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	10½—11½	
Do. 4½% Cum. Pref.	5	4½	2/3*	5—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	104—106	
I. R. & G. P. Co., Ltd.	10	10	10%	14½—15½ xd	
Do. 4% Deb. Red.	100	4	4%*	96—98	
Tel. Const. & Maintenance Co.	12	15	5%*	28½—30½	
Do. 4% Deb. Bds. Red	100	4	4%*	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9 xd	
Willans & Robinson, Ord. Shres	1	nil	1/-	⅜—1¼	
Do. 6% Cum. Pref.	5	nil	6%	3¼—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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PARTICULARS AS TO BINDING WILL BE FOUND ON PAGE III OF COVER.

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SUMMARY

The controversy with regard to priority of invention of "graded" cables is finally settled by our publication this week of the original patents taken out by Messrs. Pirelli & Co. and Mr. O'Gorman respectively. Although Mr. Jona, in Messrs. Pirelli's patent, may claim to have been the first to use rubber with a layer of paper over it for high-pressure cables, Mr. O'Gorman must be credited with the idea of using layers of paper of different specific inductive capacities with the express purpose of equalising the voltage gradient. Mr. O'Gorman was also the originator of the lead sheath directly over the stranded copper conductor, to compensate for the irregularities of surface. (Page 36.)

In a description of some of the features of the Windsor Essex and Lake Shore Rapid Railway, the first single-phase railway to be put to work in Canada, attention is drawn to the use of three-wire alternators, which give 6,600 volts for the direct supply of the trolley, and also supply a single-wire 13,200-volt feeder to a distant sub-station. (Page 38.)

A 1,500-volt continuous-current railway has been recently set to work in one of the southern valleys in Switzerland, on a route formerly worked by steam. Current is derived from a water-power station, from which three-phase transmission is taken to sub-stations equipped with motor-generators. Span-wire overhead construction is used, and each car is provided with two pairs of 750-volt motors and multiple-unit control. (Page 39.)

In reporting upon the accident to a Birmingham Corporation tramcar, on October 1st, by which two passengers died from injuries received, and twelve were injured more or less seriously, Lieut.-Col. H. A. Yorke states that the immediate cause of the disaster was the action of Inspector Hall in taking the car down Warstone Hill with a defective magnetic track brake, and experimenting with that brake on the incline. Had he applied the hand brake before starting down the incline no accident would have occurred, as the gradients are such that the car might well have been controlled by means of the hand brake only, the only precaution necessary being that the hand brake should be applied at the commencement of the hill, so that the speed of the car should be checked from the outset. (Page 42.)

A vertical rotary converter, with a capacity of 2,000 kw., has been installed in a sub-station in Chicago. This is said to be the largest vertical shaft machine of its class yet made. (Page 43.)

The recently built Hotel Adlon in Berlin has a particularly complete installation of telephones, bells, and other signalling apparatus, clocks, and fire alarms.

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The bells are placed so as to be inaudible from the rooms, and an elaborate arrangement of signal lamps takes the place of electro-magnetic indicators. (Page 44.)

A NEW automatic electric block signalling system is in use upon the Philadelphia and Western Railroad. The features of the system are the use of both rails of each track, as the returns for the current, cross-bonding facilities between all rails of both tracks at the ends of all track circuits. Single-arm, two-position home signals arranged on the normally clear principle are employed with an overlap. The signals average about 3,300 ft. apart in some districts, on account of the heavy traffic, but in other places there is uniform over-lap of 3,700 ft., allowing headway of about five minutes. (Page 45.)

A DETAILED description is given of the Pringle "tangential" trolley-wire suspension. (Page 46.)

A 100-TON electric crane of the revolving jib type, with travelling crab, which presents some interesting features, has recently been erected for the Dublin Port and Docks Board. (Page 48.)

WE publish a detailed description of the new trunk telephone exchange in Bradford, opened by the Post Office last November. The exchange embodies all the most recent devices for facilitating the utmost utilisation of the trunk lines without waste of time. Our description includes details of the arrangement by which a telegraph circuit is superposed on the lines for the purpose of transmitting all service directions, so that the telephone circuit is used for remunerative conversations only, and it also contains a description of the time check which has been evolved by the Post Office for assisting the operator to control the duration of a conversation by giving a lamp signal when the three minutes have expired. (Page 49.)

A NEW 750 kw. single-phase turbo-alternator has been installed at Eastbourne, which forms the most up-to-date item in the equipment of an undertaking dating from the early 'eighties, where the original belt and rope-driven alternators have given place later to machines driven by various types of moderate and high speed reciprocating engine. (Page 52.)

A PAPER by Mr. W. E. REED in an American contemporary, considers the question of electrical rolling mill driving, more especially with regard to equalising systems for dealing with rapid variations of load. Some examples of actual equipments are also summarised. (Page 55.)

THE production of artificial fertilisers from atmosphere nitrogen is forging ahead, and a further 4,700 h.p. plant has been erected in Norway for its manufacture. According to the figures of Mr. F. T. SNYDER the reduction of zinc ores in an electric stack-furnace is more economical than by means of the old-fashioned retorts. There is a good opening in this direction for the introduction of electric-thermic methods, because the zinc metallurgical process is one of the most wasteful of all metallurgical methods. The Norton Co., of Worcester, Mass., are manufacturing a new abrasive by purifying bauxite, and then fusing it in the electric furnace. Other notes in connection with "Electrochemistry and Electrometallurgy" are upon a new white lead and lead chromate process, and upon the recovery of tin from tin scrap. (Page 57.)

SOME additional particulars are now available of the electric locomotives under construction for the Cascade Tunnel of the Great Northern Railway of America, which will form the first example of three-phase traction in the United States. (Page 57.)

UNDER "Electrical Science, British and American," are notes on a supposedly new gas occurring in cathode ray tubes, and on the question of the trustworthiness of standard cells for the purposes of measurements of precision. In the Papers abstracted in the Continental Section, ABRAHAM and DEVAUX-CHARBONNEL indicate the principles underlying the efficiency of telephones, and BÉCLÈRE criticises Vaillant's radioscopic test for death. (Page 58.)

SOME figures from a report by a firm of accountants entrusted with an investigation of the affairs of the American Westinghouse Companies are given on page 59.

A LETTER from Mr. G. WILKINSON comments on a note in one of our contemporaries, and puts forward the claims of live steam heating against exhaust steam heating. (Page 59.)

AMONG the specifications published by the Patent Office on Thursday last is one by BABB, CHAPMAN, & COCKSHOTT, which comprises a new method of braking for electric motors on railways or tramcars. RHODES and the RHODES ELECTRICAL MANUFACTURING CO. have patented a new method of securing the segments of commutators, without the use of solid rings. SIEMENS BROS. DYNAMO WORKS, LTD., have patented a new overload cut-out, with a time-limit device of a new character. P. MACGAHAN has a new synchronising device, which does away with auxiliary transformers, and has no direct connection between bus bars and the machine being paralleled. The BRITISH THOMSON-HOUSTON CO. have amended their patent No. 8,680, of 1904, relating to systems of control of electric motors, and have added a new clause to the specification. (Page 60.)

THE Blackburn Town Council are opposing the revival and extension of time of the Blackburn, Whalley and Padiham Light Railways Order. The Bury Town Council have decided that, as the facilities for coaling and condensing are inadequate at their present station, a new works should be built, and a site has been already obtained. Dublin electricity accounts for the year ending March 31st, 1907, show considerable profits and progress. The Hackney Borough Council has agreed to the equipment, by the L.C.C., of the tramway routes in the borough, on the overhead system. The Hackney Council decided to start a showroom and sales department for electrical fittings. A clause has been inserted in the agreement between the Hammersmith Council and the Franco-British Exhibition (see ELECTRICAL ENGINEERING, January 2nd, 1908, p. 28), relating to penalties in case of a failure of supply. Hull has been troubled lately by explosions in cable boxes due to gas. The report of the Consulting Engineer to the Oxford Corporation, on the working of the Dolter system of tramway electrification, does not favour that system as applicable to Oxford. The Woolwich Borough Council have formulated new rate systems by which time switches are done away with in certain cases, and a flat rate of charge instituted. Consumers with a power supply are to be allowed to use that supply for lighting, provided the lighting does not exceed 7 per cent. of the total energy used. (Pages 61-63.)

THE Glasgow Corporation are inviting tenders for a 4,000 kw. turbo-alternator running at 750 r.p.m.; some machine tools are required for the tramways department of the Manchester Corporation, and a report is to hand that the Vienna Municipality intends to issue a loan of some £10,000,000 for the extension, among other municipal works, of the electric lighting and traction undertakings. A Paris firm of electrical contractors ask for samples, &c., from British makers of luminous decorations and art lighting for exhibit at the Marseilles Exhibition. Among the municipalities at home who are in the market for electrical goods are the London County Council, the Plymouth and Rotherham Corporations, and Barnes and Finchley Urban District Councils. (Page 63.)

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THE Electricity Committee of the Manchester Corporation recommend that Mr. S. L. Pearce, the Chief Electrical Engineer, be re-engaged for four years at a salary of £1,100 per annum for the first two years, and £1,200 for the remaining two years. There were 200 applicants for the post of Electrical Engineer to the Carlisle Corporation, and Mr. O. F. Francis, of Kirkcaldy, has been appointed. Mr. Keats, Acting Electrical Engineer to the Woolwich Borough Council, has been appointed Electrical Engineer. (Page 65.)

A RESOLUTION confirming the reduction of the capital of the South London Electric Supply Corporation by £65,000 was confirmed on Tuesday. Subscriptions are being invited for £147,300 four per cent. debentures in connection with the purchase of the undertaking of the City of Wellington Electric Light & Power Co., by the municipality. A final distribution of £1 2s. 7d. per share has been made to the shareholders of the London Southern Tramways, Ltd. A feature of our stock and share list is a general rise in London electric railway stock. (Page 66.)

THE similarity between the supply of electrical energy and the sale of tobacco is but slight; nevertheless our esteemed contemporary, the *Elektrotechnische Zeitschrift*, has found it necessary to devote a long and excellently written leading article to bring this home to the German public. This action on the part of the paper, which is the official organ of the German electrical industry, was certainly needed, for a proposal to make the supply of electrical energy for all purposes a government monopoly, has been put forward with some degree of assurance by a Berlin newspaper, which represents semi-officially the views of the Government, and it has been announced that it has been promised the sympathetic consideration of the National Liberal party. Our contemporary points out that the results of such a monopoly—which we would remark would probably be more on the lines of the postal and telegraph monopoly of this country than of the tobacco monopoly existing in some cases abroad—would be little short of a disaster, not only to the German electrical industry, but to every industry in which electrical energy is utilised.

"The effective application of electricity begins with the initial supply of raw material. The machinery for preventing the water rising in mines is electrically driven; the material is obtained by electric drilling, and it is raised, crushed, melted, rolled, turned, and welded by electricity. From the ore to the armour plate on the one hand, and to the sewing machine on the other hand, no step in the manufacture is taken which is not at the present day made with the assistance of electrical energy. The surplus energy in the whole range of the industrial districts is employed to good purpose by means of the electric current. . . . And the Government is now to step in and take the free generation and utilisation of electrical energy out of the hands of the industries themselves, in order to sell them at a profit, an essential necessity of their existence."

The above is a free translation of our contemporary's just condemnation of a scheme which can only be likened to the nightmare that might arise in the brain of one who has combined, not wisely but too well, the study of Plato's "Republic," More's "Utopia" (or some of the various absurd modern variations on their theme written with the purpose of advancing Socialistic ideas), with an over-indulgence in Christmas fare. Not only would such a measure as the threatened electricity supply monopoly seriously affect the works using the electrical energy which they produce as a by-product, but it would also prevent them from selling any surplus electrical energy outside. Moreover, the user of private generating plant would take an analogous position to the user of an illicit still. Doubtless those who defend the measure would point out that all this is easily adjustable by the issue of free licences in deserving cases, but this would prove almost unworkable in practice, and might lead to grave irregularities. Moreover, it would appear that this is not the intention, for our contemporary speaks of the taxation of electrical energy so generated, and compares it with the political-economical equivalent of taxing raw material. We need not follow the *Elektrochemische Zeitschrift* into its review of the effect that the passing of such a measure would have on the employees and on the manufacturers of electrical plant. The proposal will be so condemned by all the leaders of the electrical industry and by those who understand the conditions prevailing, that there is little likelihood of its being proceeded with. We trust that a like experiment will never be threatened in our own country.

THE advantages of single-phase traction are more particularly apparent in the case of lines of some length. Prominent among them is the simplification of the sub-station equipment as compared with that required by the system of three-phase transmission and rotary converters which not long ago could be practically regarded as standard practice in America. In addition to the substitution of stationary transformers in the sub-stations for running plant, there is, in cases where the transmission as well as the distribution is single phase, also the possibility of effecting a simplification of the transmission line by the use of two wire feeders instead of the three wires necessary for a three-phase circuit. In another column the equipment of a Canadian single-phase line is described, in which, by an ingenious arrangement, a further simplification is effected, and the feeder to the single sub-station, which is all that is required by the moderate length of the line, consists only of one wire. As indicated in the article, this is done without transformers in the generating station by means of what may be termed three-wire single-phase alternators, from which two different potentials, one for the trolley and one for the feeder, are obtained. It is probable that the number of cases in which this device is applicable will be somewhat limited, and some problems may arise from the alternator designer's point of view, owing to the possibility of different power factors in the high and low voltage parts of the circuit; and there may also be inductance troubles which would affect the transmission line in the case of long routes. The simplicity of the system, however, certainly renders it worthy of study.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, JANUARY 9TH.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at 25 Great George Street, Westminster, London. Paper to be read:—"Cost of Electrical Power for Industrial Purposes," by J. F. C. Snell.

FRIDAY, JANUARY 10TH.

Electro Harmonic Society.

8 p.m. Smoking Concert in the King's Hall, Holborn Restaurant.

SATURDAY, JANUARY 11TH.

Junior Institution of Engineers.

3 p.m. Visit to the L.C.C. Reconstruction Works in South Lambeth Road, and Motor School, Car Shed, and Substation at Clapham.

Rugby Engineering Society.

Visit to the Franco Exhibition Buildings at Shepherd's Bush, London. Train leaves Rugby 12.42 p.m.

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MONDAY, JANUARY 13TH.

Institution of Electrical Engineers: Leeds Local Section.
7.30 p.m. Meeting at the University, Leeds.

Dick, Kerr Engineering Society.
8 p.m. Ordinary meeting. Paper to be read:—"Electric Lighting of Railway Trains," by H. A. Cox.

TUESDAY, JANUARY 14TH.

Institution of Electrical Engineers: Manchester Local Section.
7.30 p.m. Ordinary meeting at the University (Physical Laboratory). Postponed from January 7th. Paper to be read:—"Magnetic Oscillations in Alternators," by G. W. Worrall.

Institution of Electrical Engineers: Glasgow Local Section.
8 p.m. Ordinary meeting at 207 Bath Street. Paper to be read:—"Cost of Electrical Power for Industrial Purposes," by J. F. C. Snell.

WEDNESDAY, JANUARY 15TH.

Institution of Electrical Engineers: Birmingham Local Section.
7.30 p.m. Ordinary meeting in the University. Paper to be read:—"The Heat Conductivity of Iron Stampings," by T. M. Barlow.

Institution of Electrical Engineers: Students' Section.
7.30 p.m. Meeting at 92 Victoria Street, London, S.W. Paper to be read:—"Electrification of the Mansfeld Copper Mines," by H. R. Speyer.

THURSDAY, JANUARY 16TH.

Union Electric Co.
7 p.m. Staff dinner at the Café Royal, Regent Street, London.

Rugby Engineering Society.
8 p.m. Ordinary meeting. Paper to be read:—"The British Locomotive," by A. W. S. Greame.

"GRADED" CABLES

IN view of the discussion which took place at the Institution of Electrical Engineers, and subsequently in our correspondence columns, with regard to graded cables, and the introduction into it of the question as to whether their invention should be righly ascribed to Mr. Mervyn O'Gorman, or Mr. Jona of Pirelli & Co., we have obtained a copy of the Italian patent specification to which reference was made in Mr. Jona's letter to us (published in our issue of December 5th, 1907). The patent is dated April 20th, 1900, and, as Mr. Jona rightly pointed out, relates to the cable which Mr. Raphael saw at the Paris Exhibition a month or two later, and described in *The Electrician*, with which paper Mr. Raphael was then connected. There is, however, no specific mention of "grading" as a means of equalising the voltage gradient, and apparently the fact that the insulating materials employed had different specific inductive capacities was not the reason for adopting the design in question. It is also clear, that so far as anticipation is concerned, although Mr. Jona (or rather Messrs. Pirelli & Co.) were the first to patent the use of rubber with layers of paper over it for high pressure cables, Mr. O'Gorman was undoubtedly the first originator and patentee of the idea to use layers of impregnated papers of different specific inductive capacities. Mr. O'Gorman was also the inventor of the use of the lead sheath directly over the stranded copper conductor (to compensate for the irregularities of its surface), which was neither used by Mr. Jona in his 1900 cable nor mentioned in the Pirelli patent.

For the purpose of comparison, we publish, in addition to a translation of Messrs. Pirelli & Co.'s Italian patent, the text of Mr. O'Gorman's two British patents on the subject.

Messrs. Pirelli & Co.'s patent of April 20th, 1900, is as follows:—

A New Type of Insulated Cable for Very High Pressures.

The cable forming the subject of the present Patent Application is constituted as follows:—The copper conductor *S* is surrounded by a first insulating layer of vulcanised rubber *G*, and subsequently by other layers *R*, composed of paper or textiles, or of paper only, or textiles only. If the cable has only one conductor (Fig. 1), drying and impregnation with insulating materials is next proceeded with, as is commonly done in cables insulated with paper and textile fabrics only.

If the cable has several conductors (Fig. 2), the conductors, insulated as before by means of rubber, paper, and textiles, are then stranded together with fillings *T* of textiles. Outside this strand is generally placed a covering *U* of other layers of paper and textiles, or paper only, or textiles only. The whole thus constituted is then dried and impregnated with insulating substances, as usual.

The cables of one or several conductors so composed are then covered by a lead tube *V* and protected by an armouring of iron *Z*, with a further covering of textiles *X*, which may eventually be added externally as in other subterranean cables (see Fig 2), or this protection is omitted as in Fig. 1.

The advantages of this type of cable are the following:—

(1) In the cables with one conductor: In the internal portion of the insulating mass there is a dielectric of high insulating power and of great electrostatic rigidity. In the external portion of this mass there is a dielectric which does not offer this property in such a high degree. Now, since the dielectric vulcanised rubber costs much more than that composed of paper and textiles, the arrangement described gives a better utilisation of this costly dielectric.

(2) In the cables of several conductors bound together: The advantages of this type are specially felt in cables with several conductors, where, besides the above advantage, there are several others. Above all, a cable constructed exclusively with paper or textiles impregnated with insulating substances is not suitable for very high tensions, for which, in fact, the best makers have generally adopted rubber as an insulator. But this has the

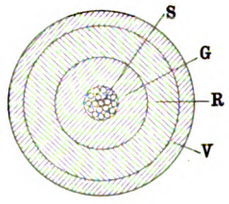


FIG. 1.

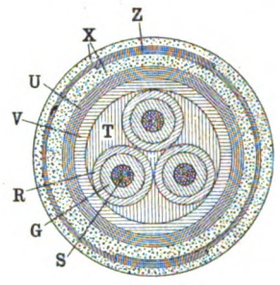


FIG. 2.

inconvenience of the gaps left in the strand between the cores. Further, the insulating thickness existing between the conductor of one core and the conductor of another core would not be proportional to the thickness of insulator existing between each conductor and the external lead, which is earthed, and so the dielectric would be more strongly stressed between the conductor and the outer lead than between two cores. In the type of cable which is the subject of the present patent application, another insulating layer may, on the other hand, be added outside the strand of the cores, so as to put the dielectric under equal stress in all directions.

The claim of Messrs. Pirelli & Co.'s Patent is as follows:—

The construction and application of a cable in which the insulator is mixed, *i.e.*, rubber inside close to the conductor, and paper and textiles, or paper only, or textiles only, in the outer part of the insulating layer, and that either in simple cables of one conductor or in multiple cables with two or more conductors.

It may be added that the addition of a worming (or "filling," as it is called in the Italian patent) to make up a strand of cores into a circular shape before placing additional layers of insulating material between the cores and the lead, was known and used regularly by British cable makers many years before the date of this patent, and it is probably for this reason that it is not included in the claim, although it is mentioned as a particular feature of the cable in the body of the specification.

Mr. O'Gorman's patent, No. 1,568, of January 23rd, 1901, relates to the grading of cables. The complete specification is as follows:—

The object of this invention is to reduce the thickness of the insulation on electric cables and to cheapen the cost of manufacture and also to reduce the loss of energy in the dielectric. In cables as hitherto constructed a number of coats of insulating material have been arranged in an arbitrary manner, for instance, the more expensive materials have been put nearest the conductor so as to economise the quantity used or the more waterproof materials put outside.

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I call "curve of voltage" a curve showing the relation between the distance from any conductor and the voltage at that distance within the insulation, and the slope of the tangent to this curve at any point I refer to as the voltage gradient at that point. I call a "homogeneous" insulating coat, an insulation possessing in all parts of any section the same specific inductive capacity, specific disruptive strength and specific conductivity, but sub-divided into layers where such sub-division is contemplated in the finished cable.

According to my invention insulating materials are selected and arranged in a large number of coats, either (1) in such a manner that the specific inductive capacity of the coats decreases outwards from the conductor and that the specific inductive capacity of each coat is proportional to the voltage gradient which would occur at the distance of that coat from the conductor if the conductor were in a homogeneous insulating coat of the thickness required according to my invention, or (2) in such a manner that the specific conductivity of the dielectric decreases outwards from the conductor, and that the specific conductivity of each coat is proportional to the voltage gradient which would occur at the distances of that coat from the conductor if the conductor were in a homogeneous insulating coat of the thickness required according to my invention, or (3) in such a manner that the specific disruptive strength of the dielectric decreases outwards from the conductor, and that the specific disruptive strength of each coat is proportional to the voltage gradient which would occur at the distance of that coat from the conductor if the conductor were in a homogeneous insulating material of the thickness required according to my invention. It must be remembered that the specific disruptive strength of many materials is greater for thin layers than for thick.

My first alternative I may employ for cables intended for alternating potential differences. My second for cables with continuous potential differences. My third may be used in combination with either my first (in the case of alternating potential differences, or with my second alternative method (in the case of continuous potential differences), when there is difficulty in obtaining materials having the full range of capacities or conductivities. When a cable is to be used for alternating and continuous potential differences, I may employ methods (1) and (2) simultaneously. It is to be noted that alternations in disruptive strength, as such, need make no change in the distribution of stress within the thickness of the layers, unless the other specific qualities are altered, and, therefore, are not essential when the potential difference to be established between the parts of the cable is small.

The coats should be as numerous as possible, and may be entirely distinct, but a slight intermingling of the material of different coats may be unavoidable, and may be no great disadvantage where it helps the regularity of the graduation. The variations of the gradient between any conductors in a homogeneous dielectric can be determined; *e.g.*, between two concentric cylindrical conductors the curve of gradients, which is steep near the inner conductor, can be mathematically obtained. The thickness of insulation determined by any of my alternative methods may be the same, and my choice of method may then depend on the rarity and cost of applying the materials required by the different methods. The number of layers in many materials, such as rubber, gutta percha, or paper, &c., cannot be increased indefinitely on account of expense, but I keep to the suggested arrangement as nearly as economy and permanency will permit.

By adjusting the qualities of the dielectric material in each coat according to my invention, the total radial thickness of insulation necessary is greatly diminished; *e.g.*, with a single or concentric conductor, and any given permissible voltage gradient, the total thickness may be made proportional to the voltage which the cable has to withstand. Any of the ordinary insulating materials may be employed, and their specific inductive capacity $\frac{\text{or}}{\text{and}}$ their specific conductivity $\frac{\text{or}}{\text{and}}$ their specific disruptive strength may be varied by impregnating or compounding them with "loading" materials differing in specific inductive capacity $\frac{\text{or}}{\text{and}}$ specific conductivity and specific disruptive strength, such as vulcanised rubber, gutta percha, bitumen, celluloids, hydrocarbon oils, mica, or the like. Where insulating materials capable of becoming fluid and of different specific conductivities and capacities are used, they may be so arranged that the materials of high conductivity have also a high capacity, so that their tendency is rather to come towards than to diverge from the places where their specific conductivity $\frac{\text{or}}{\text{and}}$ capacity is required to be proportional to the voltage gradient.

In many cases, cables may, whether their normal potential difference be continuous or alternating, be subjected to very high alternating pressures far in excess of the working maximum, and in such cases the graduation of the specific properties of the various coats should take into account this extra alternating maximum. For example, if I wish to insulate in accordance with this invention a single lead-covered cable of 37 strands each of No. 14 standard wire gauge to withstand 15,000 volts, I choose what working stress I consider safe for all the substances which I propose to employ, say 20,000 volts per centimetre. This determines the thickness of insulation, in this instance, say, 0·28 in. I now fix upon the largest number of coats, in which it is commercially advisable to divide the insulation, but I choose five coats in this instance having thicknesses of 0·08″, 0·05″, 0·05″, 0·05″, and 0·05″ respectively. For the coat of 0·08″ thick, where the gradient is least, I seek a substance which has a combination of properties in which the disruptive strength is not less than 20,000 volts per centimetre, and the specific capacity is relatively small (for example, manilla or other thin and uniform paper impregnated with rosin oil), and I obtain by experiment on the sample used or from reliable published tables of physical constants, a numeric which represents this.

In my present example this numeric is 2, and this numeric will therefore have to correspond with the mean value of the stress in that layer of 15,500 volts per centimetre. For the second layer, I require a numeric of 2·27; for the third layer, I require a numeric of 2·57; for the fourth layer, I require a numeric of 2·93; for the fifth layer, I require a numeric of 3·4; and I obtain these various numerics by adding castor oil to the rosin oil used for impregnating the paper. The exact quantities will depend upon the resistance and capacity of the castor oil, which varies in commercial samples, but in this particular instance the quantities chosen were:—For the second layer, 9·5 per cent. castor oil; for the third layer, 20·5 per cent. castor oil; for the fourth layer, 33·0 per cent. castor oil; for the fifth layer, 50·0 per cent. castor oil.

The cable of this example is intended to withstand a voltage alternating at an ordinary frequency of commercial supply currents.

One method of obtaining the exact percentage of castor oil to add is to make a series of preliminary tests on various papers impregnated with known different proportions of the oils.

In order to determine the curve of gradients for a homogeneous dielectric regardless of specific capacity, I plot the necessary curve from the well-known mathematical formula in the case of single or concentric cables, and in the case of irregular shaped or multiple conductor cables, I may calculate it or make a large-sized model section of the cable, and establish a difference of potential which represents the working conditions between the conductor or conductors and sheath. I then lay a sheet of high resistance metal across this section model, and trace out by a null galvanometer method with two needle points the equipotential lines from which the gradient can be easily determined with sufficient approximation. The curve of gradients for homogeneous dielectric, regardless of conductivity, is similar to the above.

In the case of stranded conductors a smooth homogeneous surface should first be obtained by filling up the interstices between the strands with lead or other conducting material.

The claims are:—

1. A cable in which the coats of material are arranged in such a manner that the disruptive stress in every part of the dielectric is approximately uniform.

2. Rendering the stress more uniform by changing the conductivity of the material of each coat without appreciably diminishing its specific disruptive strength.

3. Rendering the stress more uniform by changing the specific capacity of the material of each coat without appreciably diminishing its specific disruptive strength.

4. Rendering the stress more uniform by altering both the conductivity and the capacity of the coats in a regular manner, depending in each coat upon the stress to which that coat would otherwise be submitted.

5. In the manufacture of a cable reducing the thickness of insulation by rendering the factor of safety uniform in every coat by altering the disruptive strength of each coat so as to be proportional to the stress to which that coat has to be submitted.

6. The improved electric cables substantially as described.

Mr. O'Gorman's Patent, No. 21,170 of 1901, relates to covering the stranded conductor with a lead sheath directly on the copper; the complete specification is as follows:—

The object of this invention is to reduce the thickness of insulation on electric cables, and thereby cheapen the cost of manufacture. In stranded cables as hitherto constructed, the external surface of the conductors of single and multiple cables, and the internal and external surfaces of the outer conductors

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of concentric cables present in section portions of small curvature, due sometimes to the individual strands which are either small circles or other shapes presenting points, roughnesses or corrugations, and sometimes to joints or splits, kinks or twists in the individual wires themselves. The evil effect of such roughnesses is greatly enhanced by the slight decentralisation of the conductor, which occurs or is caused by an indentation of the outside of the insulation, or of the lead sheath, or when there are several separate conductors in the same cable. According to this invention a smooth homogeneous conducting surface is obtained by filling up or covering over the interstices between the strands of the conductor by a continuous conducting sheath of metal, which may either be in actual electrical contact with the conductor, or it might be very close to, but slightly insulated from, it. There are many ways in which the smooth surface may be obtained, but I prefer to cover the conductor with a continuous and seamless lead sheath by means of an hydraulic press.

The claims are:—

1. Electric cables having stranded conductors the outer surfaces of which conductors are rendered smooth by a covering of lead or other conductor substantially as described.
2. Electric cables having stranded conductors, the outer surfaces of which conductors are rendered smooth by filling up and covering over the interstices by a continuous conducting sheath of metal substantially as described.
3. An electric cable substantially as described.

WINDSOR ESSEX AND LAKE SHORE RAPID RAILWAY

A New Single-phase Distribution System

THE first single-phase electric railway to be put to work in Canada was the Windsor Essex & Lake Shore Rapid Railway, which ran its first car in September last. The line is of particular interest on account of the use of three-wire single-phase generators for supplying current to both a 6,600-volt trolley circuit and a one-wire 13,200-volt transmission line. A description of the equipment is given in the *Electric Railway Review* (Chicago).

The northern terminus of the road is Windsor, Ont., across the river from Detroit. From Windsor the line takes a southeasterly direction as far as Kingsville, a distance of some 28 miles. Further extensions are in progress.

The roadbed is built on the public highways in the towns and either at the side of a highway or on a private right of way parallel with it for the intervening distances. The track is laid with 80-pound T-rails with continuous joints, and is well ballasted with broken stone and gravel. The rail joints are electrically connected with No. 000 bonds soldered to the ball of the rail outside of towns and to the web under the fishplates in streets. Cross bonds are installed five to the mile.

A specially substantial type of overhead construction has been installed throughout the entire route, and it is interesting to note that the 6,600 volts pressure is carried on the trolley even in the towns.

The working conductor is a No. 000 grooved copper wire. It is supported by hangers spaced 10 ft. apart along a $\frac{7}{16}$-inch steel strand single cable forming the messenger. Outside of towns the messenger is hung from rod-supported angle iron brackets, and within towns the catenary cable is supported by spans of $\frac{5}{16}$-inch stranded steel cable with wood and porcelain insulators. The line is head guyed at intervals of 1,100 ft.

At Windsor a 500-volt trolley line of the Detroit United Railway system is intersected, and a special piece of overhead construction was required to prevent any possibility of the electrical crossing of the two overhead conductors, one at 6,600 volts and the other at 500 volts. As the 500-volt line was in operation before the 6,600-volt trolley was built, it became necessary for the builders of the new line to take the necessary precautions to prevent trouble. A complete separation of the circuits was made by installing about 25 ft. on either side of the 500-volt line intersecting a long wood break trolley insulator placed in the 6,600-volt trolley. This provides a dead section of catenary supported trolley for a safe distance on either side of the intersecting 500-volt trolley, which is crossed with an ordinary 90-degree trolley pan insulated for 500 volts. The length of the dead section in the 6,600-volt trolley is sufficient to assure that should a trolley pole leave the 500 volt wire it will not be able to swing far enough to make a connection with the high-pressure trolley. The dead section in the 6,600-volt trolley also requires that the single-phase cars drift across this intersection. The continuity of the 6,600-volt circuit on either side of the dead section is made complete by a jumper carried on high-tension line insulators and protected by grounded guard wires.

Thirty-foot wooden poles are used for all construction except that in the streets of Windsor. These poles are set in earth and are reinforced near the surface of the ground with a 4 ft. by 2 by 12 in. breast block.

Where span construction is used in the streets of Windsor the span wires are supported by concrete poles supplied by the Concrete Pole Company, St. Catherines, Ont. These poles are of two sizes, designed for 1,000 and 3,000 pounds strain. Both types of poles are rectangular in section. The smaller pole is 10 in. square at the butt and 6 in. square at the top, reinforced with four $\frac{7}{8}$-in. round steel rods placed within the four corners. The 3,000-pound pole is 16 in. square at the butt, 10 in. square at the top, and is similarly reinforced with four 1-in. round steel rods.

It is not necessary to describe the power-house in great detail. There are two generating sets, each driven by a 750 h.p. horizontal steam engine. Each of these engines has mounted on its shaft the field of a 500-kilowatt 25-cycle single-phase three-wire flywheel type generator, built by the Canadian Westinghouse Company, Limited. The windings of these generators are such that from the terminals may be obtained current at 13,200 volts pressure and at 6,600 volts pressure. The two windings may be used in series for obtaining these two voltages, or may be connected in parallel for obtaining the full capacity of the machine at 6,600 volts. One of the three terminals of each machine is earthed. Belt-driven exciters are employed, and the voltage is kept constant by a Tirrill regulator. The two three-wire generators feed each of two bus-bars, one carrying current at 13,200 volts and the other at 6,600 volts. The bar of the lower potential feeds direct to the trolley wire, while the one of higher potential feeds a single-wire transmission line serving

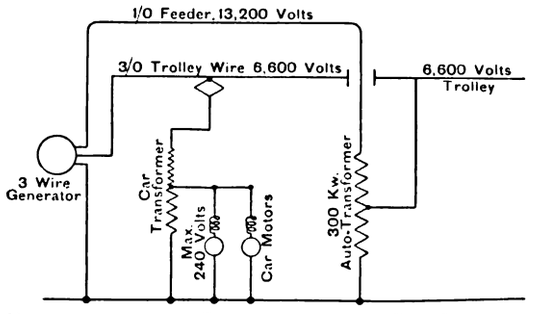


DIAGRAM SHOWING TRANSMISSION AND CAR CIRCUITS.

an auto-transformer substation at Maidstone, 18 miles from the power station.

The method of feeding the 6,600-volt trolley is of particular interest, inasmuch as there is used an auto-transformer substation requiring only a single wire for the transmission line. The trolley wire between Windsor and the Kingsville power station is divided into two sections. An 18-mile section from the power house to Maidstone is fed direct from the 6,600-volt bus of the three-wire generators in the power station. The section between Maidstone and Windsor, about 12 miles, is independent of the power-house section, and is fed by a transmission line carried at the tops of the poles along the right of way. This transmission line comprises a single No. 0 wire of hard-drawn copper supported on three-piece 40,000-volt insulators supplied by the Lima Insulator Company. The working pressure of the line is 13,200 volts. This single high-tension wire feeds a 300-kilowatt auto-transformer, which, in turn, feeds the Windsor section of the trolley wire at 6,600 volts.

The accompanying sketch shows diagrammatically how simple is the transmission and feeding system of this single-phase railway. The auto-transformer at Maidstone is installed in a concrete building 12 by 12 by 14 ft. in dimensions. The circuit-breaker and switch for handling the current fed through this transformer are located at the origin of the transmission line in the power station. Lightning protection and hand-operated disconnecting switches complete the substation equipment.

The rolling stock equipment includes five new three-compartment passenger cars equipped with motors, and four trailers and two express cars which are being rebuilt from trailer cars formerly operated on the New York City elevated lines. Each car is equipped with two Westinghouse No. 132 single-phase motors rated at 100 h.p. each. The control equipment includes an auto-transformer supported from beneath the car sills by 4 by 4 by $\frac{3}{8}$ in. angles. As the cars are double-ended two drum controllers are used to vary the voltage of the current fed through the auto-transformer to the motors. Multiple unit control is not adopted. The pantagraph trolleys collect current at 6,600 volts pressure, which is fed to the motors at a maximum pressure of 240 volts.

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A 1,500-VOLT CONTINUOUS-CURRENT RAILWAY IN THE MISOXER VALLEY

THIS railway connects the town of Bellinzona, in the Canton of Tessin, with Mesocco, in the Canton of Graubünden, and follows the course of the River Moesa, in the Misoxer Valley. The Moesa rises in the St. Bernard Alps, and joins the Ticino, which flows into Lake Maggiore. The power station for supplying the railway is situated at Cebbia, just above Mesocco, where the Moesa has a fall of 300 metres, and a minimum water supply of some 500 litres per second. The following description of the railway, which has only recently been equipped electrically, is abstracted from a recent article in *Elektrotechnik und Maschinenbau* (Vienna).

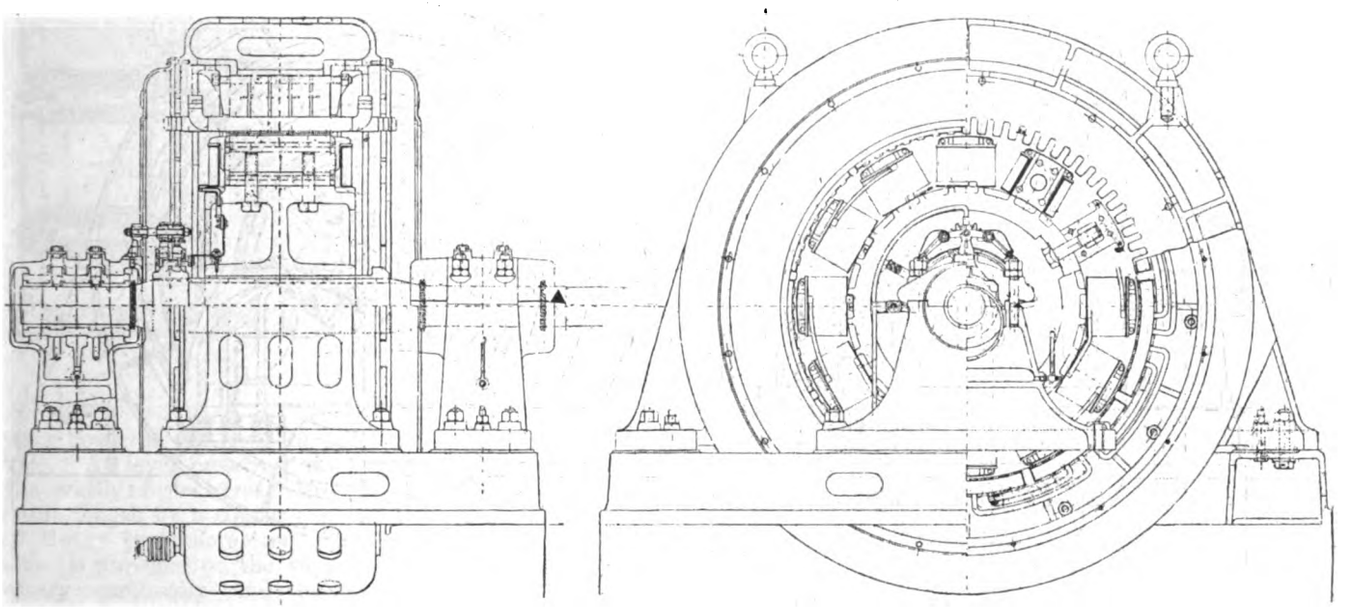


FIG. 1.—420 KW. THREE-PHASE GENERATOR.

The line is 31 kilometres in length, and rises from an altitude of 6 metres above sea-level at Bellinzona to 769 metres at Mesocco. The ascent from Bellinzona to Mesocco is continuous, and the gradients are heavy, rising to a maximum of 6·6 per cent. The 50-ton trains are to be hauled up this gradient at a speed of 19·5 km. per hour.

At Cebbia, where the generating station is situated, a dam has been built across the river, and the water flows through a canal to a reservoir, from which it is admitted to a pipe line, 1,660 metres long, constructed of cast-iron pipe of 500 mm. internal diameter. This pipe line is divided into six sections or zones of increasing thicknesses to correspond with the increasing pressure. Thus the six thicknesses of the pipe are 12, 14, 17, 20, and 28 mm., corresponding to the six average pressures of 5, 10, 15, 20, 25, and 30 atmospheres. The joints in the last two zones are protected with cast-iron rings screwed over the joints to prevent the lead caulking from being forced out.

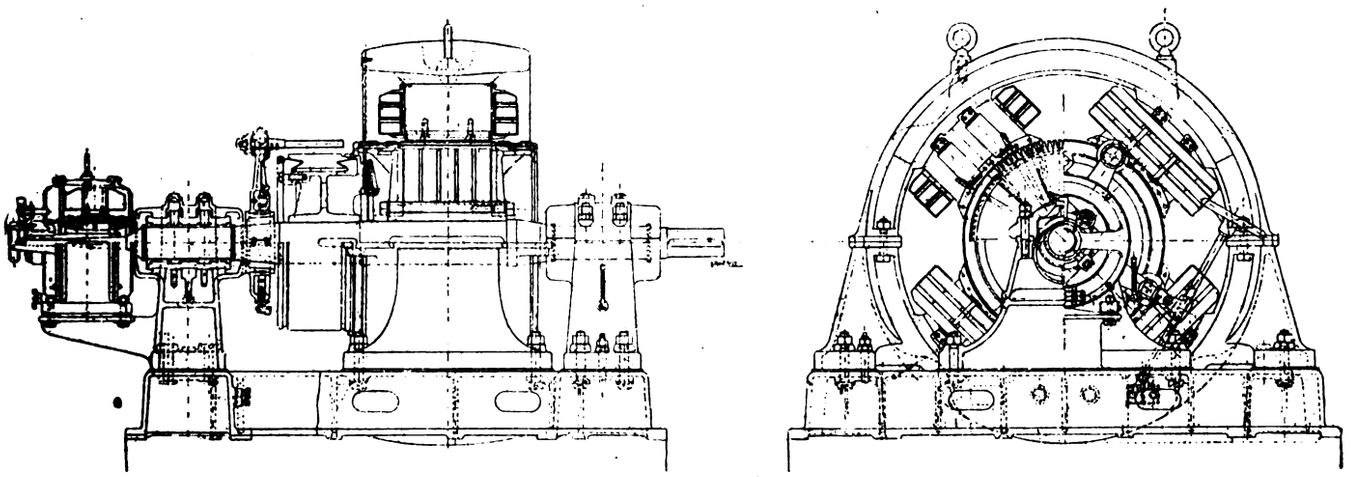


FIG. 2.—275 KW. CONTINUOUS-CURRENT GENERATOR.

There are at present in the power station two 1,000-h.p. water turbines, each of which is coupled direct to a three-phase generator on the one side, and a continuous-current generator on the other side. Between each generator and the turbine there is a flywheel and a flexible coupling. The speed of each set is 500 revs. per min. The three-phase generator has a capacity of

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420 kw., and generates at 10,000 volts and 50 cycles (Fig. 1). The continuous-current generator has a capacity of 275 kw., and generates at 1,600 volts (Fig. 2). A 13-kw., 70-volt. exciter is directly connected to the continuous-current generator. Continuous current is supplied direct to the contact wire at Mesocco, and the high-tension alternating current is transmitted to the substation at Roveredo, where it is transformed by means of motor generators into continuous current at 1,550 volts.

The six wires (two three-phase circuits) are each 4·5 mm. in diameter, and supported, on porcelain insulators, with iron pins (Fig. 4) at a distance of 600 mm. from one another.

Wooden poles are used in all cases. They are painted but not impregnated.

The continuous current for the overhead wire at Mesocco is transmitted from the power house at Cebbia, 1·3 km. distant, through two feeder cables, each of 100 sq. mm. section.

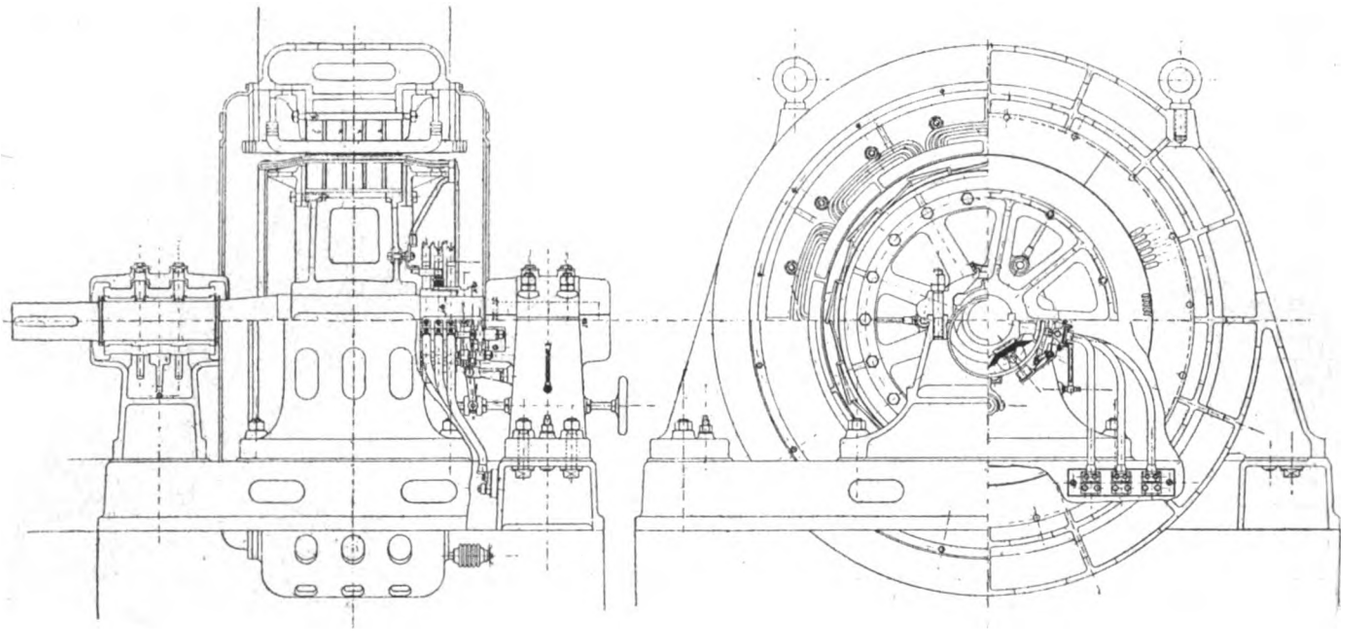


FIG. 3.—400 H.P. THREE-PHASE ASYNCHRONOUS MOTOR.

The substation at Roveredo contains two motor-generator sets, each of which consists of a 400-h.p., 9,000-volt, 490-r.p.m., 50 cycle asynchronous motor (Fig. 3), and a 275-kw., 1,500-volt continuous-current

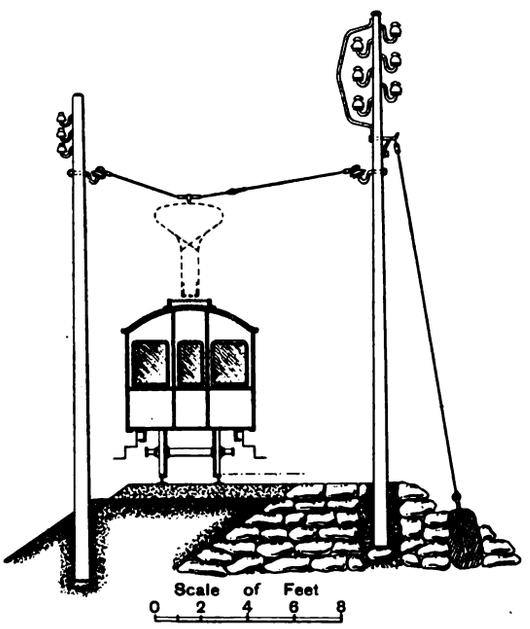


FIG. 4.—OVERHEAD EQUIPMENT.

generator. The machines in both power station and substation, as well as the car motors, were supplied by the Oerlikon Co.

The high-tension transmission line is 22·3 km. long.

The overhead wire is supported 5·5 metres above the rails over most of the route, but in the stations and at level crossing it is supported at a height of 6 metres above the rails, and in tunnels and under bridges the height is 4·3 metres. The wire is insulated from the cross-wires, and the cross-wires are fixed to the poles with insulators of the form shown in Fig. 5. The contact wire is of hard-drawn copper, 9·5 mm. in diameter. The cross-wires are of steel, 5 mm. in diameter.

The rails, which have a cross section of 100 sq. mm., are used as the return conductor. The lengths are electrically connected with flexible copper bonds. Cross connections from rail to rail are provided every 120 metres.

The contact wire is divided into six sections, which can be insulated from one another when necessary.

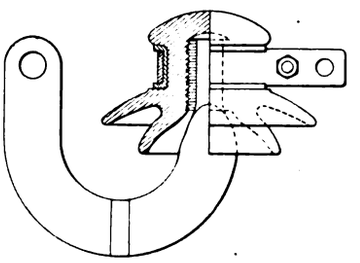


FIG. 5.—INSULATOR. SCALE, ONE-FIFTH FULL SIZE.

Between any two sections is a short piece of contact wire, which, ordinarily, is electrically connected with both adjacent sections, and, consequently, when passing over the section insulator, the current is not broken. When the two sections are insulated from one another, and only one is alive, the intervening insulated piece

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of contact wire is dead, and this prevents the dead section from being made alive through the two collector bows, as the bows cannot touch both sections at once. At level crossings the contact wire is dead for the width of the street, the current being carried over this length by a copper cable of 100 sq. mm. section. Every two kilometres, lightning protection apparatus is provided on the supporting poles, with the necessary earth-wire and buried earth-plate. The poles are spaced normally 30 metres apart, but at sharp curves this distance is reduced to 16 metres. The telephone wires, which are at 3 mm. diameter galvanised iron wire, are crossed every 300 to 500 metres.

The motor-cars were supplied by Ringhoffer, of Prague. The length of the car body is 14·1 metres, and the width is 2·65 metres. The car is divided into two compartments, II. and III. class; there is seating

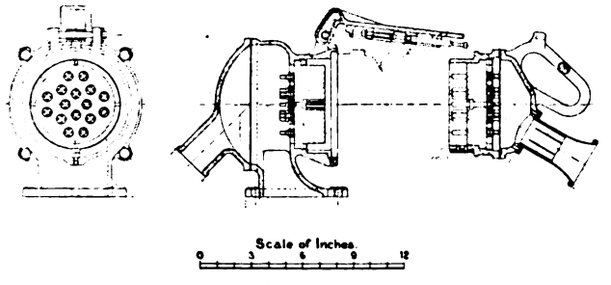


FIG. 7.—COUPLING TOE CONTROL CONNECTIONS.

room for 12 in the second class, and for 39 in the third class, making a total seating capacity of 51.

The cars are provided with Böcker air brakes.

Each motor-car has four motors, one on each axle. Each motor is rated at 66 h.p., 750 volt, two being permanently connected in series. The motors are geared, the gear ratio being 1 : 4·5. One motor-car containing four such motors can haul a 53-ton train (including the motor-car) at a speed of 38 km. per hour on the level, or at a speed of 19·8 km. per hour up a gradient of 6·6 per cent. The efficiency of the motors at rated load is 85 per cent.

The electric control system is the same as that used on the Cologne-Bonn railway, and developed by the Siemens-Schuckert Co. The control connections run through the whole length of the train, and the cars are connected by means of the coupling shown in Fig. 7.

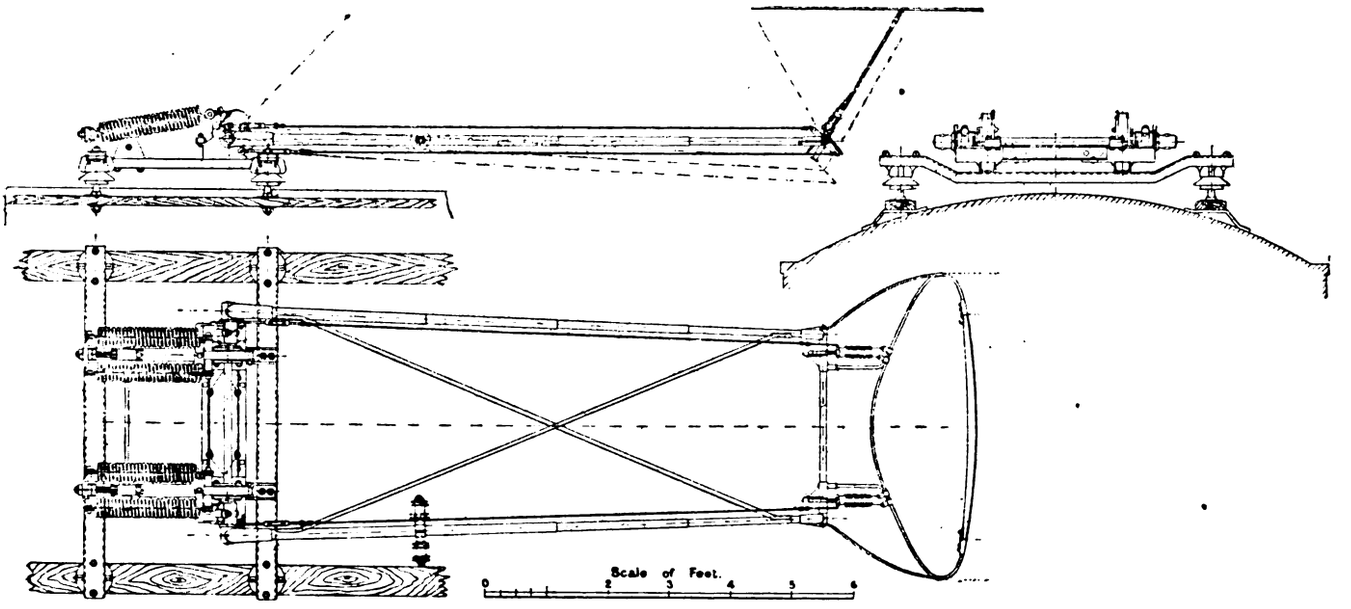


FIG. 6.—COLLECTOR BOW.

Each motor-car has two collector bows, as illustrated in Fig. 6 above.

Manitoba Telephone Purchase.—The Manitoba Government has purchased the undertaking of the Bell Telephone Co. in Manitoba for the sum of £666,000. The transfer takes place on January 15th. The Manitoba Government will issue 4 per cent. Government bonds at 40 years, payable at par.

Recent Electric Power Contracts.—We have received from the British Thomson-Houston Co., Ltd., particulars of some important contracts for power plant which they have in hand. One of these is for a 500 h.p. 500 volts 50-cycle 3-phase motor, running at 1,450 r.p.m., for the Mold Collieries, to be direct connected to a turbine pump, which will operate against a head of approximately 600 feet. In the same pump-house will also be erected two 275 h.p. motors, direct connected to slow-speed pumps running at 180 r.p.m. Another colliery equipment, the contract for which has been placed with the British Thomson-Houston Co., is that for the Moss Hall Coal Co., which includes the complete electrical equipment of this company's Maypole and Lowhall pits, including the provision of the necessary equipment for a new generating station, which comprises two 350 kw. steam-driven generators, with the necessary switchboard, the whole of the cable work for the same, and a small lighting set of 40 kw. capacity. The equipment of the Maypole Pits includes four sets of electrically-driven pumps, complete with the necessary switchgear, and the whole of the cable work, both on the surface and underground, together with all the overhead transmission line. The primary voltage is 3,000 volts, and the current, 3-phase 50 cycles. The equipment of the Lowhall Pit, which will be operated from the same generating station, includes three sets of pumps of the horizontal 3-throw type of large capacity, to which will be coupled three 135 h.p. motors, and three sets of haulage gear, together with the complete cable equipment, both surface and underground. Another important contract which we understand has been placed with the B.T.H. Co. during this past year is the electrical equipment of a Reversible Cogging Mill for Messrs. Dorman, Long & Co., Ltd., of Middlesbrough. This is said to be the first electrical equipment of this nature that has been placed with a British firm. It involves the supply of very heavy electrical machinery, including the main mill motor, which has a continuous capacity of 1,200 h.p. and a maximum torque capacity up to 3,600 h.p., developing these powers at a speed of 70 r.p.m. Another important development in the application of electrical power for industrial purposes is the advance that has been made in connection with the electrical operation of textile mills. The British Thomson-Houston Co. has now installed upwards of 10,000 h.p. in motors in textile mills in the United Kingdom, and are at present engaged in the electrical equipment of a large mill in the Manchester district which involves the installation of upwards of 75 motors, varying in capacity from 7½ h.p. to 170 h.p. each.

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THE BIRMINGHAM TRAMWAY ACCIDENT

LIEUT.-COL. H. A. YORKE has reported upon the accident that occurred on the Birmingham Corporation Tramways on October 1st (ELECTRICAL ENGINEERING, Vol. II., pp. 547 and 567). In this case, as tramcar No. 22 was descending the incline in Warstone Lane, the driver (Inspector Hall) lost control of it, with the result tht it ran away down the incline, and was overturned at the corner of Warstone Lane and Icknield Street, striking an overhead standard as it fell. Two passengers died from injuries received, and twelve were injured more or less seriously. The car was a four-wheeled, double-decked car, fitted with the hand brake, electric rheostatic brake, and the magnetic track brake, and also with four sanders, namely, two at each end, and a lifeguard of the trigger type. The total length of the car was 27 ft. 6 in., the wheel base being 6 ft. The gauge of the tramway is 3 ft. 6 in. At the time of the accident there were about 16 passengers on the car, half of whom were inside and the other half on the top. The passengers who received the fatal or serious injuries were those on the top of the car.

Warstone Lane is about a quarter of a mile long, the gradients in it being as follows, commencing from the top of the hill :—1 in 143·8, 1 in 22·7, 1 in 17, 1 in 19·7, and 1 in 36·6. The car in question left the depôt at 4.59 a.m., in charge of motorman J. E. Mountford, who on his second journey met Inspector Hall at Edmund Street, and informed him that there was something wrong with the magnetic brake at "No 2" end of the car. The car left Edmund Street for the third trip to Foundry Road at 6.29 a.m., with Inspector Hall in charge of the car, and motorman Mountford standing alongside of him. Inspector Hall seems to have tried the magnetic brake when going down the incline in Summer Row, with the result that on the first, second, and third notches it did not act properly, but brought the car up with a jerk when the handle was moved to the fourth notch. When he reached the incline in Warstone Lane he again tried the magnetic brake, which on this occasion seems to have completely failed on all notches. He then moved the handle to the "on" position, and tried the brake a second time, but still without effect. He then tried to stop the car by reversing the handle from the forward to the back position and moving the controller handle to the sixth notch of power, but still without effect. By this time he was more than half-way down the hill, and had entirely lost control of the car. He then applied his hand brake for the first time, to the fullest possible extent, but the speed of the car was such that the hand brake had little or no effect in checking it. On reaching the curve at the bottom of Warstone Lane hill the wheels skidded, and almost immediately afterwards the car turned over to the outside of the curve and fell on its side, striking a trolley wire standard in its fall, the passengers on the top being thrown on to the pavement and one of them crushed between the standard and the car.

The immediate cause of the disaster was the action of Inspector Hall in taking the car down Warstone Lane with a defective magnetic track brake, and experimenting with that brake on the incline. Had he applied the hand brake before starting down the incline, no accident would have occurred, as the gradients are such that the car might well have been controlled by means of the hand brake only, the only precaution necessary being that the hand brake should be applied at the commencement of the hill, so that the speed of the car should be checked from the outset. That this is the case is proved by the fact that the car had already been taken down the hill that morning by means of the hand brake only. Inspector Hall seems, however, to have selected this hill for the purpose of testing the magnetic brake, and did not attempt to apply the hand brake until the speed of the car was far beyond its control.

The failure of the magnetic track brake to act on this occasion, the report states, is said to have been due to a broken grid in the fourth resistance box on the car. According to a statement made by Mr. C. W. Hill, Electrical Engineer of the Corporation Tramways, the controller at "No. 2" end of the car, and the insulation of the cabling and wiring of the car, after the accident was found to be in good order, and the only defect that could be discovered was the broken grid. The resistance boxes, of which there are five, are in use both for propelling and braking purposes, and it might be thought that such a fracture would be discoverable, not only when the magnetic brake was in use, but also when current was being supplied from the trolley wire for the purpose of starting the car. Mr. Hill put forward the theory that the electrical pressure of the current for driving purposes would be sufficiently great to bridge the gap formed by the fracture, whereas, in the initial stages of braking, current generated by the motors acting as generators would have a low pressure, and would not be able to overcome the interruption in the circuit. Experiments made by Mr. A. P. Trotter, the Electrical Adviser to the Board of Trade, at 8 Richmond Terrace, however, says Lieut.-Col. Yorke, hardly support this theory, as it was found that a current of 10 amperes, which is probably less than the usual current passing when cars are starting from rest, is sufficient to cause fusing to take place between the two opposing ends of the fracture and between the sides of the broken and adjacent members of the grid. No such signs of fusing were, however, discernible in this case. It was, therefore, impossible to say whether the above explanation of the failure of the magnetic track brake is the correct one or not.

CATALOGUES AND PAMPHLETS RECEIVED

FEED WATER HEATERS.—A new edition of a pamphlet describing the "Wilkinson" line steam feed water heater is to hand. This apparatus, the object of which is to obtain economies by ensuring that the temperature of the feed shall approximate as nearly as possible to that of the steam in the boiler, was described in some detail in ELECTRICAL ENGINEERING, Vol. II., page 301, and some further results of tests were given on page 623 of the same volume. A statement as to the change of agency for the apparatus appears under "Miscellaneous Business Notes." Inquiries are facilitated by the convenient blank inquiry form contained in the pamphlet.

FLAME ARC LAMPS.—A new catalogue from Messrs. Crompton & Co., Ltd., deals with the Crompton-Blondel system of flame arc lighting with continuous currents. The construction of the Crompton-Blondel lamp and the particularly advantageous distribution of light obtained therefrom were fully dealt with in ELECTRICAL ENGINEERING, Vol. II., page 853, and the specification of the Blondel patent was given in Vol. I., page 521.

INCANDESCENT LAMPS.—A card printed by the three-colour process from the British Thomson-Houston Co. contains a reproduction of a painting entitled "Sunset in the Fens," with a suggestion that when the sun has set, B. T.-H. Edison lamps should be used.

OSRAM LAMPS.—Messrs. Pooley & Austin have issued a pamphlet putting forth the advantages of the Osram lamp, and giving figures as to the economy in current to be obtained as compared with carbon filament lamps of equal candle-power.

ROLLER BEARINGS.—The revised catalogue of the Empire Roller Bearings Co., Ltd., points out the advantages claimed for well designed roller bearings over plain bearings, and gives a general description of the Empire patent roller bearing axle boxes for railway and tramway vehicles, giving results of tests showing the reduction both of starting and running friction obtained by their use. Special forms of bearing for trucks, colliery tubs, &c., are described, as well as a standard swivel pattern for shafting. Empire Roller Bearings are also applied to road waggons, lifts, ventilating fans, rolling mills, agricultural machinery, harbour dredgers, and other purposes, where an accurately aligned load can be secured under ordinary conditions of work.

WIRES AND CABLES.—The Western Electric Co. have issued a new abridged price list, arranged in a convenient form, of vulcanised electric light wires and cables, twin circular conductors, twin vulcanised flexible cords, and electrolier wire, all in accordance with the standards of the Cable Makers' Association.

The Burbacher Hütte Iron & Steel Works.—In Figure 8 of this article, published in our last issue, the letters V and A have been transposed by a draughtsman's error. The voltmeter is naturally connected across the circuit, and the ammeter in series with it.

Runaway Tramcar Accident at Glasgow.—A fatal runaway tramcar accident occurred at about 5 p.m. on Friday evening upon the Glasgow Corporation tramway system. It took place upon the incline known as the Bell of the Brae, between Cathedral Square and Duke Street, upon the Springbrow-Mount Florida route. The weather was frosty and foggy at the time, and through some at present unknown reason, a car became unmanageable, and dashed down the hill. The first obstacle to the runaway car was a horse-drawn goods lorry, belonging to the Glasgow & South Western Railway Co. This was smashed, and swept out of the way, and the car, continuing its runaway journey soon dashed into another lorry belonging to the same company, whilst further on yet another lorry, unable to get clear of the track, was smashed and the horse killed. This latter collision pitched the driver of the tramcar out into the roadway, and also smashed a sectional pillar box on the pavement. Two other lorries were subsequently damaged by collision, but as the car reached more level ground, it naturally slackened speed considerably, and was brought to a standstill by the conductor applying the brakes. Unfortunately the accident has resulted in two deaths, for the driver of the car who was thrown into the road, and a van-boy who was on one of the lorries which were smashed, have both succumbed to their injuries. A number of the passengers, who numbered between 30 and 40, were slightly injured, but the comparative immunity from injury to these appears to have been due, first, to the fact that the car kept to the rails, and secondly, because the conductor locked the doors of the car and refused to allow any of the passengers to jump off, which must have saved many serious injuries. In all, eight persons were injured, and three have been detained in hospital.

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VERTICAL SHAFT ROTARY CONVERTERS

ON page 23 of ELECTRICAL ENGINEERING for January 2nd we gave a short note relating to a large vertical shaft rotary converter recently installed in a sub-station in Chicago, and we are now able to supplement this description by some illustrations showing the arrangement of the machine and some additional particulars which have appeared in the *Electrical World* (New York). The machine in question was installed by the Commonwealth Edison Company, of Chicago, in its Market Street sub-station, and is the first vertical shaft rotary converter to be put in operation in an American central station.

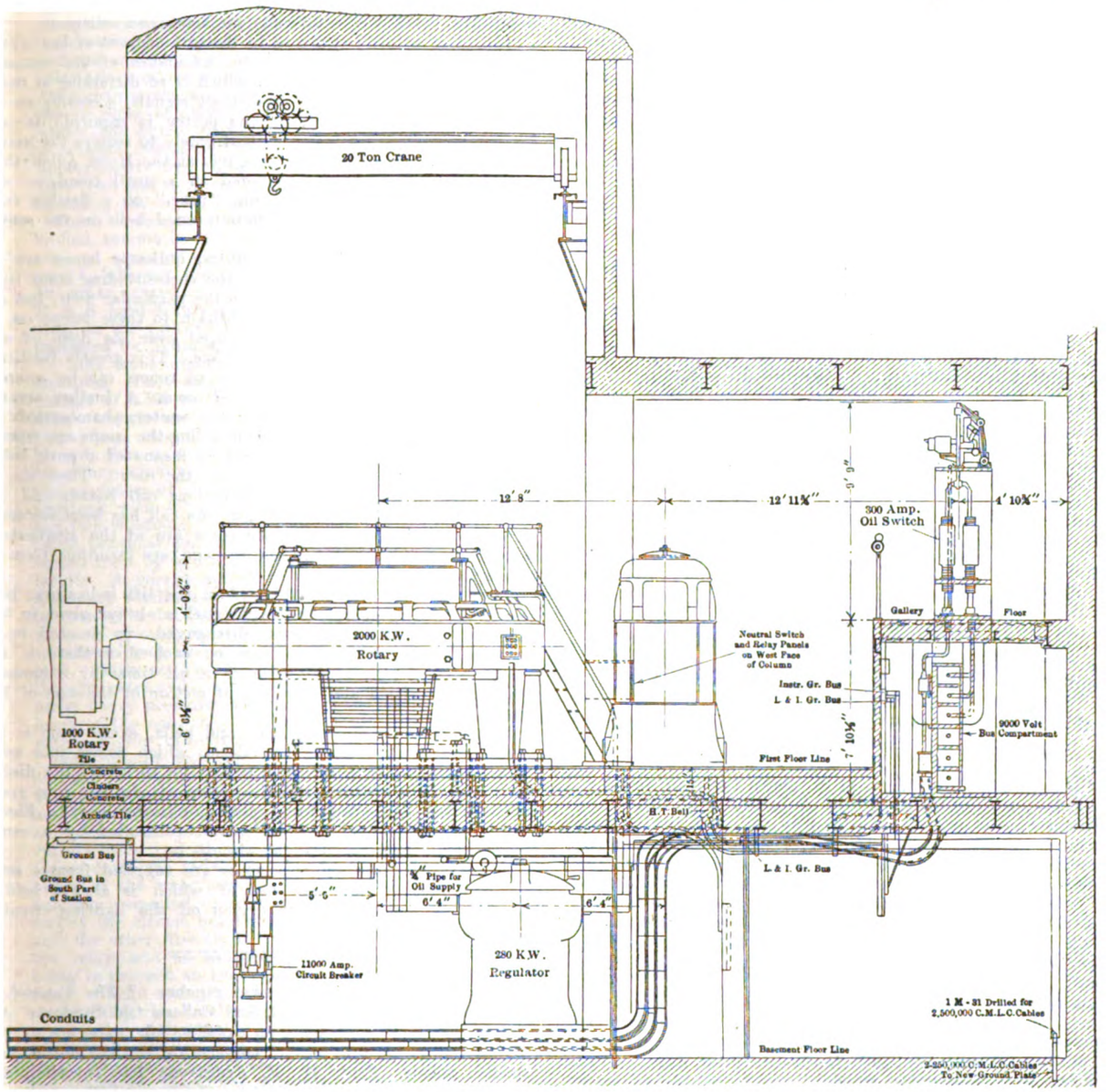


FIG. 1.—SECTIONAL ELEVATION OF SUBSTATION, SHOWING ARRANGEMENT OF VERTICAL SHAFT ROTARY CONVERTER AND SWITCHGEAR.

The same company has already in use five 2,000-kw. vertical shaft motor-generator frequency changers, which are very satisfactory. The frequency changers have step bearings similar in principle to those on the Curtis steam turbine; the weight of the bearing being carried on a film of oil or water forced under the bearing. The rotary converter under consideration, however, differs considerably in construction from the frequency changer sets. As already stated, it is a 2,000-kw. General Electric machine running at a speed of 166 r.p.m. Provision is made for carrying the weight of the revolving armature either on a roller bearing or on an oil pressure bearing. The roller bearing has given good results in factory test runs, and it is confidently expected that it will be the form of bearing finally adopted. To provide for operation, should changes be necessary during the perfecting of the roller bearing, however, an oil bearing, interchangeable with the roller bearing, has been provided, together with a set of pumps for maintaining the pressure in the oil bearing. Fig. 2 is a vertical sectional drawing showing the relation of parts. The armature of the machine revolves about a stationary central shaft or pivot, 23 in. in diameter, which carries on its upper end the interchangeable roller or oil pressure bearing. The armature is mounted on a sleeve which revolves outside of the stationary shaft. The weight of this sleeve and the armature which it carries is taken by the bearing at the upper end. To get at the roller bearing, it is only necessary to remove a steel cap from the upper end of the revolving sleeve, after having first relieved this steel cap of the weight of the armature and sleeve by means of screw-jacks. These screw-jacks, which are a permanent part of the machine, consist simply of a set of screws which are accessible from the basement below the machine.

The field magnet structure, carrying 18 poles, is supported on cast-iron pillars resting on a concrete base ring. To keep the revolving armature in line, there are two guide bearings, each 14 in. long, below the roller bearing. To change from roller bearing to oil pressure bearing, it is a simple matter to take

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the weight off the top bearing, withdraw the cap screws holding the top plate and change from a roller to oil pressure bearing or *vice versa*.

The advantages of the vertical shaft rotary converter are many. There is a saving of about 17 per cent. of weight in the vertical shaft machines, as compared with the horizontal shaft machines this company has in service. The horizontal shaft machines, to be sure, run at a lower speed, but they have been the only one available, so that leaving out of account the questionable possibility of building satisfactory higher speed horizontal shaft machines, there is an important reduction in weight by the vertical shaft construction. One of the most important advantages of this construction is the accessibility of the brushes. The brushes on the vertical shaft machine are readily accessible to an attendant on a platform extending around the machine and resting just above the field poles. On a horizontal shaft machine the attendant must climb ladders in difficult positions. The weight of the vertical shaft, 2,000-kw. machine is stated to be about 67 tons. The diameter of the circular floor space occupied by it is 15 ft. 3 in. The height above the floor is 9 ft. 3 in. The 2,000-kw. horizontal shaft machines of the company occupy a floor space of 16 ft. 6 in. ×

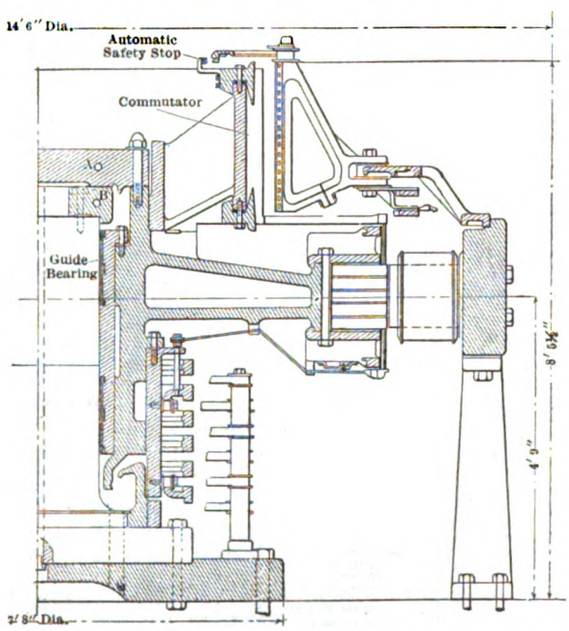


FIG. 2.—SECTION OF PART OF 2,000-KW. VERTICAL SHAFT ROTARY CONVERTER.

16 ft. 6in., and extend 12 ft. 11 in. above the floor and 3 ft. 7 in. below, making the total over all height 16 ft. 6in.

The machine is entirely supported by the steel and concrete floor of the building as shown in Fig. 1. The electrical apparatus in the basement consists of a 250-kw. induction regulator for the alternating current end, and two single-pole 11,000 ampere solenoid-operated circuit-breakers in the direct current leads. The 300 ampere oil switch shown on the right control the alternating current side as a complete unit, as there is no further switch on the low tension side of the step down transformer.

This rotary converter gives direct current at from 240 to 300 volts. The neutral of the low tension side of the transformer is connected to ground and to the neutral of the direct-current system, thus doing away with the necessity of direct-current balancing sets. This is the standard practice of the Commonwealth Edison Company. The rotary converter is the latest addition to a sub-station which already has four 1,000-kw. horizontal shaft rotary converters. An interesting economic feature of this sub-station is the use of a transformer giving an increased voltage for one of the rotary converters in order that the direct-current voltage delivered may be high enough to charge the batteries. The transformer connections allow the converter to be worked at 300 to 360 volts instead of 240 to 300 volts. This arrangement is claimed to present considerable advantage over the use of a separate booster for battery-charging.

Institution of Electrical Engineers: Students' Section.—A visit has been arranged to the works of the India Rubber, Gutta Percha, and Telegraph Works Ct., Ltd., on February 15th, at 10 a.m., and students wishing to join the party should send in their names at once to the hon. sec., Mr. W. B. Thompson.

A HOTEL TELEPHONE AND SIGNAL EQUIPMENT

SOME notes are given in the *Elektrotechnische Zeitschrift* on the very complete installation of electric bells, telephones, and clocks at the Hotel Adlon, Unter den Linden, Berlin, which presents several points of interest.

The telephone system consists of a switchboard with the operator's positions worked on the central battery system, equipped with lamp calling signals and double ring-off signals. This board serves as a local exchange for the 400 telephone stations in the various rooms of the hotel, and also is connected by eighty junction lines to the exchanges of the Berlin telephone system. Every room is provided with a telephone, which can be used not only for internal communication, but also to speak with the outside telephone system. Separate telephones are also installed, apart from the main switchboard, for use in connection with the restaurant, kitchens, and cellars.

The chief points considered in the arrangement of the system of bells from the rooms were the avoidance of the continual ringing of bells in the passages, which is so disturbing in many hotels, and the facilitating of distinct signals, according as the waiter, the chambermaid, or the porter is required. It was formerly usual in most Continental hotels to require the visitor to ring one, two, or three times, but at the Hotel Adlon three separate push-buttons are provided on a small board, as well as another set on a neatly made "pear" on a flexible cord. These pushes control three different-toned bells in the service rooms.

Instead of the ordinary indicators, indicator lamps are employed, and when a bell is rung the corresponding lamp lights up not only in the service room on the particular floor, but also in a central control office. In addition to these lamps on the call boards, there is a lamp arranged over the door of each room, which lights up at the same time. This greatly facilitates rapid service, as a greater number of rooms can be attended to without returning to the service room. A further arrangement of lamps indicates whether the waiter, chambermaid, or porter is required. The relays controlling the lamps are released by the servant answering the call by means of a push button in the passage close to the door of the room. Thus the extinguishing of the lamps on the various call boards and over the door of the room indicates that the call has been answered. The three bells in each service room are of the single-stroke type, and, not being out in the passage, are inaudible from the visitors' rooms.

Lamp signals are also employed in the lift indicators; there are two main lifts, and the call signal is always given in both at once, so that whichever is disengaged can proceed to the required floor. At the lift door on each floor there is also placed a lamp board, which shows at all times by a luminous signal the position and direction of motion of the cars of both lifts.

In addition to the telephones and bells, every room is provided with an automatic fire alarm, which comes into action at a certain temperature. The wiring for these is quite distinct from the other circuits, and the rooms are divided into groups of ten, and connected to a central indicator board. Electric clocks are provided in every room, controlled by a central standard clock through eight circuits.

The whole of the signal services are supplied from a set of six accumulator batteries, one of which is always held in reserve. A motor generator driven off the lighting circuit is used for charging.

"The Central."—The December number of *The Central*, the magazine of the Central Technical College Old Students' Association, has as a frontispiece an excellent photogravure of Prof. W. E. Dalby, the professor of engineering at the College, in his sterner moods. Prof. H. E. Armstrong has contributed an interesting article on "The Nature of Chemical Change," which shows what important research work has been done in the Chemical Department of the College; there is a description by Mr. T. H. Mann of the new work on the Cardiff Railway, several books are reviewed, and Mr. E. W. Lewis has written an instructive article on india-rubber, "From Tree to Tyre." The number also contains a review of the 1906-7 college session, and the usual copious "Old Student Notes." Old students of the College who are not yet members of the Old Students' Association should communicate with Dr. E. Frankland Armstrong, the hon. sec. (98 London Road, Reading), and they are also urged, especially if they have vacant appointments to fill, to make use of the Association's employment agency, of which Mr. R. J. Caldwell, B.Sc., and Mr. R. Whymper (Central Technical College, Exhibition Road, S.W.) are honorary secretaries.

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A NEW AUTOMATIC ELECTRIC BLOCK SIGNAL SYSTEM

ONE of the most noteworthy features of the Philadelphia & Western Railroad is the automatic electric block signal system as described in the *Street Railway Journal* This road is a double-track, high-speed, direct-current electric line extending westward, a distance of eleven and one-half miles. The essential features of this system are as follows:—The retention of both rails of each track for the return of the propulsion current; cross-bonding facilities between all rails of both tracks at the ends of all track circuits and between one rail of each track intermediate between the end of said sections, wherever desired; the use of ironless reactance bonds, permitting very long track circuits to be operated with a minimum expenditure of energy; the use of alternating currents only for the track circuits, and the operation of all the devices connected with the system, thus doing away with all batteries and the expense incident to their maintenance.

Single-arm, two-position home signals arranged on the normally clear principle are employed with an overlap. In certain places the signals average about 3,300 ft. apart, and a full block overlap is being employed to permit a two-minute headway. In others, the signal spacing averages one and one-half miles with a uniform overlap of about 3,700 ft., allowing a headway of approximately five minutes. Twenty-five-cycle, single-phase current from transformers in the railway's power plant is used for operating the entire signal system.

Power is delivered to the switchboard through a remote controlled automatic oil switch. Each feeder circuit is equipped with an ammeter and an electrically tripped, hand-operated oil switch, whereby the system may be relieved in case of a cross on either transmission line. The latter consists of two No. 6 B. & S hard-drawn bare copper wires strung on separate cross-arms on the railroad company's high-tension pole line, which is protected by lightning arresters.

"Line transformers" are installed at all signal and overlap locations. They step down directly from the transmission line voltage of 2,300 to the voltages required for the signal system. These transformers are protected on the primary side by cartridge fuses mounted in watertight cast-iron boxes, and so arranged that a fuse can be replaced without danger. The secondary windings are three in number, a 55-volt winding for the operation of the signal motors, lights, and line relays, and provided with a tap for local phases of all polyphase relays; and two windings for supplying energy to the track circuits, taps being provided on these windings so that the voltage can be varied from 2½ to 15, as required for track circuits of different length. A copper shield is placed between the primary and secondary windings and connected to ground, affording protection in case of a breakdown in insulation. All coils are insulated with an oil and moisture resisting compound by the "vacuum treatment" process, in which the coils are heated in an air-tight tank. After a vacuum has been secured and the moisture thereby extracted, insulating compound is forced into the coil under heavy pressure, which causes the liquid to penetrate to the heart of the coil, with the result that every wire is surrounded with a highly insulated covering.

Both rails of each track are made available for the propulsion current by ironless "reactance bonds" connected to the rails. When so connected they form a path of low ohmic resistance and large current capacity for the traction current, and at the same time offer an impedance to the passage of the alternating current from rail to rail, whereby a portion of said current is forced down the rails to operate the track relay. The reactance bonds at the transformer end of the track circuit has a single winding connected directly to the rails. The bond at the other end of the circuit has two windings, one connected to the rails and the other directly to the relay. The winding connected to the relay acts as the secondary of a transformer, its object being to prevent an excessive flow of direct current through the relay which, owing to the low ohmic resistance of the relay, would otherwise result were the relay connected directly to the track rails. Attention is called to the fact that these bonds are of the ironless type, and hence are not subject to saturation due to an unbalanced condition of the traction current in the rails, the reactance, therefore, remaining constant under all such conditions. It is also to be noted that alternate rails in adjacent track circuits are connected by heavy "diagonal bonds" so arranged that the breaking down of any insulated rail-joint will short-circuit either the relay or transformer and prevent the giving of a false clear indication. Cross-bonding between tracks may be effected by making connection, at any point desired, to the rails, which are made continuous by the diagonal bonds.

The bonds in question are made up of flat copper strips of large cross section wound in the form of a spiral, the turns being suitably insulated from each other. The coils, when wound, are heavily taped and then impregnated as in the case of the transformer coils. These coils are assembled in pairs in flat iron cases and mounted on extended ties. A connecting chamber is provided in the case between the coils, in which all the coil-ends terminate, and where all connections to the rails, relays, and transformers are made and then concealed by a suitable cover. The copper connections to the rails after leaving the bonds go directly downward and under ground to the rails where, after passing a short distance above ground to insure flexibility they are connected. This construction conceals the copper as much as possible, and reduces theft to a minimum. Energy is supplied to the track circuits directly from the low-voltage high-current windings on the line transformer, through adjustable cast-iron resistance grids, which limit the current flow when a train is standing at the transformer. These grids are mounted in separate perforated cast-iron boxes. The moving contacts are mounted on a horizontal wooden bar, to which motion is imparted by a small split-phase induction motor having two stationary windings. One of these windings is connected directly to the reactance-bond secondary, and the other directly to a low-voltage tap on the line transformer. When thus connected, a phase difference exists between the two coils and rotation of the armature is thereby produced.

Of the energy in the two relay windings, that supplied by the transformer direct is by far the greater. This requires but a small amount of energy from the track to give positive action of the relay, and as a result very long blocks can be operated with comparatively little energy, as evidenced by the fact that in this installation track circuits 8,880 ft. long are operated with energy fed in at one end. As alternating current only can cause the relay to operate, it is immune to the effects of direct current. All contacts and other working parts are made visible by glass-covered openings. Watertight construction is effected by using rubber gaskets. These relays are positive in action, and give an exceptionally heavy rubbing pressure between the contacts in closing, and an extra wide opening when de-energised. Contacts can be provided, as required, up to a maximum of four front and four back per relay. They are insulated to withstand a breakdown pressure of 3,000 volts alternating current.

The track circuit control relays are to hold a given signal at stop until the train is out of the overlap for the next signal in advance. These relays must be able to carry continuously and break the entire current flowing to the track circuit at the rear of a signal, and, of course, must continue to do so without injury. These relays as designed will carry an alternating current of from fifty amperes to seventy-five amperes, and break the same at twenty-five volts continuously without overheating and without perceptible arcing, although the current required to be carried in practice is much less than this. The construction and operation of these relays is similar to that of the track relays except that the contacts are made very much heavier, and the necessary phase displacement to produce rotation is effected by a small reactance coil, placed in series with one of the relay windings. There are a great variety of uses to which these relays can be adapted by simply changing the windings or contacts or by the addition of stock parts.

When wound to a low resistance they may be used as track relays, with contacts to the number of four front and four back, and when equipped with heavy contacts they can be used for the control of low-voltage heavy currents as already described. When equipped with carbon to carbon contacts they will break small currents of high voltage (up to 600). When wound to a high resistance they may be used as line relays with any reasonable equipment of contacts desired. By adding an upward extension to carry a small semaphore arm, they can be used as tower indicators, and, when placed in a suitable case, as switch indicators. The movements when placed in a case and equipped with a shutter and suitable contacts can be used as light signals for tunnel work. Furthermore, the feature which this relay possesses of operating in one direction with a given phase relation and in the opposite direction when said phase relation is reversed (and since a given reactance or resistance is necessary to produce rotation in a given direction), the possibility of false operation due to foreign currents or crosses is much more remote than in the case of direct-current relays and certain other alternating-current relays. This feature also makes it possible in many cases to use but one line wire where two would otherwise be required.

The motor-control relay is so controlled by the three track circuits in advance of a given signal that it cannot close until the train is out of the overlap for the next signal in advance. This relay directly controls the clearing of the signal, and is of the alternating-current tractive type. It is designed so that a uniform magnetic pull is exerted on the armature, notwithstanding the fact that the current in the magnetic coils alternates. In many respects it is similar to the direct-current track and line relays manufactured by this company.

The signal mechanism employed is a two-arm movement, and is operated by a small single-phase induction motor, which is connected through suitable gearing to a slot wheel. Projecting from the sides of the said slot wheel are pins which as they come around engage the slot dog in such manner as to clear the signal in case the slot is energised. The slot magnet is designed to operate on alternating current, and to give a uniform pull without noise and vibration. It has an exceptionally high "drop away" point. The movement of the blade in clearing is limited by the stop arm, which becomes effec-

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tive only when the slot is energised, and is so arranged that the signal blade is brought precisely to, and held at, the clear position, no matter what the speed of clearing. The circuit-breaker contacts are enclosed in a dust-proof case with a glass front, which is mounted at the top of the mechanism. The dash-pot is of the buffer type, allowing a free initial movement of the blade in returning to the stop position. All the signals are lighted by two 4 c.p. 50-volt lamps connected in parallel.

All relays are housed in wooden boxes, which in turn are enclosed in cast-iron boxes. In the lower part of the iron boxes are mounted the terminal boards, where all outgoing wires terminate on suitable binding posts and to which all apparatus within the boxes themselves are connected by flexible leads. All transformer secondary fuses are also mounted on this same board. The relay-boxes, grid-boxes, and line transformers are mounted one above the other on suitable stub poles provided for the purpose.

THE PRINGLE "TANGENTIAL" TROLLEY-WIRE SUSPENSION

IN our description of the tramway extensions at Derby (ELECTRICAL ENGINEERING, December 19th, 1907), we gave some particulars of the new method of trolley-wire suspension employed there, which is the invention of Mr. P. J. Pringle, Borough Electrical Engineer and Tramways Manager to the Burton-on-Trent Corporation. Mr. Pringle has now given us some additional information with regard to his system. It has been erected on about 1½ route miles with bracket arms and about 1¼ miles with span wire in Derby by the tramway department staff of that town, and has given no trouble there during the few weeks that these routes have been in operation. In Burton, all parts of the line in which there is the greatest rigidity, have been changed over to this system, and it is being given a trial in about half a dozen other tramway undertakings.

Mr. Pringle points out that after a tramway has been running three or four years, trouble with breakages of the trolley wire at the ears are usually experienced, and he tells us that in Manchester, Dublin, and Berlin fractures of the trolley wire have become so frequent that it has been necessary to put a supporting anchor wire on either side of nearly every ear, so that, in the event of a fracture, the anchor wire will hold up the trolley wire.

With circular wire, however carefully finished off the ears may be, there must be a blow between the ear and the trolley wheel to a more or less extent, together with arcing at the trailing ends of the ears. When the soldered ear is replaced by the clinched ear, it is necessary to make the sides of the ear a little stouter, and, although breakages are less liable to occur, these two effects are slightly increased unless a grooved or "figure 8" wire is employed. This, however, makes it necessary to keep the trolley wheel turned up regularly from time to time during its life, and Mr. Pringle contends that there is a more rapid wear of the trolley wheels, and on the trolley wire towards the centre of the spans, which is due to the difficulty of keeping the grooves of the wire on the horizontal plane after it has left the ears. Another cause contributing to the fracture of the trolley wire at the ear is that, in spite of the flexibility of bow-string suspension and span-wire

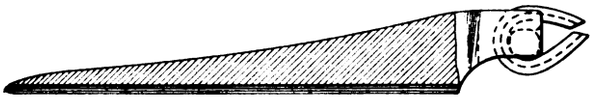


FIG. 1.—EAR USED FOR PRINGLE SUSPENSION. SCALE: ONE-THIRD FULL SIZE.

construction, there is still a certain amount of hinging action at the ends of the ears, so that the wire at this point is submitted to alternating stresses.

All these tendencies, Mr. Pringle claims, are eliminated by his new system of suspension, the main principle of which is the supporting of the trolley wire and its fittings by means of suspension wires approximately tangential to the natural curve of the trolley wire. Figs. 1, 2, and 3 show the method as applied to bracket-arm suspension. In Fig. 3 the ordinary bow-string and the Pringle suspension are illustrated side by side for the purposes of comparison, the former being to the front and the latter to the back. Instead of an ordinary ear, two 8-in. ears (Fig. 1), similar to those used for anchor ears in ordinary work, are employed. These are placed with their tips about 5 ft. from the centre of the suspension, on either side, and the trolley wire

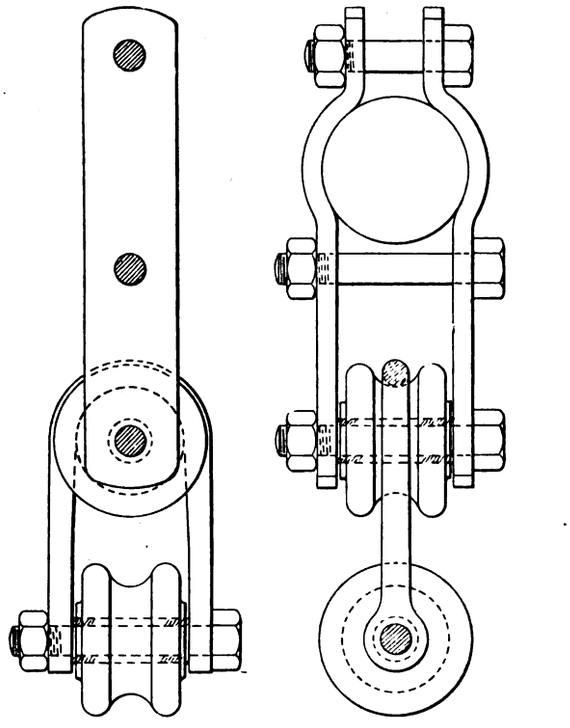


FIG. 2.—BRACKET ARM ATTACHMENT FOR PRINGLE SUSPENSION. SCALE: ONE-THIRD FULL SIZE.

is soldered into them in the usual way. A suspension wire, usually of 7/12 gauge, is fastened between these two ears, passing over the lower grooved insulator shown in Fig. 2, but not fixed to it except when anchoring is required. The construction of the fixture to the bracket arm is clearly shown in Fig. 2. Both the upper and lower insulators are of the brown-ware reel pattern.

The downward pull of a 000 trolley wire on an ordinary ear is about 60 lb. with the average distance between supports, and in the case of the Pringle suspension it is transferred to the insulator, while the force on the ears is purely tensile. There is sufficient flexibility to allow a vertical motion of the trolley wire of about 1¼ in. and a horizontal motion of about 3 in. Besides diminishing enormously the alternating stresses on the trolley wire at the ears, it is found in practice that the blow on the wire as the trolley passes on to it from the ear is greatly reduced. The form of ear is "non-fouling"; the ear is in soldered contact with only the top half of the wire, as owing to the stress being almost parallel to the wire there is little danger of peeling away, and consequently no necessity for a great depth of groove. The ears are milled out a few

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mils larger than the actual diameter of the trolley wire, and the latter is tinned previously to applying the ears. Two small thumbscrew clamps are used for holding the trolley wire tight down in the groove of the ear during the soldering process.

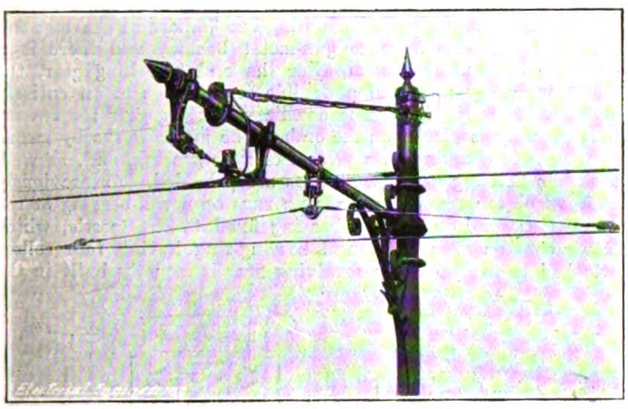


FIG. 3.—BRACKET ARM WITH ORDINARY BOW-STRING SUSPENSION AND PRINGLE TANGENTIAL SUSPENSION.

A number of tests have been made by Mr. Pringle, using 000 B. & S. trolley wire 0·409 in. diameter, and with the 8-in. ear used on straight line work, the ear casting has broken at stresses of 3,000 lb. without the ear attempting to leave the wire.

With the pull-off ears, which are about 12 in. long

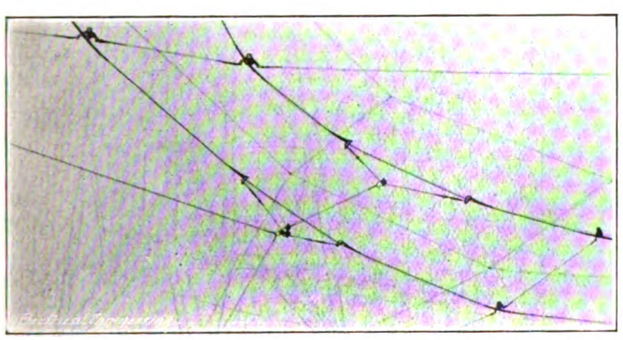


FIG. 4.—USE OF THE PRINGLE SUSPENSION ON A CURVE.

and of a stronger pattern, several tests have been made to prove that the trolley wire will fracture (requiring a stress of some 6,000 lb. to effect this) without any signs of the soldering giving way.

Mr. Pringle is now experimenting with malleable iron ears, which would not be feasible under ordinary

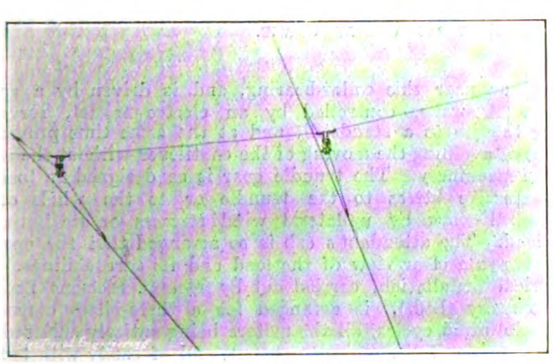


FIG. 5.—SPAN-WIRE SUSPENSION.

conditions, as malleable iron is unsuitable as a current-collecting surface. He informs us that the soldering with malleable iron ears has given just as reliable results as gun-metal, under stresses sufficient to fracture the trolley wire. It is anticipated that the use of malleable ears will tend to cheapen the cost of construction, which is already no greater than that of the ordinary suspension.

Previously to using the brown-ware reel insulator for both primary and secondary insulation, Mr. Pringle had fifty pairs of these under continuous test at 500 volts at his power station, where they were exposed to weather and any dirt or dust that might be about. Even in very heavy rain the leakage current from these insulators was only about 20 milli-amperes, and when the rain moderated the insulation at once rose. The same set of insulators were placed under test at 2,000 volts alternating for several months continuously with satisfactory results.

Fig. 4 shows the method of using the Pringle system on a curve. All bends in the line and pull-offs have



FIG. 6.—PRINGLE TRIPLE TANGENTIAL SUSPENSION.

the angle halved, so that much easier running is given, and high speeds are possible on bad pull-offs. It is also claimed that side wear on the wire is reduced.

On span-wire work (Fig. 5), the new suspension costs slightly more than ordinary span-wire work, but if all the advantages claimed are fully borne out in practice, it is evident that the saving in repairs and maintenance will far more than counterbalance the slight difference. Fig. 6 shows a modification, in the form of a triple tangential suspension, to reduce the sag in a trolley wire when higher speeds are required than those in ordinary tramway work. In this illustration one wire is supported on this system, and the other on the ordinary span-wire system, to show the difference in sag.

We are asked to state that Messrs. G. W. Green & Co., who are the sole licensees of the system, have assisted in working out the necessary details in its construction. The Consolidated Accessories Co. are the selling agents.

Franco-British Exhibition.—In connection with the movement to organise a co-operative electrical exhibit at the Franco-British Exhibition, by the electric supply companies of London and electrical manufacturing firms (ELECTRICAL ENGINEERING, Vol. II., p. 964), the following firms have now expressed their willingness to take part in the scheme. Full details of the scheme are being prepared, and in the meantime Mr. C. G. Northcote, the organising manager of the electrical section, will be pleased to hear from any other firms who are desirous of supporting the movement:—Armorduct Manufacturing Co., Ltd.; Berry Skinner & Co.; British Thomson-Houston, Ltd., British Prometheus Co., Ltd.; British Westinghouse Electric & Manufacturing Co., Ltd.; Bertram Thomas; Crompton & Co., Ltd.; Dowsing Radiant Heat Co., Ltd.; Edison & Swan United Electric Light Co., Ltd.; Foster Arc Lamp & Engineering Co., Ltd.; Huntalite Co.; Imperial Lighting Co.; Langdon, Davies Motor Co.; Linolite Co.; Marconi's Wireless Telegraph Co., Ltd.; Oliver Arc Lamp Co., Ltd.; Perfecta Seamless Tube Co., Ltd.; Robertson Electric Lamps, Ltd.; Simmonds Bros.; Sun Electrical Co., Ltd.; Union Electric Co.

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A 100-TON ELECTRIC WHARF CRANE

A 100-TON electric wharf crane has been recently constructed and erected for the Dublin Port and Docks Board by the Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft, of Nuremberg, Germany, and mechanical details are shown in Fig 1, and a general view of the crane is given in Fig. 2. The design is of a light and open type, and the two main girders of the jib are joined throughout their entire length by horizontal cantilevers, by means of which the jib has considerably more rigidity against the horizontal stresses. Above and on both sides of the crab-travelling track is a railed ladder, by means of which the crab is at all times accessible. Vertical crossbars take over the stresses caused by horizontal and wing pressure, and by means of these the stresses are transferred to the pillars or through the horizontal ring-girder on to the supporting frame. The scaffolding is connected by anchor-bolts to the foundation body, which is provided with an iron centre, are two brakes working quite independently of one another. One brake is worked by an electric brake magnet, and the other is a mechanical and automatically working Lamell brake of the builders' patent type, which ensures even lowering, independent of the attendant's skill. The important bearings are fitted with interchangeable gun-metal bushes, and there is a complete lubricating system. For the crab-travelling gear, the motor works by means of a flexible coupling on to an entirely enclosed worm gearing. The auxiliary hoisting gear for twenty tons capacity is placed on the crab. The motor works by means of a flexible coupling on a system of spur gearing, and, as with the main hoisting gear, two brakes are provided. As previously mentioned, the revolving crane-jib runs on a rail-bearing at the foundation, and in a collar-bearing fixed to the trestle, which latter consists of a horizontal bearing-ring having four rollers attached to the jib. The revolving gear is securely built in the

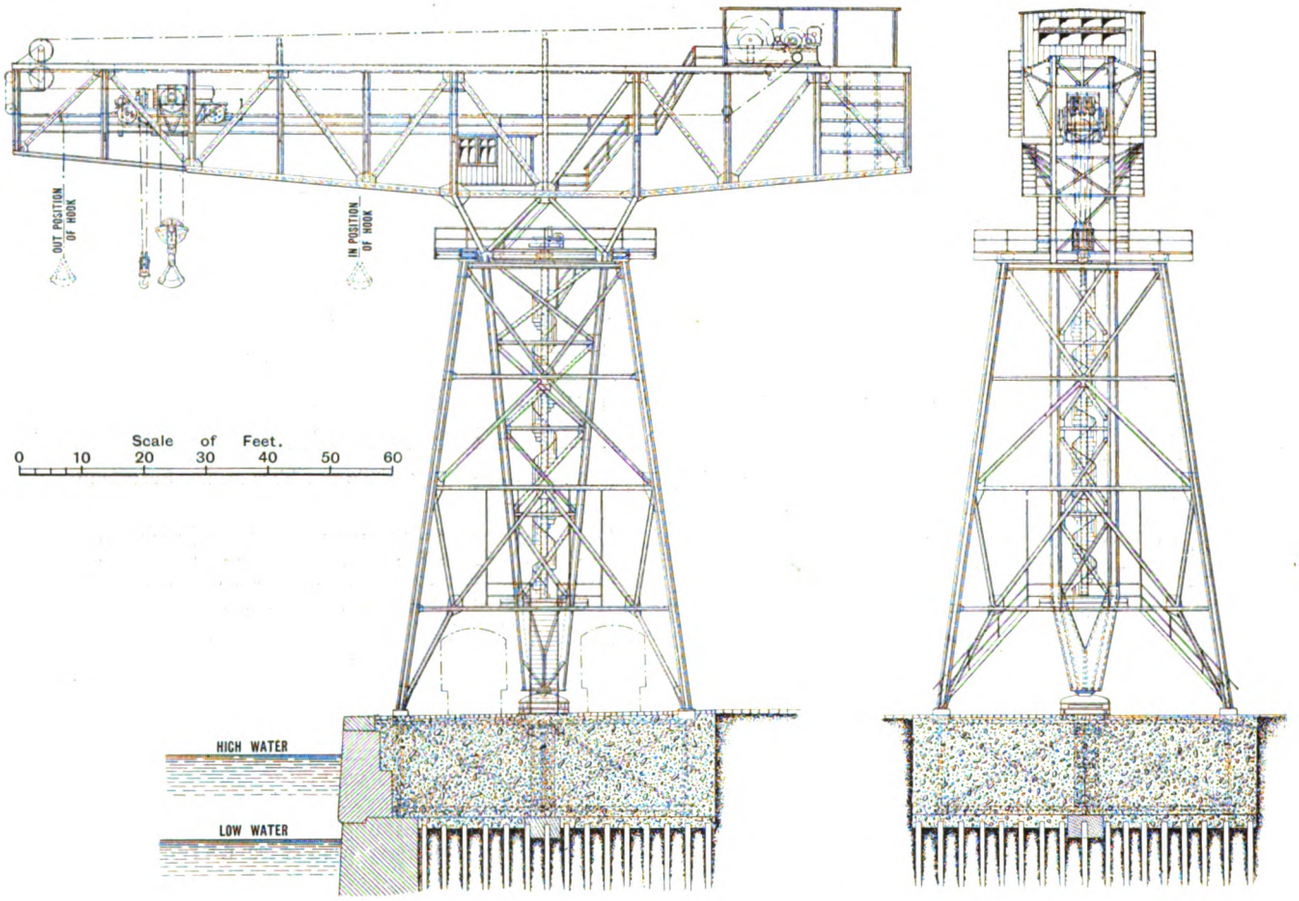


FIG. 1.—GENERAL ARRANGEMENT OF 100-TON ELECTRIC WHARF CRANE.

so that all vertical and horizontal stresses are sustained by the steel structure, that is to say, the concrete is not called upon to withstand any bending stresses. The revolving jib on which the crab runs is provided with a rear arm for the counterweight and with a vertical pillar. This revolving part runs on roller bearings at the base, whilst the horizontal stresses of the upper part are carried by the collar-bearing attached to the stationary trestle, and provided with rollers. The counterweight is placed at the back cantilever, and consists of a stiffened plate tank filled with concrete. A spiral railed staircase leads to the upper platform of the trestle, and easy access can thus be had to the attendant's cabin, and to the two stairways attached to the crane jib, as well as to the compartment containing the gear. The hoisting gear and the crab-travelling gear are both located in the house situated at the rear arm of the jib. The driving of the hoisting gear is by means of a flexible coupling, and an entirely enclosed system of spur gearing with cut teeth, which further operates by means of spur wheels on to two grooved rope drums. The rope is so led from the hook pulley on to these drums that any side tension or unevenness of the pulley—either to the highest or lowest position—is rendered impossible. There jib pillar near this collar-bearing, and is driven by a special motor. A brake, controlled by an electro-magnet, serves to bring the jib to a standstill, and at the same time provides a means of avoiding the moving of the cantilever without the action of the machinery. The trundle gear is so designed as to avoid an excessive stress to the trundle or to the whole of the structural work by unilateral wind stresses or oscillating of the load. The attendant's cab is so arranged that the operator has always a clear view of the load and its surroundings. The electrical installation, carried out by Messrs. Siemens Brothers & Company (Ltd.), is arranged for a three-phase current at 346 volts at 25 cycles, all the motors being entirely enclosed and fully capable of the requisite output, and of easily withstanding sudden rushes of current. The current is taken to the motors and electric magnet for the auxiliary hoisting gear situated on the crab by a sliding contact fixed on the inside of the jib. The following are the leading dimensions—Maximum radius, from the outer edge of the quay wall to the hoisting rope axis, with a 100 tons 45 ft., with 20 tons 50 ft. Minimum radius, from revolving axis to the hoisting rope axis, 100 tons, 30 ft. Revolving axis to outer edge of quay wall, 30 ft. Height of

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lower edge of load hook, when at its highest position over the quay wall, with 100 tons 70 ft., with 20 tons 70ft. Greatest height of lift, for 100 tons 100 ft., and for 20 tons 100 ft. The working speeds are: lifting, 100 tons, 5 ft. per minute; 50 tons, 10 ft. per minute; 20 tons (auxiliary hoisting gear), 20 ft. per minute (with reversed wheel gearing); speed of crab, 28 ft. per minute; duration of a complete crane revolution, 8 to 10 minutes. Working at low speed, the lifts are, 100 tons, about 3 ft. per minute; 50 tons, about 6 ft. per minute (with reversed wheel gearing); speed of crab, 22 ft. per minute; and duration of a complete crane revolution, 10 to 12 minutes.

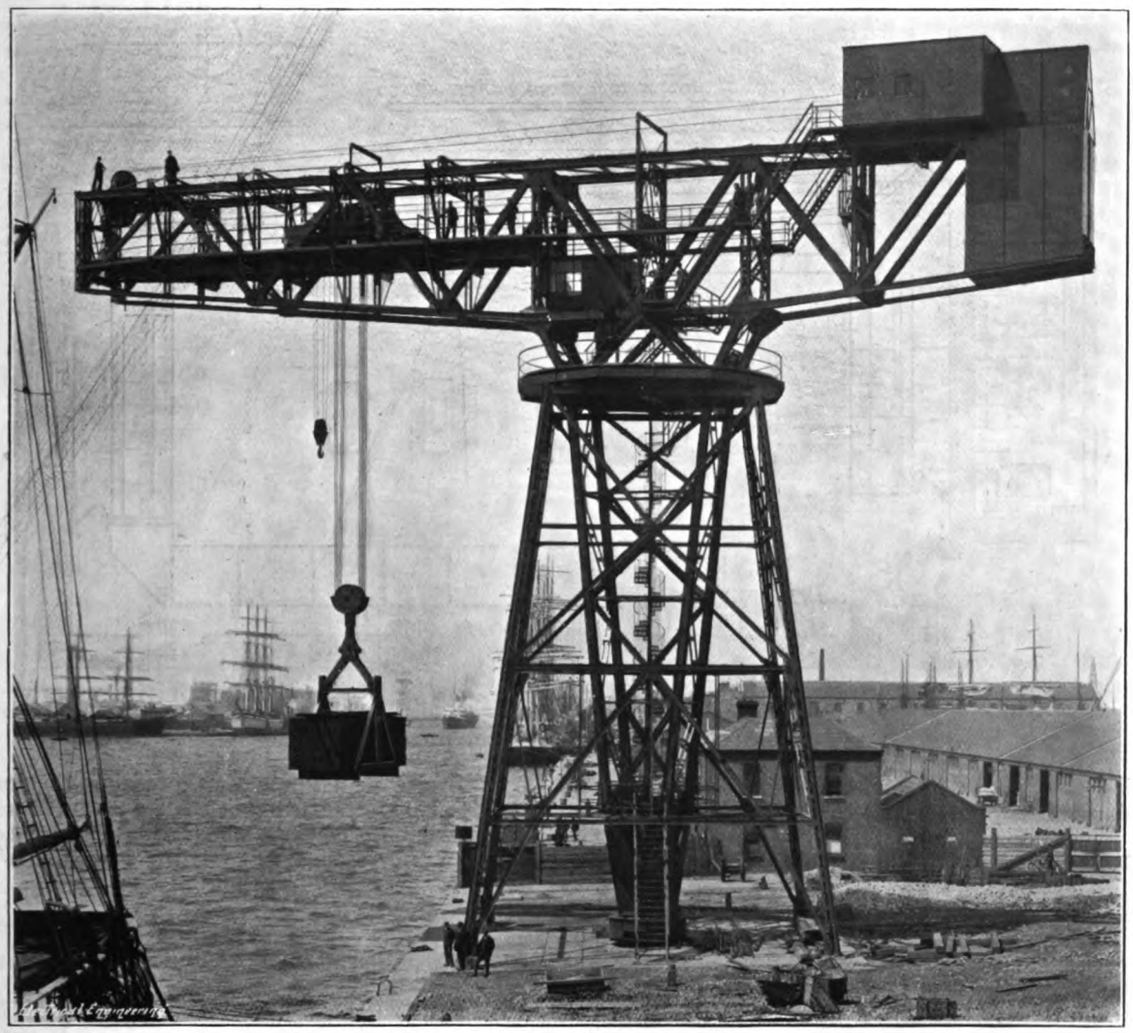


FIG. 2.—VIEW OF 100-TON ELECTRIC WHARF CRANE AT DUBLIN.

NEW TRUNK TELEPHONE EXCHANGE AT BRADFORD

ON November 9th the Trunk Exchange at Bradford was transferred from the north to the south end of the Post Office building, where a new room had been recently completed. The walls are of white-glazed bricks, the roof has both ceiling and lantern lights, there are windows on three sides, and the room is, in consequence, admirably suitable for the purpose. It is heated by hot-water radiators, whilst ceiling pipes on the same system are fixed to prevent cold air falling down upon the operators' heads from the roof windows. Fire buckets filled with sand, and iron cylinders containing asbestos cloths, are placed around the room in convenient and handy positions in case of emergency.

The new switchboard, constructed and wired by the British Insulated & Helsby Cables, Ltd., consists of 16 three-panel Trunk and Junction switch sections, as shown upon the plan in Fig. 1. Included in this number are the record and reserve sections, the latter being fully fitted for the purpose of transferring the trunks from those sections which are thrown out of use for their periodic overhaul. The first 11 trunk panels are fitted up for concentration purposes during slack periods, and in accordance with standard methods. Provision has been made for extending the switchboard, as shown by dotted lines, along the west side of the room.

In the design of the switchboard every effort has been made to reduce risk of fire to a minimum. Its framework of iron is rigid and strong, and has been painted to prevent rust, and it is earth connected. The cable-bearers and troughings are also of iron. The front of the board, which presents a handsome appearance, has its polished mahogany facings and continuous plug shelf, as well as the ebonised panels, backed with uralite. Above the panels and along the whole length of the suite adjustable reflectors with incandescent lamps serve to illuminate the board.

The three-panel sections are separated by an intermediate panel carrying the ticket racks and switches.

Fig. 2 has been taken to show the apparatus used in connection with the telegraph call wires. The trunk panels of two sections, Nos. 20 and 21, are shown. On

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either side are the junction panels, No. J10 only being included on the illustration. Junction panel J11 is on the right of 21.

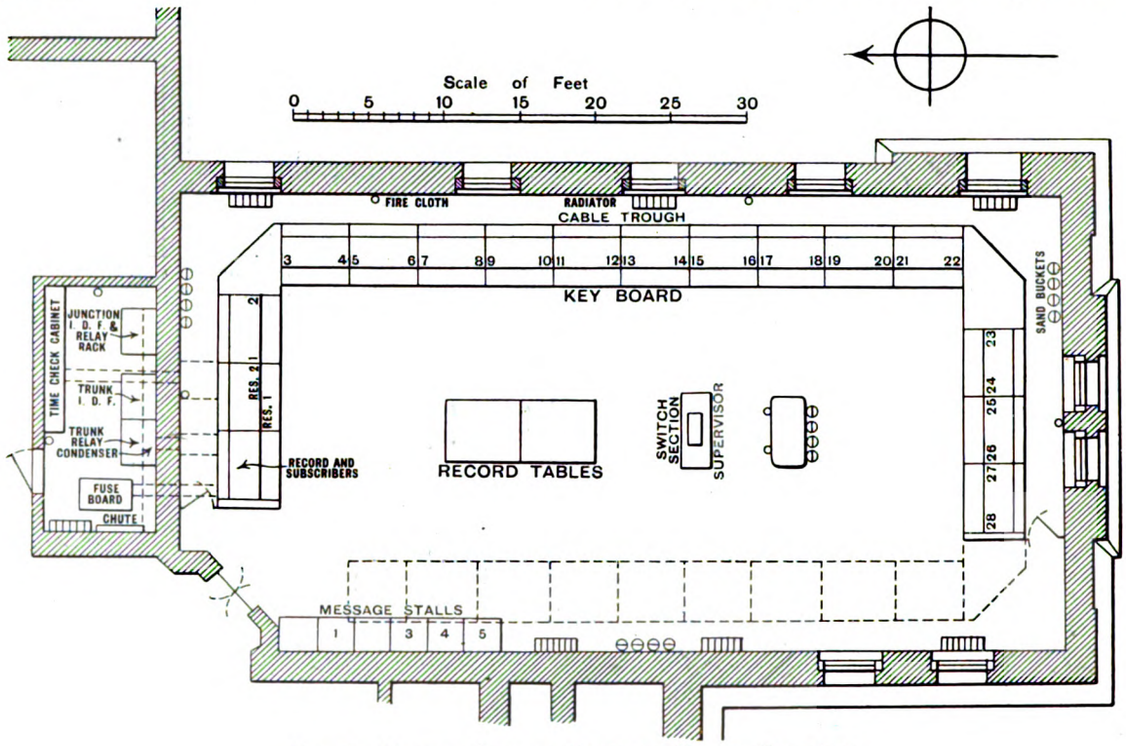


FIG. 1.—GROUND PLAN OF BRADFORD TRUNK EXCHANGE.

During the busy periods of the day the ordinary methods of transmitting the particulars of the calls over the trunk lines between Bradford and certain other trunk centres are rendered unnecessary by the use of the telegraph direct call wire system, resulting in an increased revenue of the earning capacity of the lines, and avoiding loss of time. The services of an additional operator are necessary. She is seated between the ordinary operators at the detachable desk fitted in the front of the keyboard opposite the intermediate panel. Her headgear sounder, with its perforated band, is shown against the sloping desk. The Morse key is immediately below. Upon one of the trunk lines an earthed telegraph circuit is superimposed, whose signals in no way interfere with the conversation taking place over that particular line. The trunks controlled by this call wire are divided into groups for incoming and outgoing traffic. By this method of working the trunk lines are exclusively devoted to conversations, whilst all messages and particulars of calls or complaints are passed over the call wire. To facilitate transmission of signals, certain phrases in frequent use are sent in code.

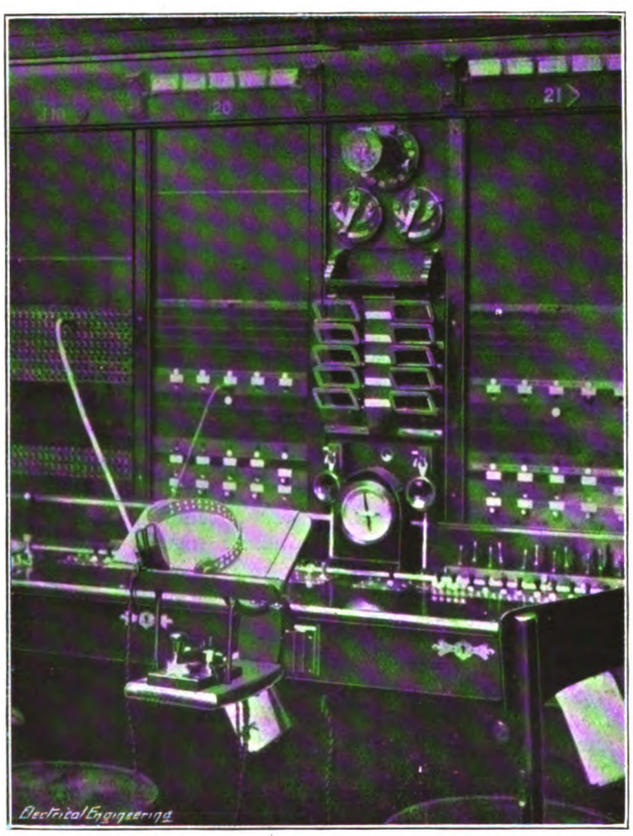


FIG. 2.—A PAIR OF TRUNK PANELS, WITH INTERMEDIATE TELEGRAPH CALL ARRANGEMENT.

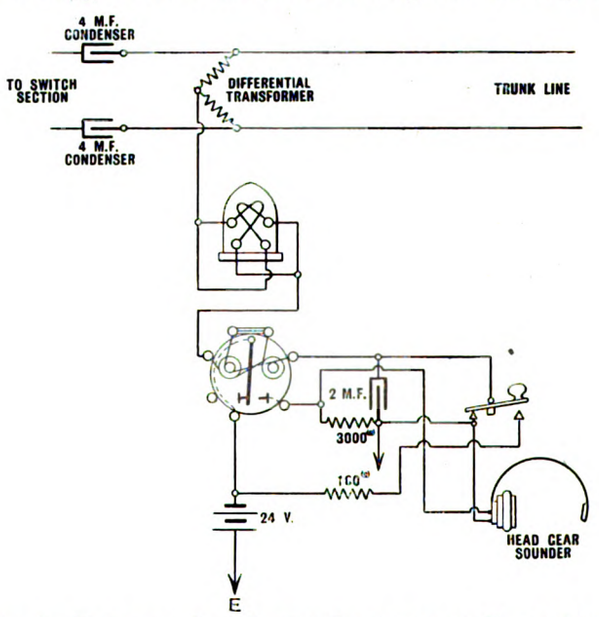


FIG. 3.—TELEGRAPH CALL CIRCUIT SUPERPOSED ON TRUNK LINE.

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Fig. 3 is the skeleton diagram of the circuit. Each station is joined up alike. The currents from the sending station pass through its own relay in a "spacing" direction; the sending operator therefore does not hear her own signals. Her sounder is only actuated by the distant stations signals. The differential galvanometer and condenser are joined up in such a way as to retard the telegraph battery currents, and reduce the possibility of disturbance on the trunk line. The sounds are produced by the movements of a small plunger in the headgear sounder. This plunger is propelled from an iron tube, and attracted by an iron screw when the local circuit of the relay is closed, and it is brought back to normal at its cessation by means of an antagonistic spring. The volume of sound is small, and does not inconvenience the operator.

Each trunk operator is provided with an additional receiver, which, when out of use, hangs upon a lever rest under her set of ticket racks to the left or right as the case may be. This is for use in connection with long-distance calls.

The junction panel is reserved for junction multiples, and transfer multiples between section and section for through trunking. The former occupy the centre portion, the latter the lower portion. In Fig. 4 skeleton diagrams are given, including the junction side of the trunk cord circuit, where means are provided by which the operator obtains both audible and visual "engaged" signals. Should either junction or transfer line be engaged, there will be an earthed battery with its positive pole connected to the bush of each jack of the circuit, which will find a path *via* the tip of the red plug and the earthed relay R7, producing a click in the receiver, and causing the lamp to glow.

In the centre of the trunk panels in Fig. 2 is seen the red test lamp L3. Below this are five lamps and jacks in connection with the calling circuit of transfers from the local and trunk sections. The pilot lamp, common to the circuits on the board, follows. Below these are the time check keys, line lamps, trunk jacks, night concentration jacks with plugs inserted, and the wire links for cutting out the relays when cord testing takes place.

Six pairs of plugs and cords are fitted, and provision is made for a seventh pair. In each cord circuit are three lamps. These are protected by a guard against

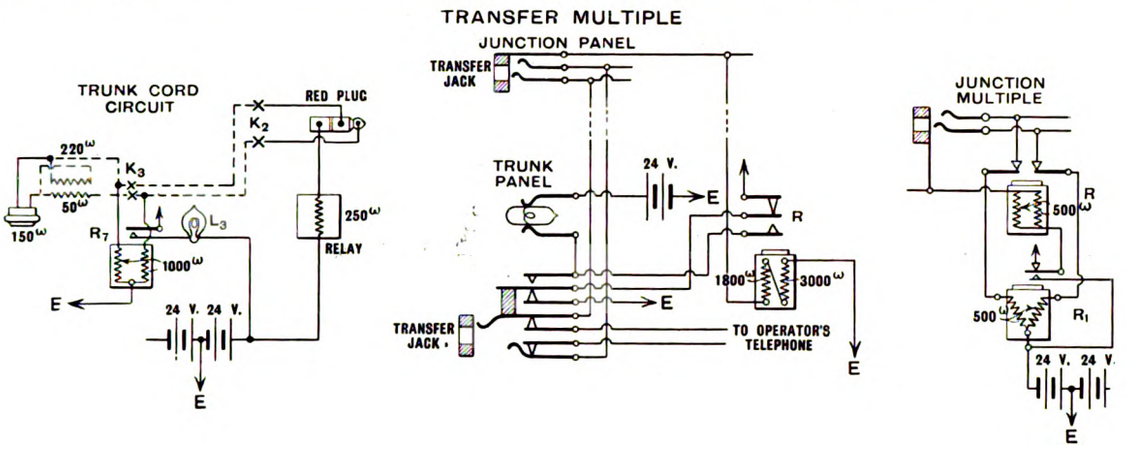


FIG. 4.—DIAGRAM OF TRUNK CORD CIRCUIT. TRANSFER MULTIPLE AND JUNCTION MULTIPLE.

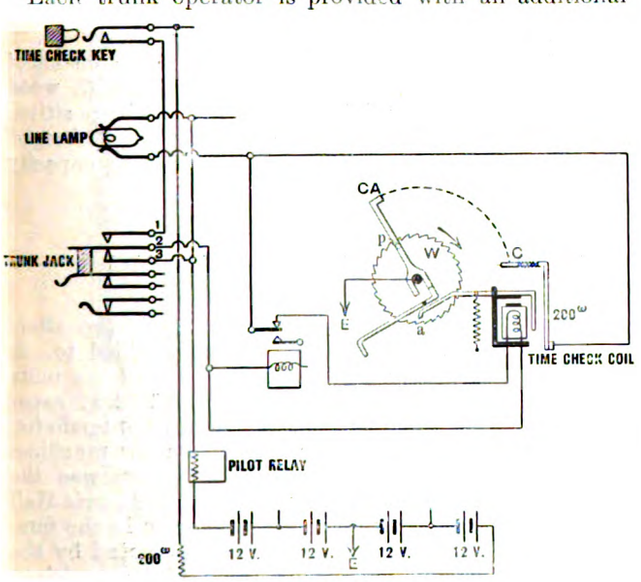


FIG. 5.—TIME CHECK.

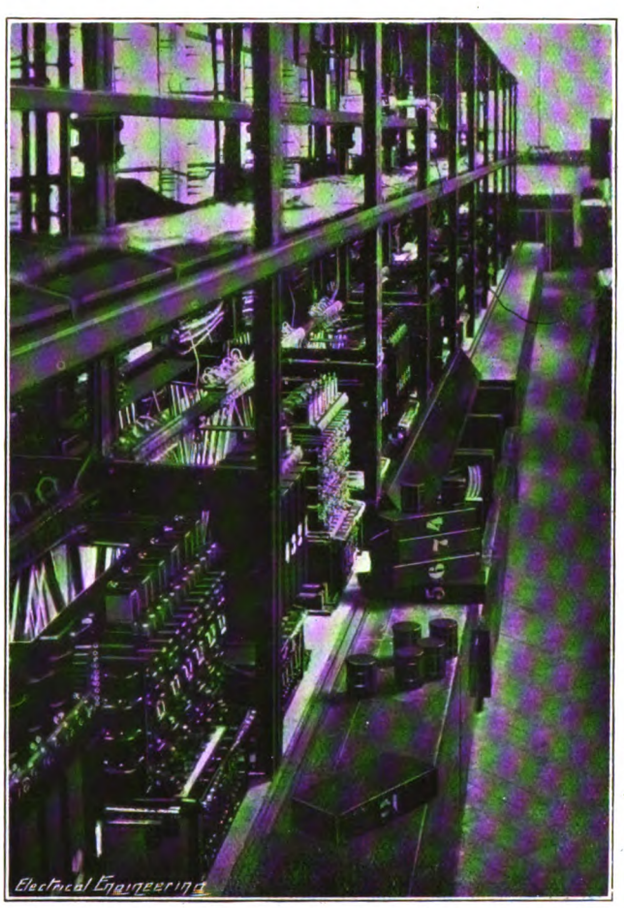


FIG. 6.—BACK OF SWITCHBOARD WITH ALL SLIDING PANELS REMOVED.

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damage from falling plugs due to any slip on the part of an operator.

The keyboard has a capacity for 20 call-wire keys, but only five are fitted. By depressing one, the operator is in direct communication with one of the junction operators of the National Telephone Co.'s Exchange.

A calculagraph for recording the exact times of each conversation is placed on the keyboard in front of each junction panel for the joint use of two operators. A coupling key is also provided for each keyboard for connecting the adjacent sets together.

Below the keyboard are wire baskets for waste paper, removable panels lined with uralite, and a continuous foot rail for the comfort of the operator.

In this exchange the time check is fitted to assist the operator to control the duration of a conversation. An electrical seconds pendulum is adjusted to give second impulses through the relays controlling the driving gear, which revolves the spindle carrying the toothed wheels in connection with each time check coil. The skeleton diagram is shown in Fig. 5. It will be noticed that when a plug is inserted in the trunk jack, contacts 1 and 2 are made, while 2 and 3 are broken. At the commencement of a conversation on the trunk line the operator depresses the time check key, which thereby closes the battery circuit through the time check coil, lamp, and pilot relay. The coil becomes energised, the armature is actuated, its remote end, *a*, lifts the tumbler arm, C A, whose pin, P, engaging with the revolving toothed wheel, W, is carried round towards C.

At the expiration of three minutes the arm reaches the hinged platform contact, C, earthing the line lamp which now glows. The operator ascertains if an extension of time is required, and if so depresses the key twice. The armature is actuated, and brings into operation a curved resetting rod, not shown, which strikes the arm off the wheel. The arm then falls back to its normal position. The second current causes it to re-engage for a second period. Should the plug be withdrawn before the expiration of the three minutes the coil is energised immediately the tumbler arm reaches the platform C, and the arm struck off.

If the plug is not withdrawn, or the key depressed, the arm is carried further round, and pressing down upon the movable platform is pushed away so that its pin is disengaged from the wheel, and the arm is restored by gravity.

Fig. 6 shows the back of the switchboard with the iron sliding panels removed to show the relays, &c. The power cables are supported on iron brackets in the roof of the section, and their ends terminated at tags mounted on vulcanised fibre bases.

The record tables, supervisors switch sections, and telegram stalls are of the standard types.

The intermediate distributing frames call for no special mention. The usual switchboard cables (42 and 84 twin wire, 12½ lb.) were laid between these frames and the trunk test board tags on the instrument side.

The machinery has been installed in the basement. The motor-generator for charging the cells is a 5·8 b.h.p. motor, coupled to a 70-volt, 80-ampere generator at 950 revolutions per minute. These are of the standard four-pole enclosed type, with carbon brushes, ventilated by means of a fan on the end of the armatures. The coupled machine rests on a common bed plate, and is earthed by means of a carbon brush running on a coupling.

The motor-starting panel consists of an ironclad starting switch with overload and no-voltage release, protected by two ironclad S.P. cut-outs, and an ironclad D.P. switch, all mounted on an iron frame. The voltage of the generator is controlled by a rheostat on the power board, and can be varied between 50 and 70 volts.

The power board in the battery room is constructed of a slate slab enclosed in an iron cabinet and fitted with a Nalder automatic cut-out in the battery leads, an ammeter and voltmeter with their switches, two electrolytic meters, a generator field rheostat, and three throw-over switches, two of which are five-pole, and control the charge and discharge of each battery, whilst the third is a six-pole switch to cross over portions of the battery to equalise their working.

The battery, supplied by the Chloride Co., consists of two sets of 24 cells, type SG4, nine-plate, with wood board separators, supplying 24 and 12 volt positive, and 24 and 12 volt negative, each set being charged and discharged alternate days. Its ultimate capacity is 240 ampere hours at the nine-hour rate.

EXTENSIONS OF GENERATING PLANT AT EASTBOURNE

THE Eastbourne electricity undertaking, originally started by a company and now carried on by the Corporation, has a longer history to look back upon than most electric supply undertakings, and it is of some interest to note the various changes in the generating plant installed from time to time, presenting, as they do, typical examples of what has been considered the best practice at various periods. With the exception of the early arc lighting, the system of supply, single-phase, with transformers, has remained all through, but the generating sets have ranged, as we shall see hereafter, from the machines driven by belting from countershafts familiar in the early 'eighties to the fine turbo-alternator just erected.

Before describing this latest extension we will give a brief historical sketch of the development of the undertaking. Electric lighting in Eastbourne started in 1882, in which year the Eastbourne Electric Light Company obtained a concession from the Hammond Electric Light and Power Co., and carried out the lighting of the parade with Brush arc lamps. A limited amount of incandescent lighting was attempted in series with the arc circuits, but this was superseded in the following year by the inauguration of a single-phase system with transformers. The original arc lighting plant was at the old Water Works, but was moved to a site in Junction Road in 1884, where the alternating plant was installed and gradually added to. It is interesting to trace the increasing sizes of the units adopted. The oldest machines were of 25-kw. capacity, and were driven by belting from countershafts. A pair of 75-kw. belt-driven Ellwell-Parker machines were afterwards added, and the next step was the installation of a 100-kw. rope-driven Lowrie-Hall machine. Some of the machinery is shown in the foreground in Fig. 1. A new era was inaugurated by the subsequent introduction of direct coupled sets driven by high-speed engines.

The career of the company closed by the taking over of the undertaking by the Corporation at the beginning of 1900, when, acting on the report of Mr. Hawtayne, the Corporation decided upon the erection of the present station at the east end of the town. This station was completed and supply commenced early in 1902. At first both stations were kept running, but the old alternating plant was finally shut down in July, 1902, although the arc lighter continued to run for a few months longer. The three direct coupled sets and the boilers were then moved from the old works and the former placed in the engine-room of the new station alongside the two Ferranti sets, which formed its initial equipment. At this stage, there-

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fore, the equipment was as follows:—Two 400-kw. Ferranti engines and alternators, one 200-kw. E.C.C. alternator driven by Willans engine, one 150-kw E.C.C. alternator driven by Davey Paxman high-speed engine, and the small 50-kw. set for taking the day load, also driven by a Willans engine. These machines are shown in Fig. 2, which depicts the appearance of

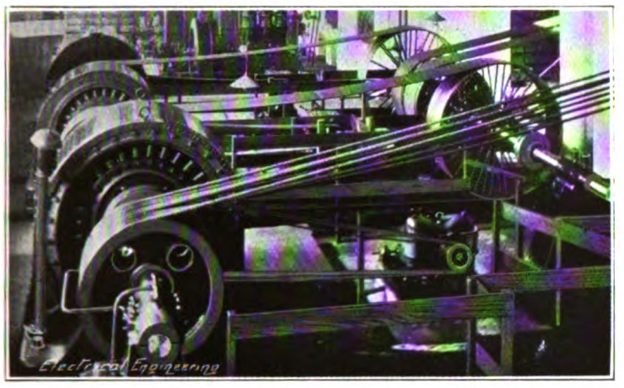


FIG. 1.—BELT AND ROPE DRIVEN PLANT IN OLD STATION.

the engine-room prior to the addition of the new turbo-alternator which has taken its place this winter.

We do not propose to give a full description of the whole of the station, as it is the purpose of this article briefly to recapitulate the different forms of generating sets which have been adopted from time to time, and to describe more particularly the very latest extension of plant which has been carried out.

The new set, which has been necessitated to keep pace with the rapidly growing load, consists of the 750-kw. Willans-Bruce Peebles turbo-alternator which is shown in Fig. 3. It has been possible to find room for this set and the extra boiler plant without any addition to the existing buildings, by a certain amount of rearrangement of the plant, both in the engine-room and the boiler-house. Another important feature introduced for the first time into the station is the provision of condensing plant, as all the older sets ran non-condensing. In this connection a large cooling pond, further details of which are given hereafter, had to be constructed.

The new set is placed across the east end of the engine-room in front of the switchboard, and the 50-kw. set partly shown on the extreme right in Fig. 2 has been moved to the other end of the room opposite one of the Ferranti sets. The generator is of Messrs. Bruce Peebles and Co.'s standard high-speed revolving field type with four poles. Its rated output is 940 k.v.a. at a power factor of 0·8 at 2,200 to 2,400 volts single phase, 50 cycles, and it runs at a speed of 1,500 r.p.m. The guaranteed overloads are 25 per cent. for two hours and 33 per cent. for half an hour, and the inherent regulation is specified to be such that the rise in voltage on switching off full non-inductive load shall not exceed 7 per cent., or, in the case of full inductive load, 17 per cent. The exciter is a four-pole machine rated at 15 kw., and coupled directly to the shaft. The maximum excitation required by the alternator, however, is stated not to exceed about 8 kw. The whole voltage regulation is carried out on the exciter shunt without any series rheostat. The exciter has, therefore, to work at times with a somewhat weak field, but is enabled to withstand these conditions without sparking by being provided with commutating poles. The outer end of the exciter shaft is provided with a ball bearing. The general construction of the alternator follows in most points the lines now becoming familiar with British high-speed designs. The frame is not of the entirely boxed-in type with a "chimney," favoured principally on the Continent. The casing is perforated with a number of holes which give ample access of air to the back of the stator core, and the general ventilation of the machine is assisted by a series of fan blades carried

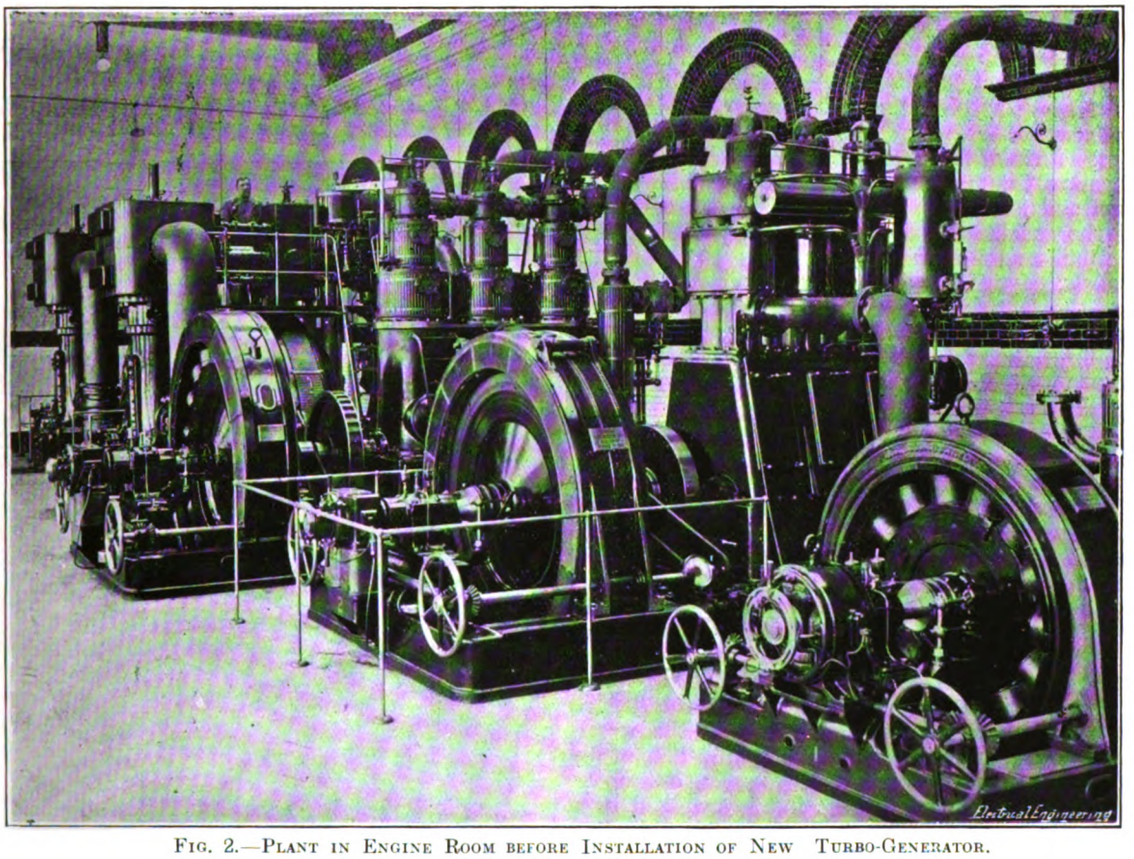


FIG. 2.—PLANT IN ENGINE ROOM BEFORE INSTALLATION OF NEW TURBO-GENERATOR.

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on the rotor. The poles are of the salient type with the pole-shoes affixed after the bobbins have been slipped on. The construction is simple and substantial, particularly as regards the clamping of the coils. The asymmetrical appearance of the single-phase stator winding in comparison with that of a three or two-

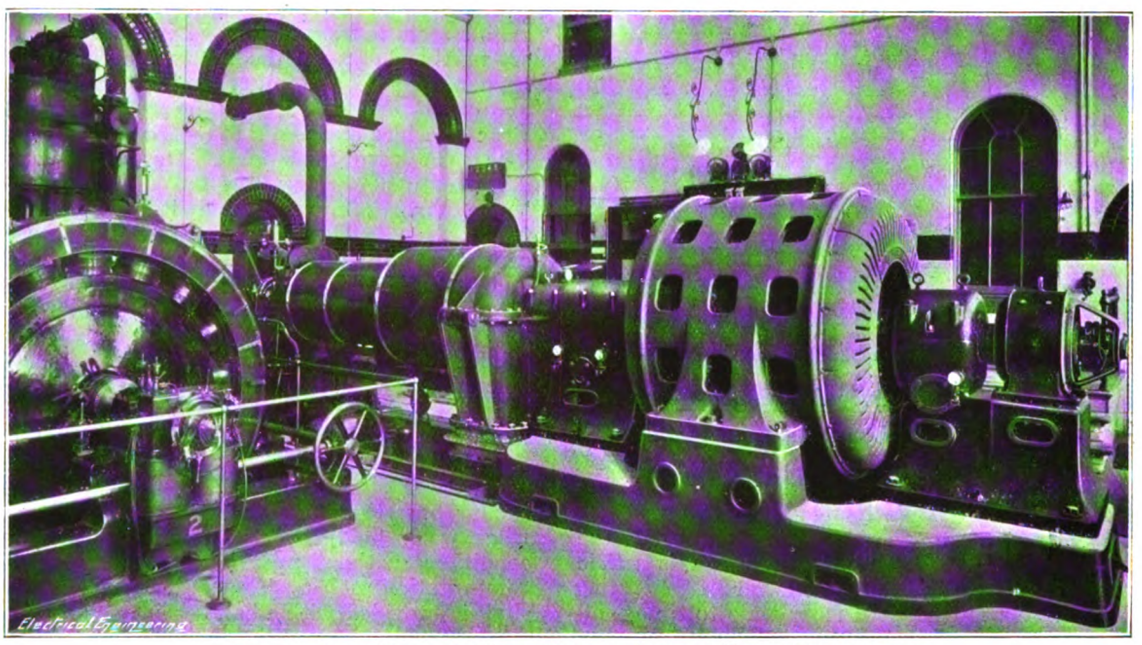


FIG. 3.—NEW WILLANS BRUCE PEEBLES 750 KW. TURBO-GENERATOR.

phase machine is at once apparent, and the somewhat large air-gap (about $\frac{5}{8}$ in.), necessitated in single-phase machines to obtain good inherent regulation, is also noticeable.

The turbine is of the standard Willans-Parsons type, with blading manufactured under the Willans and Robinson and Sankey patents. The general construction of the machine is similar to that of the turbine set described and illustrated in ELECTRICAL ENGINEERING, Vol. I., page 959, except for its somewhat smaller size, and the fact that the auxiliary motor for altering the speed by acting on the setting of the governor has not been thought necessary, as the set is placed so near the switchboard. Otherwise the governor gear is of similar design.

The condensing plant under the turbine, part of which is shown in Fig. 4, is of Messrs. Richardson, Westgarth, & Co.'s "contraflo" type. With this type of condenser it was not found convenient to bolt the condenser rigidly to the exhaust flange of the turbine and mount the condenser body on springs, as is often done in Messrs. Willans and Robinson's plants, so a flexible "concertina" joint has been inserted between the exhaust-valve and the condenser to make the necessary provision for expansion. The air-pump proper is of the familiar Edwards' three-throw type, driven through gearing by a 12 h.p. Rhodes single-phase commutator motor of the repulsion-induction type, running at 720 r.p.m. This type of motor is arranged to give a high starting torque as a repulsion motor when starting, but is switched over automatically so as to act practically as an induction motor when up to speed. Like all the other auxiliary motors it runs on a 200-volt circuit. A hot well pump and a force-pump are driven off the same shaft as the air-pump. The condenser is divided into several partitions, each drained separately; this drainage water is dealt with by the hot well pump, but the force-pump takes the water from steam not dealt with by the air-pump and the spray water. The circulating pump is of Messrs. Greenwood & Batley's centrifugal type, driven by a 12 h.p. slip-ring single-phase induction motor, manufactured by the Fuller Electrical Co. This set runs at 1,450 r.p.m., and can deal with 900 gallons per minute up to 25 ft. head. A Templer and Ranoe patent automatic atmospheric exhaust-valve is provided, which makes connection to the main exhaust-pipe of the other engines in the station when necessary.

The cooling water is taken to the new spray cooling-pond already mentioned. This is 89 ft. × 79 ft. 6 in. × 3 ft. 6 in. deep, and with a total capacity of 145,000 gallons. There are in all 80 spraying nozzles,

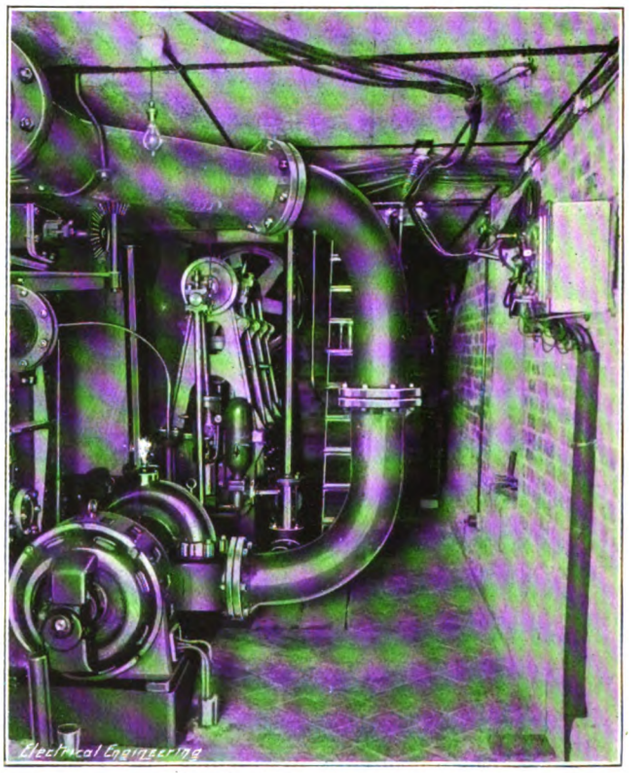


FIG. 4.—CONDENSING PLANT.

and from 70 to 75,000 gallons of water can be dealt with per hour. The pond itself was constructed by the Corporation by direct labour, and is lined with "Callendrite" bitumen sheeting, but the whole of the spraying equipment was supplied by Messrs. J. H.

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Harrison, of Middlesbrough, whose "Simplex" type of nozzle shown in section in Fig. 5 is used. The nozzle itself is made of gun-metal, the central portion being in the form of an inverted hollow cone, having two holes through the sides set at such an angle with each other that water passing through them from the lower side forms two streams which strike each other, and are thus broken up into fine particles. In this form the water offers a very large surface in proportion to its bulk, which is freely acted upon by the atmosphere as it falls through it into the pond below.

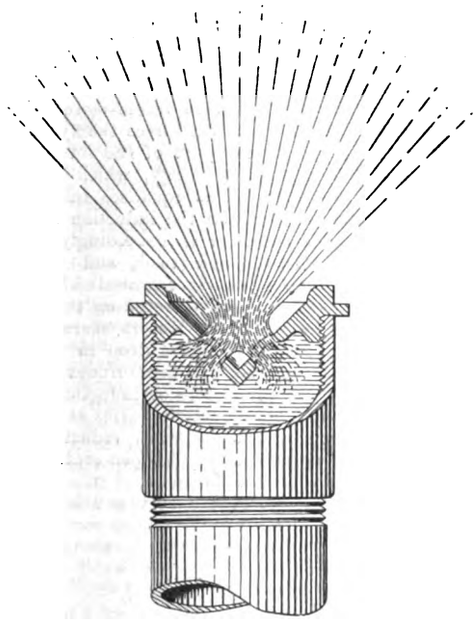


FIG. 5.—SECTION OF SPRAYING NOZZLE USED IN COOLING POND.

There is no doubt that the cooling obtained is quite as good, or, perhaps, even better than with the ordinary wooden cooling tower, but, of course, in cases where space is limited, the latter has to be used.

The switchboard extensions consist of a single machine panel and a spare panel mounted alongside and continuous with the old-fashioned Ferranti board. All the new switchgear is of Messrs. Cowan's, Ltd., manufacture, with Messrs. Everett & Edgcumbe's instruments. The main oil switch is provided with Mr. Leonard Andrew's patent discriminating reverse-current release, but not an overload attachment. The panel itself contains only the operating handle, relays, instruments, and exciter switchgear. The main oil switch is fitted in a separate room behind the wall, and the exciter field rheostat is placed below the floor. A single-pole field breaking switch with non-inductive resistance is provided. The spare panel, when complete, will carry a bus-bar recording voltmeter and a total output meter. No new synchronising gear has been provided beyond provision for plugging on to an extension of the existing Ferranti synchronising bar.

The room behind the switchboard, which now contains the new H.T. switchgear, was formerly a test-room before the new test-room upstairs was equipped. It also serves as a works sub-station, containing a pair of small transformers, stepping down to 100 and 200 volts respectively for station lighting and auxiliary motors respectively. These transformers are provided with connections from a series of tappings to regulating switches, by which the secondary voltage can be adjusted in six or seven steps of about 2 volts each. These transformers, switches, &c., are enclosed in a cage of wire netting, and replace smaller transformers formerly used.

The changes in the boiler-house consisted in the provision of a new double-drum Babcock and Wilcox hand-fired water-tube boiler of 16,000 lb. per hour evaporative capacity, fitted with integral superheater, and the moving of one of the existing "economic" boilers about 18 ft. to one side to find room for this. Here, as in the engine-room, no extensions to the buildings were necessary. The alterations to the steam piping were very simple, involving principally an extension of the existing main sectionalised header running behind the boilers parallel to the length of the engine-room. A new Wier steam feed-pump has also been put in. The new boiler arrangements entailed practically no alterations to the existing flues. Messrs. Babcock & Wilcox are the contractors responsible for the new steam and water pipework required.

The load at Eastbourne is, of course, principally lighting, although we understand that there is also a very appreciable load consisting of single-phase motors, to which current is supplied at prices ranging from 2½d. to 1d. per unit, according to the demand. Induction motors are principally used, and these are found to run quite satisfactorily on the 50-cycle circuit. Regarding the latest development in lighting, the Osram lamp, as in many places, is rapidly coming to the fore, and is being to some extent employed for public lighting. Six have been put up in one street, and seven arc lamp-posts have already been provided with 2-arm Osram lamp brackets, while a further 51 are to be similarly equipped. Extensions of business are, no doubt, facilitated by the well-equipped showroom maintained by the Corporation Electricity Department in the town, from which fittings, &c., may be chosen by any consumer, to whom they will be supplied through a wiring contractor.

We wish to express our indebtedness to Mr. J. K. Brydges, Borough Electrical Engineer, to whose specifications the new plant has been supplied and erected, for kindly allowing our representative to inspect the new plant, and putting the information upon which this article is based at our disposal.

ELECTRIC DRIVING IN IRON AND STEEL MILLS

IN a recent contribution to the *Electric Journal* (Pittsburg), Mr. W. Edgar Reed points out that heavy mill work requires a drive capable of standing intermittent and excessive loads, and it is of the greatest importance to have at the same time a very flexible coupling between prime mover and rolls in order to reduce the cost of repairs to a minimum. Electricity offers the most flexible connection known, and is the system best suited to the excessive variations in power required. The variations in power required for a two-high reversing mill may sometimes amount to as much as 3,500 h.p. in a few seconds.

Power for iron and steel mills may be purchased outside or generated at the mills, and is generally derived from water falls, steam, or gas engine-driven electric generators. The waste gases from blast furnaces, when close to the generating station, offer a comparatively cheap source of power. These waste gases are now utilised for this purpose, especially in countries where the cost of fuel is comparatively high. Even in Pennsylvania, where coal is very cheap, it has been found advantageous to use blast furnace gases for the generation of power.

When power for a mill is bought from an outside company, which also furnishes power from its system for other purposes requiring good voltage regulation, large fluctuating loads would be objectionable. The excessive intermittent loads common in mill work, especially if the driving motors in the mills are large compared with the capacity of the power station, may seriously affect the regulation. Under these circumstances the cost of power may be very high unless some method is used to equalise or smooth out the large variations in power. The maximum power required, although it may last for a short time only, determines the maximum size of the complete station and the cost of power. For this reason it is often sold on the basis of the maximum instead of the average or total power consumed. It is therefore very desirable to reduce the maximum

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demands of peak loads as much as possible in order to secure improved regulation and reduce the cost. The smoothing down of the peak demands will at the same time improve the efficiency of the system by allowing a fairly constant load approximating full-load to be placed on the central station apparatus.

Methods of Equalising.—In the case of continuous mills, when the maximum load lasts but a few seconds, the peak overload may be reduced to satisfactory values by increasing the kinetic energy which the rotating parts give up as the heavy overload comes on. This is accomplished by increasing the flywheel effect by adding weight to the rotating elements or placing a flywheel on the motor shaft, and at the same time designing the motor or control so that the speed drops rapidly as the heavy overloads come on. Increasing the flywheel effect reduces the maximum overload on the motor and line, and by suitable design this overload can be made any desired amount.

When the rolls are to be reversed, the kinetic energy or flywheel effect of the reversing parts should be reduced to a minimum, instead of being increased, as was the case for continuous mills, in order to reduce the energy required in reversing. Some mills are reversed at three second intervals for several passes. The time then increases for succeeding passes. Another method of equalising loads is required for this kind of mill service. One form of equaliser that is suitable for these requirements consists of a motor generator flywheel set connected between the roll-driving motor and the source of power. The general arrangement and connections for such a set are shown in the figure. This system has been found to be very efficient in equalising the large variable and intermittent loads found in large reversing mill work. The system can also be used to good advantage in many cases for driving small mills.

This equaliser set consists of an induction motor with an external resistance in the secondary circuit, driving a flywheel and a direct-current generator. A direct-current motor having

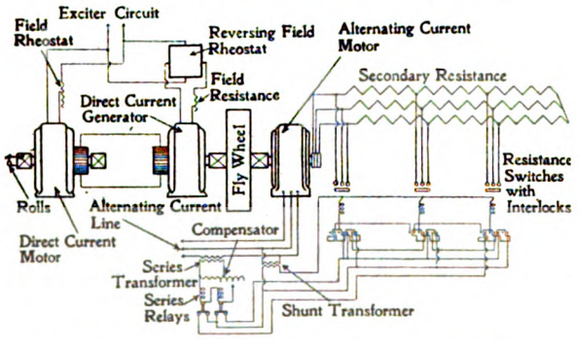


DIAGRAM OF CONNECTIONS, EQUALISER SYSTEM.

drooping speed characteristics could be used in place of the induction motor. The direct-current generator is electrically connected to the roll motor, whose speed and reversing are controlled by regulating or reversing the generator field current. In slowing down the field of the generator is weakened and the roll motor reverses the current through the generator, thus tending to operate the generator as a motor and act as a dynamic brake on the roll motor. Both motor and generator may have auxiliary poles to insure good commutation.

The alternating-current motor is of the wound rotor type, which permits the use of variable resistances in the rotor circuits and the use of a slip regulator for producing a variable speed motor. By the use of this equalising method a nearly constant supply of current may be taken from the line independent of the power being delivered by the roll motor. When the load comes on the direct-current generator, the flywheel gives up energy and supplies that portion of the power required in excess of the average.

In order that a flywheel may give up its kinetic energy when the excessive overloads come on, it is necessary that its speed decrease. The greater the decrease in speed (in a given time), the more energy will be given up, as the kinetic energy in a given wheel is proportional to the square of its speed. This is accomplished by making the speed of the motor automatically adjustable by inserting resistance in the rotor winding, and thus varying the slip. The slip of an induction motor increases with increase of load, but the normal slip is fairly low and the corresponding drop in speed small. The slip is also increased with the increase of rotor resistance.

The efficiency of the induction motor varies inversely as the slip, each per cent. increase in slip meaning approximately one per cent. decrease in efficiency. The slip required of these motors depends upon the value of the peak overload, its duration and interval between peaks, as well as upon the flywheel effect of the rotating parts. It can generally be adjusted for values up to approximately 20 per cent.; a motor having 16 per cent. slip at full load would have approximately 24 per cent. slip at 50 per cent. overload. This 20 per cent. decrease in speed would require the flywheel and all other rotating parts of the set to give up approximately 42 per cent. of their total kinetic energy

Two relays are placed in the circuit which supplies the induction motor. These relays are arranged to change the secondary resistance of the rotor so that the motor may drop in speed as the load increases without drawing a greater current from the line. Both relays are closed when starting or at light loads. As the speed increases the resistance switches are closed by the rotor current, first one, then two, three, four, &c., until the current in the induction motor reaches the desired maximum, when the first relay opens the auxiliary circuit so that no more switches can close. When a heavy load comes on the flywheel gives out energy and slows down, allowing more current to be taken from the line. This causes the second relay to operate and cause the resistance switches to insert more resistance in proper order again. This adjustment forces the flywheel instead of the motor to take the greater part of the intermittent load by giving up part of its kinetic energy, which was stored up before the overload came on. This equalises the irregularities and gives a fairly constant load on the induction motor and all other apparatus back of it; makes an exceedingly flexible connection between prime mover and load, and procures good voltage regulation of line. This is essential when light and some other kinds of apparatus are operated on the same circuit as the motors and the conditions of motors operating auxiliary apparatus is also much improved, as a drop in voltage means a reduction of the starting and pull-out torques of shunt and compound-wound direct-current motors or induction motors. The torque and output of an induction motor varies as the square of the applied voltage, hence a 10 per cent. reduction in voltage would therefore mean approximately 20 per cent. reduction in maximum starting and pull-out torque.

If power is bought outside, such a system would certainly be required, and it is also advantageous where power is generated by the mill company. Some idea of the importance of such a system can be seen from an installation which required 4,000 horse-power in driving motors and only 1,400 horse-power approximately in the motor of the equaliser set and all apparatus back of it, including the transmission line, switchboard, instruments, electric generator, engines, boilers, and fuel.

Continuous Mill.—Among the many installations that have been made recently is the following:—Two 1,500 horse-power, compound-wound, 220-volt, 100–125 r.p.m., direct-current motors at the Edgar Thomson Steel Works, for driving continuous rail mills. These motors are direct-connected to the rolls. Special attention has been given to the mechanical design. The bearings are of the oil ring and forced circulation babbit lined type, 25 in. in diameter and 62 in. long. They are also arranged for water cooling. The motor is also very liberally designed and commutation is exceedingly good. A 125,000 pound cast steel segmental flywheel, 18 ft. in diameter, is mounted on the motor shaft to assist in equalising the load on the motor and power house. The speed of the motor drops from approximately 125 to 90 r.p.m. in actual operation, which allows the flywheel to take care of the peak loads.

Reversing Mills.—Installation at the Hildegarde Works (Austrian Silesia).—This mill is for rolling two-ton ingots down to billets for making girders, rail, &c., and for the first passes should reverse every six to eight seconds. The mill is driven by a four bearing set of three direct-current motors. These motors are connected together by two rigid couplings and are divided into three units in order to keep the inertia of the rotating parts as low as possible as well as for manufacturing advantages. The normal rating of each motor is 1,200 horse-power at 330 volts, and speeds obtained are from 0 to 120 r.p.m. The maximum horse-power of each motor is 3,000, which makes 9,000 horse-power maximum for operating the ingot mill. The motors have series and shunt separately excited windings, and the armatures are connected in series.

The equaliser is a four bearing set consisting of an induction motor, two direct-current generators, and two flywheels, and runs at 375 to 310 r.p.m. The flywheels are made of cast steel, are 13 ft. in diameter, and each one weighs about 26 tons. Water-cooled brakes are mounted on the wheels for stopping the set quickly in case of necessity. The two direct-current generators and the three mill motors are connected permanently in series, the mill motors being controlled and reversed by the field current of the generators. This control is easily and quickly operated. When reversing the set acts as a brake for the mill motors, and energy is returned to the equaliser set. The speed of the induction motor is controlled automatically by inserting the resistance of a water rheostat in the rotor circuit.

The power taken from the generating station does not exceed

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25 per cent. of the maximum power required for operating the mill.

Installation at the Illinois Steel Works.—This 30-in. two-high plate mill is driven by two 2,000 horse-power, 575 volt normal rating direct-current shunt-wound motors mounted on a common shaft. The speed varies from 0 to 150 r.p.m. The mill should be capable of reversing every four to six seconds. Good commutation is secured at low voltages, and heavy currents by the use of commutating poles and compensating coils wound in slots in the pole faces. The power taken from the generating station is approximately 30 per cent. of the maximum power taken by the mill motor.

ELECTROCHEMISTRY AND ELECTRO-METALLURGY

THE Norsk Hydroelektrisk Kvaelstof Co. of Notodden is now working in conjunction with the Badischen Anilin- und Soda-Fabrik, of Ludwigshafen, in connection with the manufacture of calcium nitrate from the atmosphere, by the Berkeland-Eyde system. They are now completing a new power station at Svaelgios, capable of delivering 47,000 h.p. The energy is obtained from water power, the water flowing from the dam through a canal and tunnel a distance of about 650 metres (715 yards), the rate of flow being about 100 cubic metres (3,530 cubic feet) per second. Owing to the turbine house being built in an exceedingly narrow, rocky gorge, the water is led to the turbines by means of perpendicular tunnels cut through the rocks, instead of, as is usual, by means of pipes. The turbines, which are from 10 to 12,000 h.p., are directly coupled with the dynamos. These turbines, which are said to be the largest and most powerful in Europe, have been built by J. M. Voith, of Heidenheim. It is hoped very shortly to have the plant in operation. Other works, to give even greater power for the fixation of atmosphere, are already projected, and in time it is expected that a great part of the water power of Norway will be utilised for the manufacture of artificial nitrogenous fertilisers.

An abstract of a Paper upon "Electric Zinc Smelting," by F. T. Snyder, is given in *Electrochemical and Metallurgical Industry* of December. The comparative cost of the smelting in two plants each of 25,000 tons annual capacity is given. The first cost for plant in each case is about the same, viz., rather over £100,000. The salaries and general operating costs, depreciation, and so on, are practically the same. The cost of working a modern retort plant in which coal is burnt is about 16s. per ton of raw material. The labour on an electric plant can be kept below 12s., because of the greater compactness of the plant. When retorts are employed it is necessary to give a very thorough previous roasting to remove the sulphur, with the electric stack furnace practically as good results are given with ores containing 6 per cent. of sulphur as with those containing only 1 per cent. A retort plant will consume 4,200 lb. of coal per ton of raw ore, 600 lb. being used in roasting. But with the electric stack furnace 1,200 electrical horse-power hours are required per ton, which represents a consumption of 1,800 lb. of coal; also the coal required for roasting is only about one-half. Consequently about one ton of coal per ton of ore is saved.

With the retort plant 800 lb. of reducing material will be used per ton of ore; with the electric stack furnace about 200 lb. The renewal of retorts is calculated by the author to be about 1s. 8d. per ton of ore; this is, of course, saved in the stack plant, but the consumption of electrodes will cost about 10d. per ton. A summing up of these differences shows a saving of about 10s. per ton of ore operated upon by the electrical method. But a further saving of over 15s. per ton is obtained by the increased recovery of zinc with the stack plant.

With the electric stack plant, a certain quantity of iron in the zinc ore is an advantage. Up to a point where the iron percentage is equal to one-half of the silica percentage, iron is not only required but must be added if not present in the ore. Lead in the ore is reduced, and can be separately collected, consequently it is not necessary to so thoroughly concentrate the ore as when the retorts are employed. With zinc concentrates containing 3 per cent. of lead, 50 lb. per ton of raw ore, or 2½ per cent. will be saved in the electric retort furnace, but lost in retort smelting. The author finally concludes that these and other savings will save practically £2 per ton upon the zinc produced if the electric furnace be employed.

L'Industrie Electrique of October 25th describes the method of Theirot and Nougier for obtaining tin from tin-scrap and tin residues. In the first place, the tin is heated with sodium hydroxide and converted into sodium stannate. Copper and lead and other impurities are then removed, and the pure sodium stannate solution is electrolysed with iron anodes and cathodes of tin. With a current density of 300 to 400 amperes per square meter, and at a temperature of 80 to 90° C., a solid and reguline deposit of tin is obtained. The electrical pressure at the electrodes is 2·4 volts. In order to obtain satisfactory results it is found advantageous to thoroughly circulate the electrolyte and to keep the solution at a definite concentration.

According to *Electrochemical and Metallurgical Industry* of December, the Norton Co., of Worcester, Mass., are manufacturing a new abrasive called alundum. This substance consists of purified bauxite, which is first heated in calciners, to drive off water, and is then melted in an electric furnace at a temperature of 2,700° to 3,300° C. The electric furnace plant employed is situated at Niagara Falls. The alundum is worked into grinding wheels, and various sharpening stones. It is claimed that alundum is an abrasive of great sharpness and of great hardness, and is absolutely uniform.

E. D. Chaplin, in his American Patent 871,161 (1907), describes a process for the electrolytic production of white lead. A cell with three compartments is used, a solution of sodium nitrate and sodium chlorate being supplied to the middle compartment. The solution in this compartment is kept a little above the level of the solution in the other two compartments, in order to prevent mixing of the anode and cathode solutions. The anode is of lead and the cathode of copper. At the anode lead nitrate is in the first place produced, and then this is supposed to be converted into lead oxychloride, which is soluble in the electrolyte, which is kept at an elevated temperature by means of steam coils. The sodium hydroxide produced at the cathode is converted into carbonate in a separate tank by passing carbon dioxide into it. The two solutions are then mixed and the precipitate white lead filtered off, the same electrolyte being used over again.

Mr. Chaplin also has a second Patent 871,162 (1907), dealing with the preparation of chrome yellow. In this case the first part of the proceeding, that is, the electrolysis, is the same as in the preceding case. But the sodium hydroxide is mixed with chrome alum in sufficient quantities to re-dissolve the chromic hydroxide, which is first precipitated. This solution is then mixed with sodium chloride, and electrolysed in an anode compartment. By this means the chromic solution is oxidised to chromate. On now mixing the lead oxychloride solution with the chromate, a precipitate of chrome yellow is obtained.

ELECTRIC TRACTION IN THE CASCADE TUNNEL

Three-phase Locomotives

THE announcement was made in ELECTRICAL ENGINEERING, Vol. I., page 945, that three-phase locomotives were to be adopted by the Great Northern Railway Co. of America for service in the Cascade Tunnel. Some further particulars of the locomotives in question, which are now under construction by the General Electric Co., are given in the *Street Railway Journal* (New York).

The tunnel is approximately 2¾ miles in length, with no ventilating shaft, and a uniform grade east of 1·6 per cent. in the tunnel section, making the difficulties of ventilation with steam locomotive operation very serious. Apart from danger of poisonous gases of combustion, the interior of the tunnel has become so fouled with soot as to reduce the tractive effort of the steam locomotives now used, by reason of the slippery condition of the rails.

The locomotives will weigh 100 tons each, with all the weight on the drivers. Each locomotive will be equipped with four three-phase induction motors of 325 h.p. capacity, mounted on two articulated bogie trucks, and each machine will have a capacity of hauling a 500-ton train load up a 2 per cent. grade at 15 miles per hour, and, as the motors are reversible, the speed of the train can be controlled down grade by regeneration. It is hoped by this means to introduce an additional feature of safety, and eliminate the possibility of breakdown due to overheated wheel tyres and brake shoes.

The locomotives will receive their supply from two 6,600-volt conductors fed from a step-down transformer station located at the entrance of the tunnel. The generating station will be located on the Wenatchee River, 30 miles from the tunnel, and power will be transmitted over duplicate transmission lines at thirty-three thousand volts. The generating station will contain two 2,000-kw. three-phase water-wheel-driven generators operating at 25 cycles, and arrangements are being made to take care of excess power of regeneration due to an unbalanced load up and down grade. The entire installation is expected to be ready in about one year, and work is already well under way on the water-power development, as well as the electrical apparatus.

Institution of Electrical Engineers: Manchester Section.—The meeting which was announced for Tuesday last, and at which Mr. G. W. Worrall's Paper on "Magnetic Oscillations in Alternators," was to have been read, was postponed, and will take place next Tuesday, January 14th, at 7.30 p.m., in the University (Physical Laboratory), Manchester.

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ELECTRICAL SCIENCE

British and American

An Unknown Gas from Aluminium Electrodes.—When cathode rays are generated by an influence machine in a vacuum tube containing a pure gas, the relation between the pressure, p, of the gas and the discharge potential, V, can be represented by p^2V = constant. This relation is independent of the current, but does not hold at all in gaseous mixtures. During the passage of the discharge a gas is continuously evolved from the electrodes, if these are of aluminium, which gradually renders the original gas impure, so that the above relation ceases to hold. If the tube is kept on the pump so as to maintain the pressure within the range required for the production of cathode rays, then after the discharge has passed several hours, the value of p^2V again becomes a constant. But the value of this constant is the same whatever gas originally filled the tube, and is about one-quarter of the constant given by a new tube filled with hydrogen. In the December *Philosophical Magazine*, R. v. Hirsch and F. Soddy examine into the nature of the gas evolved from the electrodes. The known dependence of the constant value of p^2V on the molecular weight had already suggested that the gas has a molecular weight 4, so the observers carefully sought for helium spectroscopically and electrically. The only positive indication, reached after many experiments, was found in the fact that English bulbs showed a marked absorption under conditions in which German bulbs were generating the unknown gas. This difference was traced to the electrodes, and English electrodes in a German bulb gave off no gas. The authors suggest that the presence of sodium in the German aluminium may play an indirect part in the phenomenon. The presence of a trace of sodium in aluminium renders it, as is well known, capable of decomposing water, so that an electrode of such metal, by mere exposure to the air, may become charged with hydrogen probably chemically combined as hydride. The authors venture the opinion that the unknown gas may be a modification of hydrogen just as ozone is a modification of oxygen, and capable of withstanding the discharge of an influence machine. The discharge of an inductorium may decompose it, and thus can be explained the fact that the hydrogen spectrum always appears in the final stages.

Clark and Weston Standard Cells.—In the December issue of the *Bulletin* of the Washington Bureau of Standards, F. A. Wolff and C. E. Waters set out in full detail the results of a prolonged study of the Clark and the Weston cells. Their investigations relate principally to the effect on the E.M.F. of a cell, of the mode of preparation and purification of the materials. For example, the mercurous sulphate used in making the cells was prepared, severally, by electrolysis in two different types of apparatus, by the action of fuming sulphuric acid on mercury, by the reaction between sulphuric acid and mercurous nitrate, by the action on mercury of dilute solution of nitric acid in sudphuric acid, by the reduction of mercuric sulphate by mercury, by the reduction of mercuric sulphate by sulphurous acid, by the recrystallisation of commercial mercurous sulphate from sulphuric acid, and by various modes of digesting commercial mercurous sulphate in sulphuric acid. The most satisfactory cells were obtained when grey samples of mercurous sulphate prepared by the electrolytic process were used. Among the cells made with the chemically-prepared samples of sulphate, those containing the samples obtained by reducing mercuric sulphate with sulphurous acid were the worst. But practically any method of preparation can be made to yield good results in respect of final E.M.F. The remaining materials used in the construction of standard cells can, it is shown, easily be obtained exceedingly pure; and, besides, the usual impurities, even if present in relatively large quantity, exert practically no influence on the E.M.F., not more than two or three parts in 100,000. Moreover, the authors find that the size of grain of the constituents has no appreciable effect, and the tables they give prove that, once set up, the cells keep a very constant E.M.F. for at least a year. Since the labour of preparing the materials is much greater than the work of setting up the cells, the authors propose that materials of standard purity should be furnished by the various national physical laboratories, so that standard cells could be set up quickly by the private investigator, and used with confidence as a fundamental electrical standard. In the opinion of the authors, the standard cell is to be preferred to the silver voltameter (which they designate "coulometer"), not only because of the now undoubted reproducibility of the standard cell, but also because nearly all voltage and current measurements of precision are made by the potentiometer directly in terms of the E.M.F. of the standard cell, or in terms of that E.M.F. and a standard resistance.

Continental

Efficiency of the Telephone.—F. H. Abraham and Devaux Charbonnel give, in the *Comptes rendus* for December 23rd, some instructions concerning the most efficient arrangement of telephone lines. For a given sound, the microphone behaves as an alternator without inductance, having an internal resistance of about 10 ohms. If the line is very long, it may be regarded as an ohmic resistance R, of the order of 500 ohms, in series with a capacity C of a fraction of a microfarnd. At the receiver, the line acts as an alternator, having these same characteristic constants, R and C, and an E.M.F. amounting to a definite fraction of the E.M.F. supplied. These assumptions may be made the basis of a complete theory of the transmission of a musical note along a very long telephone line. The authors specify the conditions which make for the loudest rendering. For every type of receiver the diameter of the wire must be such that the resistance of each of the two receivers shall be a little higher than one-quarter of the apparent ohmic line resistance R. In practice, this means choosing receivers with a resistance of about 100 ohms. If M is the internal resistance of the microphone, the most favourable transforming ratio is a little higher than $\sqrt{R/2M}$.

In practice, this means a transforming ratio of 6 or 7. The impedance of the thin wire of the transformer must be decidedly greater than the apparent line resistance R. The above conditions are usually observed in good commercial circuits. As regards the efficiency of commercial telephone transformers, the authors find that to be less than 60 per cent. these are, in fact, too small. An efficiency of 90 per cent. should be easily attainable without making the transformers too costly or too cumbrous. The authors give the following dimensions as a model :—Length, 17 cm.; external diameter, 3 cm.; total section of iron wires, 0·3 sq. cm.; turns of thick wire, 550; turns of thin wire, 3,300; diameter of thick wire, 1·1 mm.; diameter of thin wire, 0·4 mm.; resistance of thick wire, 0·9 ohm; resistance of thin wire, 24 ohms.; and inductance of the same, 0·4 henry. Too much must not, however, be expected from this improvement, as the ear is not very sensitive to loudness, an increase of 50 per cent. being barely distinguishable. The improvement of the microphone offers a much more promising field, and the authors believe that all existing types are capable of great improvement.

X-ray Test for Death.—Charles Vaillant presented a note to the French Academy on November 18th last, announcing that the radiography of the stomach and the large intestine furnished a conclusive test for death. He alleged that these organs, being arrested in their otherwise incessant motion, and being also filled with gaseous sulphides, which become phosphorescent under the action of X-rays, become clearly visible in all their detail on the radiograph. Some additional material on this important subject is furnished in the *Comptes rendus* for December 23rd by M. Béclère, who, however, points out that such radiographs cannot be relied upon in every case. When the breathing action is suspended, for instance, it is quite possible to obtain sharp detail on radiographs of the lungs. The stomach may also be clearly delineated when it is filled with any kind of gas, as with carbonic acid evolved on swallowing bicarbonate of soda and tartaric acid. On the other hand, the perishable motions of the intestines often continue for some time after death. The distinction is not one between rest and motion. It is merely a distinction of degree. The alleged tests of death may be simulated by a comparative immobility of the intestines accompanying the cessation of breath, or even by its paralytic immobility.

The Electricity Supply Bill.—The Incorporated Municipal Electrical Association has sent a circular letter to various municipal bodies enclosing a copy of the following resolution, which has been adopted by the Association :—"That the Association urges the Board of Trade to reintroduce the Electricity Supply Bill during the coming Session, and exercise every means to have the same passed into law." The municipal bodies are requested to bring the matter under the notice of their local Parliamentary representatives with a view to obtaining their co-operation to bring about the desired result.

Electric Power Supply in Essex.—The Town Clerk of Colchester has sent a circular letter to the municipalities affected, calling attention to certain provisions in reference to the supply of electrical energy, sought to be obtained by the Great Eastern Railway Co. under the General Powers Bill they are promoting for the ensuing session of Parliament. The Electricity Supply Committee of Colchester are of opinion that the interests of authorities possessing powers of electrical supply may be seriously affected by the proposed measure, and the various Town Councils are urged to oppose the Bill. We give the clause objected to below :—"19.—(1) It shall be lawful for the company from their works at Parkeston or elsewhere to supply either in bulk or otherwise electrical energy not required for their own purposes to any tenants of the company or occupiers of premises connected by siding with any railways of or leased to or worked by the company and to any local or sanitary authority or to any company authorised to supply electrical energy and any such authority or company may take such electrical energy from the company notwithstanding anything in any Act or Order authorising such authority or company to supply electrical energy. (2) The company on the one hand and any such tenants occupiers authority or company on the other hand may enter into and carry into effect agreements with reference to any such supply of electrical energy by the company and the rents or sums of money to be paid or other consideration to be given in respect of such supply. (3) The company may recover any rents of sums of money from time to time payable in respect of any such supply of electrical energy summarily."

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THE AMERICAN WESTINGHOUSE COMPANIES

ACCORDING to the *Electrical World* (New York), Messrs. Haskins & Sells, certified public accountants, in compliance with the request of the receivers, have made an audit of the books and accounts of the Westinghouse Electric & Manufacturing Co., which was made public after the meeting of the creditors. The consolidated and condensed statement of income of the Westinghouse Electric & Manufacturing Co., and subsidiary manufacturing companies in the United States, shows a balance available for the payment of interest and dividends for the seven financial years ended March 31st, 1907, and for the seven months ended October 31st, 1907, as follows :—

	7 mos. ended Oct. 31, 1907.	Total for 7 years and 7 mos. ended Oct. 31, 1907.	Average per annum for 7 years and 7 mos. ended Oct. 31, 1907.
Sales	$22,265,322	$181,723,643	$23,963,557
Cost of sales	19,334,540	154,411,675	20,361,979
Net earnings ...	$2,930,782	$27,311,968	$3,601,578
Other income	869,833	5,328,929	702,716
Total income	$3,800,615	$32,640,987	$4,304,294
Inventory adjustments, &c.	717,393	3,951,961	521,137
Net income applicable to int. and div'ds	$3,083,222	$28,688,936	$3,783,157

The credits made to the company's surplus account during the seven years and seven months ended October 31st, 1907, which are not included in the statement of earning and expenses, because they cannot be considered as income applicable to the payment of interest and dividends, being of an extraordinary and unusual nature, and not dependent upon the regular operations of the business, are as follows :—

Premium on capital stock sold during the period ...	$5,884,150
Profit on stocks and bonds sold during the period ...	1,465,890
Profit on real estate sold	84,200
Profit on exchange of assenting capital stock for non-assenting capital stock under terms of reorganisation of 1892	2,357
Unclaimed dividends	126
Profit through adjustment of Sawyer-Man Electric Co. accounts previously charged off (prior to the year 1901)	143,987
Miscellaneous	67,516
Total	$7,648,247

The charges made by the company against its surplus account for items of an extraordinary nature, which were not applicable to the income, prior to determining the amount available for interest and dividends, and which are not included in the income statement, have been as follows :—

Interest	$6,682,414
Dividends on stock	14,384,632
Depreciation of sundry stocks and bonds, consisting principally of stock of Consolidated Electric Light Co., U.S. Electric Lighting Co., Multiphase Motor Co., Electro Magnetic Traction Co., and Manhattan General Construction Co.	1,290,177
Amount charged off in connection with closing up the Walker Co. matters	981,056
Special charges for depreciation in addition to those included in the operating expenses	897,876
Premiums and commissions on debenture certificates purchased	45.535
Amount paid Westinghouse Glass Co. for purchase of lease of property required by Allegheny Foundry ...	12.234
Fire loss, Chicago stock	18.219
State tax on increase of capital stock	25,111
N.Y. Stock Exchange fee for increase capital stock ...	650
Services of Trust Co. in connection with capital stock Consolidated Electric Lighting Co.	500
Cost of moving lamp factory from Pittsburg to New York	100.161
Devising and installing accounting system	52.000
Commissions on issues of capital obligations	780,000
Legal services and expenses in connection with the issue of capital obligations	14.418
Discount on ten-year collateral note	202.703
Discount on convertible bonds charged off	158,333
Amount paid Geo. Westinghouse for payments made in the interest of the company to various officers, engineers, and other employees of Electric Company, in addition to their regular salaries paid by the company during last 10 or 12 years	400.000
Miscellaneous	45.058
Total	$26,091,079

The increase in the surplus account of the Westinghouse Electric & Manufacturing Co. and subsidiary manufacturing companies in the United States during the seven years and seven months ended October 31st, 1907, has amounted to $10,246,104, as follows :—

Net income available for interest and dividends ...	$28,688,936
Other profit and loss credits	7,648,247
Total credits	$36,337,183
Charges made against surplus account	26.091,079
Balance, being the increase in the surplus account ...	$10,246,104

The creditors and stockholders of the Westinghouse Electric & Manufacturing Co., who have been working out the details of the plan for raising new capital and restoring the company to its stockholders, after a long conference last week announced the organisation of a committee of creditors, of which James N. Jarvie, representing the National Bank of Commerce and other financial institutions, was made chairman. The committee comprises Richard Delafield, President of the National Park Bank; James N. Jarvie, representing the National Bank of Commerce and other financial institutions; Albert H. Wiggin, Vice-President Chase National Bank; F. H. Skelding, President of the First National Bank of Pittsburg; Charles A. Moore, of Manning, Maxwell & Moore; Neal Rantoul, of F. S. Moseley & Co., of Boston. A seventh member residing in Chicago is to be added.

CORRESPONDENCE

To the Editor of ELECTRICAL ENGINEERING.

SIR,—My attention has been called to some observations in the December issue of the *Engineering Review* on "Live Steam Feed Heating," by Mr. Wm. Paterson, in which he states that there "has been quite a resurrection of appliances for live steam heating," but he "is doubtful as to the economy resulting from such apparatus in every day working." Mr. Paterson then goes on to state that these appliances are not new, and states that a reference to the Patent Office records will prove this. Finally, he winds up by extolling the virtues of exhaust feed water heating and purifying plant.

That the latter class of plant is, under certain conditions, both useful and economical I can testify after long experience. When, however, he advocates this system at the expense of damning live steam heating, which, when properly applied, is capable of furnishing as great or greater economies than the former plant, I, as an interested party, am compelled to join issue with him. Further, live steam heating of the feed can and does furnish an economy which is superimposed upon economies capable of attainment either by Mr. Paterson's apparatus or by improved combustion, or by both.

None of the obsolete forms of live steam heaters, and very few of the modern types of live steam heaters furnish to the boilers water which is hot enough to give good economy. This economy goes up with great rapidity with the last few degrees increment of heat, bringing the feed water quite up to the temperature of the steam, hence the importance of employing an internal heater, which will give full steam temperature to the feed water, and at the same time furnish drier steam from the boiler.

There is no subject in connection with boiler-house plant upon which there are wider or more emphatic differences of opinion between engineers than as to the economy or otherwise of using live steam-heated feed water for boiler feeding purposes, the reason being that the subject is very imperfectly understood, and there are numbers of manufacturers selling live steam heaters who are evidently not conversant with the conditions necessary to produce economical results. In numbers of cases live steam heaters are at work ostensibly for the purpose of economising coal, but as a matter of fact they are entailing a heavier consumption of fuel than would be required were the boilers minus the live steam heaters.

Live steam heating under certain circumstances substantially economises coal and greatly increases the output of steam for the boilers, but there are distinct limitations to the economy which can be obtained, and it is important that all steam users contemplating the adoption of such apparatus should seek competent advice on the matter, otherwise after having spent their money they may find that their consumption of coal, instead of decreasing, has increased. In view of the present high prices and prospective increasing cost of fuel, it is a matter of considerable importance that manufacturers and steam users who are wise enough to avail themselves of every economy, should be carefully advised in this matter, or they may increase their coal bill and entirely miss the substantial economies and lessened fuel cost which live steam heaters are capable of producing.

Believe me,
Yours faithfully,
G. WILKINSON.

HARROGATE, *Jan. 4th*, 1908.

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"ELECTRICAL ENGINEERING" PATENT RECORD

(This Patent Record is compiled by our own Editorial Staff and is Strictly Copyright.)

Specifications Published Dec. 27th

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

1906 Patents

28,793, BABB, CHAPMAN & COCKSHOTT. An improved method of braking on electric railways, tramways, or other machinery driven by electric motors to get rid of the uncertainty of action due to dirty commutators and faulty contacts and connections with the ordinary rheostatic methods. An additional circuit, either electrically distinct from, or in connection with, the ordinary braking circuit, or with a re-arranged braking circuit is provided, which derives its current from the same source as the driving motor or some auxiliary force. The additional circuits are arranged so that the current from this source shall pass through the fields of the motors, or through the whole motors acting as generators, in the same direction as the current would flow in ordinary braking motors, and by providing auxiliary windings on the fields of the motors. The current may be allowed to continue flowing in the circuit throughout the whole range of the braking operations, or can be discontinued at any point by temporarily connecting up the motor fields, and passing through them a current of suitable value. The necessary connections are made on the existing controllers, so arranged that the necessary contacts are made by means of switches, quite apart from the ordinary controller, but operated by movements of it. Three claims, three figures.

1907 Patents

316, A. L. RHODES & RHODES ELECTRICAL MANUFACTURING CO., LTD. Instead of using solid, wedge-shaped rings for holding commutator segments in their positions, the present patent, a ring of bent sheet steel, is used, so that the weight of these parts is considerably reduced. The ring may or may not be in two or more pieces, and is fitted with back plates, which lie against the two free edges of the ring, and receive pressure from annular nuts, which are screwed upon the main casting of the commutator. Two claims, one figure.

2,227, SIEMENS BROS. DYNAMO WORKS, LTD. A time-limit device for circuit-breakers, in which a train of wheels governed by a fly regulator is connected with the plunger of the circuit-breaker, so that if it commences to move under the action of an ordinary overload, it will throw the train of wheels into motion, and will not be released, and allowed to complete its motion, and work the main switch until the wheels have completed a certain number of revolutions, and the interval in which they do this will be shorter as the overload is greater. The connection of the train of wheels is made through a suitable friction coupling device, capable of being regulated to slip more or less easily, and is set so that if the overload should be excessive, the pull of the plunger will be so sudden that it will slip at once, and allow the circuit-breaker to act instantaneously. Four claims, five figures.

16,514, P. MACGAHAN. This invention provides a device for automatically connecting an alternating current dynamo to an alternating current supply circuit when the electro-motive forces of the two circuits agree in phase and frequency. The connection of the machine circuit is effected by means of two electro-magnets, each provided with two windings, adapted to be connected respectively to the alternating circuit, and the machine, the windings of one electro-magnet being arranged to act in conjunction with one another, and those of the other electro-magnet to act in opposition to one another when the currents in the windings agree in phase. The circuits of the actuating windings are so arranged and simplified that auxiliary transformers are dispensed with, and no direct connection exists between the machine and the circuit to which it is to be connected. Two claims, three figures.

Specifications Published To-day

The following Patent Specifications will be published to-morrow, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Names in brackets indicate communicators of inventions from abroad.

Summaries of the more important of these patents will appear in our next issue.

1906 Patents

22,500, COLLYER. Earthing and protecting electric conductors.
25,009, BRITISH THOMSON-HOUSTON CO. & DALTON. Arc Lamps.
26,066, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Trucks for electrically-propelled vehicles.
27,520, KANDO. Control of multiphase motors.
28,559, LOCKETT. Tramcar brakes.
28,503, BONINE. Method of controlling dynamo-electric machines and apparatus therefor.
28,579, CHLORIDE ELECTRICAL STORAGE CO. & HEAP. Lid bolt for storage battery boxes and the like.
28,634, COLLIE. Apparatus for indicating the magnitude of torque or turning effort in shafting.
28,830, HAYWOOD, & MCKENZIE & HOLLAND, LTD. Electric treadles or rail deflection contact makers for railway signalling and the like.
29,019, GRÖNDAL KJELLIN CO. & HÄRDÉN. Induction furnaces.
29,072, BROWN. Electrically-operated railway and like signals.
29,120, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric heaters for fluids.
29,300, COWPER-COLES. Electro-deposition of iron.

1907 Patents

97, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Protective devices for electric transmission systems.
829, MORISON. Apparatus for separating oil from feed-water.
1,197A, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Treatment of refractory materials by electricity.
1,348, ELECTRIC IGNITION CO. & HALL. Insulation of dynamo armatures.
1,587, LAKE (*Kellogg Switchboard Supply Co.*). Party line telephone systems and apparatus therefor.
3,078, NOBBS & NOBBS. Electric steam radiator for heating buildings or the like.
3,214, HOOKHAM & SPRAGUE. Counting trains for electricity meters and the like.
3,278, BARNETT. Electric distributors for use in internal-combustion engines.
4,338, AUSTIN. Receivers for wireless and other telegraphy.
4,801, POULSEN. Receivers for wireless signalling.
5,155, ALBION MOTOR CAR CO. & MURRAY. Magneto-electric generators.
5,574, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Insulating material and processes for making the same.
5,904, FOSTER. Electric measuring and recording instruments of the thermal type.
7,800, GOODMAN & ACKLAND. Conduits for electrical cables and wires.
9,463, NORTH & POHL. Electrolytic electricity meters.
10,369, ATELIERS THOMSON-HOUSTON. Commutation of dynamo-electric machines.
12,860, RIVERS-MOORE & DONALD. Contact or commutator for dynamo-electric machines.
13,021, WOODHOUSE. Brush-holders and carriers for electric generators and motors.
13,259, HICKLEY. Brush holders for dynamos and motors.
15,017, KUZEL. Metallic filament lamps.
15,769, BEECHER. Electrical railway systems.
16,098, COWPER-COLES. Apparatus for electro-plating.
17,492, FINLAY. Anode for electrolysis.
18,020, LUNDBERG, LUNDBERG, & LUNDBERG. Electrical switches.
18,082, SZEK. Carbon-electrodes.
18,398, BIEWEND. Manufacture of steel and electro-metallurgical induction furnaces for use therein.
22,612, KJELLBERG. Electric switches.

The following complete Specifications are open to Public Inspection at the Patent Office, but are not yet published for sale.

1907 Patents

11,594A, ALLGEMEINE ELEKTRICITÄTS-GES. Electric motors specially adapted for rolling mills.
19,340, SIEMENS & HALSKE AKT.-GES. Signalling telegraphs.
27,744, ALLGEMEINE ELEKTRICITÄTS-GES. Signalling systems and control systems for mines and the like.

Amended Patent

8,680. 1904. THE BRITISH THOMSON-HOUSTON CO. have obtained leave to amend this specification, by the addition of the following paragraph: "It has hitherto been proposed to electrically work reciprocating machines by apparatus consisting of a reversing switch, and starting switch, operated from reciprocating mechanism, and circuits controlled by the switches by which the motor is worked at suitable speeds on the cutting stroke of the tool, in such machines, as planes, &c., and retarded and reversed, worked at a maximum speed on the return stroke of the tool, retarded and again reversed, the reversal and restarting in each case being made in a strong magnetic field, and the speed acceleration on the return stroke effected by weakening the shunt field of the motor by the introduction of resistances in the field circuit."

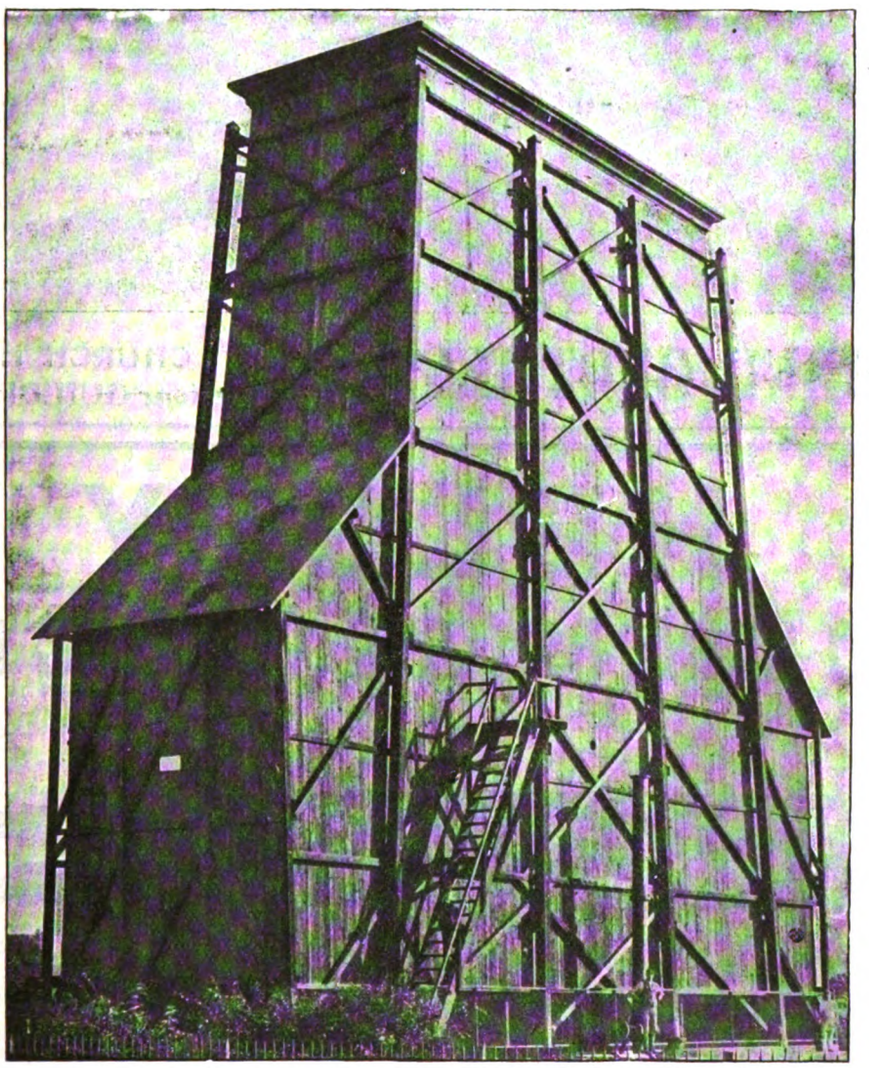
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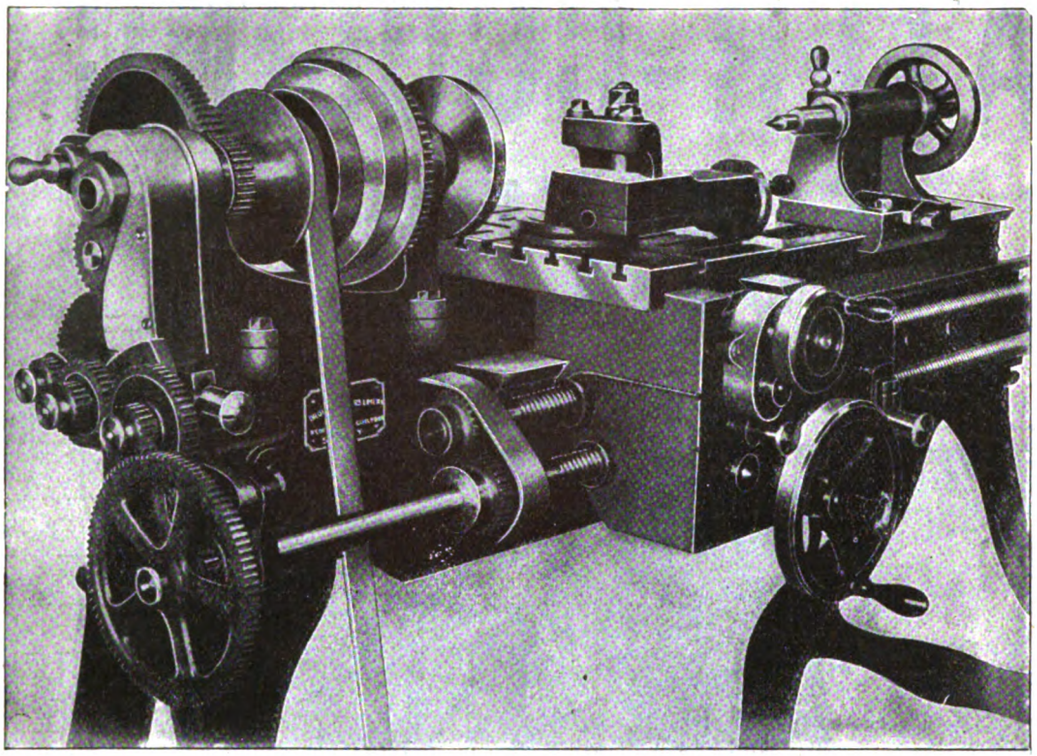
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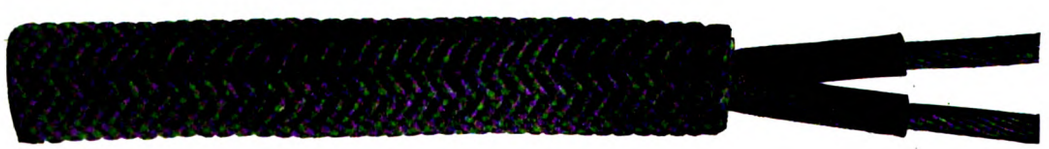
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LOCAL NOTES

ARBROATH: *Electric Lighting Station.*—The plans presented by Mr. G. Balfour, electrical engineer, of London, for the erection of the electric lighting station, were formally passed by the Dean of Guild Court on the 6th inst. The scheme is for electric lighting and power for the town. The station will be built at South Grimsby.

BELFAST: *Cavehill and Whitewell Tramways.*—At the monthly meeting of the Council on Wednesday, January 1st, when the resolutions passed at the meeting of December 2nd were confirmed "That a Bill to confirm the agreement, dated May 1st, 1907, and made between the Cavehill and Whitewell Tramway Company of the one part, and the Lord Mayor, aldermen, and citizens of the city of Belfast of the other part, for the purchase of the tramway of the company and their lands of Drumnadrough, County Antrim, also to wind up the said company, be promoted in the ensuing Session of Parliament, and that the expenses attending the promotion of such Bill shall be defrayed out of the General Purposes Fund or rate." The resolution was put to the meeting and carried.

The Electricity Accounts Audit.—At the weekly meeting of the Tramways and Electrical Committee on the 6th inst.—Sir Robert Anderson presiding—the City Surveyor, Mr. Cutler, submitted a voluminous report dealing with the alleged inaccuracies brought forward by the Citizens' Association in connection with the conversion of the tramway system, and the alleged overpayment of sums of £661 11s., £5,670, £277 7s. 4d., £2,218 10s., £1,417 13s. 3d., £7,390, £5,518, £2,931, and £12,000, in connection with various parts of the work. The committee decided to postpone the consideration of the matter for a fortnight. It may be recalled that the Corporation expressed itself confident in Mr. Cutler's figures when the matter was brought before it.

BIRMINGHAM: *Tramway Receipts.*—The traffic returns of the public tramways for the week ending December 28th, as compared with those for the preceding week, are as follows:—December 28th, receipts, £6,172; passengers, 1,547,991; December 21st. receipts, £6,099; passengers, 1,587,905; or an increase of £73 and a decrease of 39,944 passengers. The figures for the whole year of working are not yet entire, as the tramways only passed into the control of the Corporation a year ago from the British Electric Traction Co. In 51 weeks and five days covered by the returns to hand, 71,645,112 passengers have been carried, and the receipts amount to nearly £284,000, giving a weekly average of 1,400,000, and receipts of over £5,000. Taking the working costs at 6½d. per car mile, and the earning at 9d. per car mile, which figure has been exceeded on several weeks of the year, the profits earned should be well over £50,000 for the twelve months.

BLACKBURN: *Light Railway Order.*—The Blackburn Town Council, on January 3rd, instructed their Town Clerk to take necessary proceedings to oppose the application of the promoters of the Blackburn, Whalley, and Padiham Light Railways for a revival and extension of time of their order.

BURY: *Electricity Station Extensions.*—The Bury Town Council, at a meeting held on January 2nd, decided that the Electricity Committee should be empowered to proceed with the preliminary arrangements for carrying out the necessary extensions at Chamber Hall, including provisional acquisition of land and railway siding accommodation, and for application to the Local Government Board for sanction to borrow the necessary money to carry out the extensions. The proposal is to build a new generating station on the high-tension alternating system. This has been necessitated by the large demands made locally for power to drive the textile factories. As the plant at the existing station is now worked at its full capacity, it has been decided that instead of extending the present station, which does not provide sufficient facilities for coaling, and for condensing water, a new site with a railway siding and adequate provision for condensing water has been obtained at Chamber Hall from the Earl of Derby.

COBHAM: *Proposed Electricity Supply.*—Owing to the gas in Cobham being 5s. per 1,000 ft., the Parish Council has never adopted the Public Lighting Act, and the streets have never been lighted by artificial means. The Woking Electric Supply Co. is seeking a Provisional Order to install electric light in the village, and is prepared to tender for the lighting of the streets, and to supply light for other purposes at 6d. per unit.

DUBLIN: *Electricity Accounts.*—The Lighting Committee of the Dublin Corporation have issued a report of the progress of their undertaking for the year ended March 31st, 1907. The gross amount received was £44,225, of which £10,736 was credited to the electricity accounts for the cost of public lighting, and the balance of £33,849 was from private consumers, rentals of meters, and work done for the Corporation, &c. The total expenditure chargeable against the gross income was £22,029, leaving a gross profit of £22,196. £216 is to be deducted from this, being amounts written off accounts and interest paid on consumers' deposits. The balance was devoted to the repayment of principal of loans and the payment of interest. Progress has been so rapid that the estimated output of 1,520,000 units, given when the station was extended, and which it was thought would take years to reach, has already been exceeded by 700,000 units.

HALIFAX: *Insurance Scheme.*—The Halifax Tramways Committee on January 3rd unanimously adopted a suggested scheme for the formation by municipalities and tramway companies of a fund for mutual insurance against tramway accidents. It was resolved to ask the Town Council to take the initial steps for convening a conference of representatives of corporations and tramway companies at which the matter might be considered. The proposed scheme is to cover the total liabilities incurred from any accident during a whole year. At present the Halifax Corporation have their liability covered only to the extent of £1,000 on a single accident, and up to a total of £4,500 for one year.

HULL: *Explosions in Electric Cable Manholes.*—Considerable damage has been done to several of the manhole covers due to an accumulation of gas in the cable ducts, which became ignited. A considerable portion of the pavement was blown up in one case. Eight manhole covers in all were blown off in the district. The windows of the surrounding property suffered severely, and Trinity House and the Inland Revenue offices had scarcely an unbroken pane of glass left in the front of the buildings.

LONDON: *Battersea: Electricity Undertaking Progress.*—The number of consumers on the books of the electricity undertaking on December 17th was 1,065, against 1,015 at the end of the previous quarter. Energy was supplied for private lighting on December 17th equivalent to 73,170 8-c.p. lamps, an increase during the quarter of 4,578 lamps, and motive power was being supplied equivalent in h.p. to 1,706, an increase during the three months of 316. The public lamps only increased during the quarter by eight 8-c.p.'s to 6,272. The Finance Committee has approved of a contribution out of the Borough funds of one-third of the cost of the improvements in connection with the electrification of the tramways on Lavender Hill and St. John's Hill.

Hackney: Electricity Sales Department.—The Electric Lighting Committee of the Hackney Borough Council has decided to found an advisory and sales department in connection with their undertaking, and to appoint a sales engineer at a salary of £120 a year, increasing by £10 a year to a maximum of £150; the permanency of the appointment will depend on the success of the department. In order to encourage the accession of consumers, it is desirable that a showroom should be equipped for the exhibition of various kinds of fittings, lamps, radiators, motors, and other apparatus, can be shown in operation, and where clients could get all the information they required. It is proposed to commence the initial scheme from the existing offices. It will be the sales engineer's duty to take charge of the Council's sales department, and canvass for orders under the direction of the borough electrical engineer. The committee have drawn up a scheme for providing consumers with electrical installations:—(1) (*a*) A cash purchase system; (*b*) a hire purchase system, including inspection, insurance, and maintenance of wiring, switches, and fuses during the hiring period, with payments by instalments spread over a term agreed upon with the consumer (not in any case to exceed five years), after which the installation is completely the property of the consumer. The charge to the consumer to be made up of (i.) the capital outlay on the installation, *i.e.*, the net cost to the Council; (ii.) percentage additions thereto for administration, supervision, inspection, maintenance, insurance, and profit; (iii.) interest on outstanding instalments. (2) The installation work to be carried out by approved contractors. (3) Arrangements to be made for the maintenance of consumers' apparatus by the Council as occasion requires. The committee will submit a report as to the financial arrangements which may be necessary and a scale of charges for the services of the department.

The Electrification of the Tramways.—An intimation was received from Hackney Borough Council that they have decided to withdraw their objection to the adoption by the L.C.C. of the overhead system of electric traction in Lea Bridge Road. Mr. Heather (Chairman of the Committee) said he hoped the L.C.C. would now proceed with the scheme.

Hammersmith: New Sub-Station.—The Electricity Committee of the Borough Council has decided to erect a standard sub-station at the corner of King Street and Down Place, with permanent switchgear at a cost of £365.

The Law and Parliamentary Committee has decided in favour of opposing the Bill to be presented in the forthcoming session of Parliament to incorporate the West London, Barnes & Richmond Tramways Co., and to empower the company to make and maintain tramways and other works in the counties of London and Surrey, to confer further powers in respect of the Richmond (Surrey) electric light undertaking, and for other purposes.

Franco-British Exhibition Electric Supply.—A draft agreement has been arrived at between the directors of the Franco-British Exhibition and the Law and Parliamentary Committee of the Borough Council to the effect that if there is a total failure

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of the supply for 24 hours consecutively, the consumers will be entitled to a proportionate reduction in their liability for the guaranteed minimum payment.

Islington: North London Trams.—The Town Clerk of Islington has received a letter from the London County Council intimating that they propose to proceed at an early date with the reconstruction for electric traction on the conduit system of the tramways from King's Cross, via Caledonian Road, and Camden Road to Holloway Road, and thence, via Seven Sisters Road, to Finsbury Park.

Paddington: Electric Tramways Control.—The Works Committee of the Council, after an interview with the Improvements Committee of the London County Council, recommend that, subject to the Metropolitan Electric Tramways (Limited) agreeing with the Paddington Council with regard to widening Harrow Road, no opposition be offered the company's Bill for extending their lines within the borough. Further, the Works Committee recommend that such representations be made to the Board of Trade as may appear necessary concerning "the inconvenience which would result in the event of there being dual control of the tramway lines in Paddington."

The company called attention to the inconvenience which would be caused to residents in Paddington if the service of cars between Willesden and Lock Bridge had to be stopped at the county boundary. Representatives of the Borough Council waited upon the Improvements Committee of the L.C.C., and informed them that if the tramways were extended through Paddington the local authority would not bear any portion of the expense of street widenings. They would also expect recoupment of the expense incurred in carrying out the improvement at Pickford's. The chairman of the Improvements Committee of the L.C.C. stated that the County Council were not proposing to put forward a Bill this year, but they would consider the clauses of the Tramways Company's Bill, and try to bring about an agreement between the parties concerned.

Woolwich: Rates for Lighting and Power.—At the meeting of the Borough Council on January 2nd the Council came to the following decision:—(*a*) That when the load factor of any consumer taking a supply of energy for power purposes upon which the actual maximum demand exceeds 15 per cent., or the supply is for heating purposes, no time switches shall be installed, and the supply shall be given at a flat rate of 1d. per unit net, provided that such consumer undertakes to restrict the demand for power purposes on peak load to a minimum. (*b*) That when the load factor of any consumer taking a supply of electrical energy for power purposes exceeds 15 per cent., calculated as above, such consumer shall have the option to use not more than 7 per cent. of the total energy demanded for lighting purposes. The acting engineer also made a report with reference to the price of supply to illuminated signs, shop facias, &c. The Electricity Committee, when the question of price was before them some months ago, were reluctant to grant power rates for this purpose, on the ground that it was a matter of lighting, not power, and fixed the price at 2d. per unit. The engineer desired to have authority to quote power rates when any demand was made by a consumer whose load factor exceeds 15 per cent., equivalent to 1,312 hours of steady use per annum. The Council decided to continue the rate of 2d. per unit for current for electric signs and illuminated facias in cases where the load factor was less than 15 per cent., and at the rate of 1d. per unit net when the load factor exceeded 15 per cent. The Council's costs in opposing the London County Council (Electric Supply) Bill, the Administrative County of London and District Electric Power Bill, and the London Electric Supply Bill, last Session, amounted to £284 13s. 9d., and this sum will be made a general charge upon the borough funds.

LONGTON: *Electric Tramways.*—A report has been received by the Town Council with regard to the inspection of the tramway lines by Colonel Druitt, and it was intimated that the Board of Trade had consented to the continuance of the use of electricity on the lines generally.

OXFORD: *Dolter Surface Contact System.*—In connection with our reference to this matter last week, we are now able to give the report of Mr. Stephen Sellon to the Oxford Corporation upon the visit of a delegation from the Corporation to Hastings, and the working of the Dolter system there. The report, which is addressed to the Town Clerk, reads as follows:—"In accordance with your instructions, I accompanied the members of your Corporation to Hastings on December 16th, for the purpose of inspecting the tramway system installed there by the Dolter Company. By section 62 (2) of the Oxford and District Tramways Act, 1907, it is provided that the City of Oxford Electric Tramways, Ltd., may instal the Dolter surface-contact system in Oxford if it can be proved that such system has been working satisfactorily for six months in any place in Great Britain, and I understand that the visit to Hastings was made with the object of deciding whether your Corporation would be justified in permitting the adoption of this system at Oxford. As requested, I now give my views in writing:—Your Corporation will bear in mind that on September 25th, 1906, I reported upon various surface-contact systems which had been inspected by them, and in dealing with the Dolter system I expressed the opinion that the experimental stage had not yet been passed. I am still of that opinion. No system can be said to be in any other than an experimental stage if, in addition to the ordinary working expenses and staff required on a tramway system, the services of a patrol, numbering about four men to the mile, is necessary for the purpose of locating and dealing with live studs; neither is the possibility of live studs permissible in the streets of Oxford. The natural advantages which were secured by the Dolter Company at Hastings for a working example of their system are obvious—a level line, wood pavement, comparatively light vehicular traffic, further assisted by being laid on the side of the road. These exceptionally favourable circumstances are not present in Oxford, and therefore any failures in Hastings will be accentuated in Oxford. A perfected system is one that is not only satisfactory in respect to mechanical efficiency, but also in respect to economical working. A system which requires upon a level road 25 per cent. more current than the average electrical undertaking, besides the addition in staff above referred to, cannot be deemed satisfactory. Section 6 (2) of the above-mentioned Act also provides that should the Oxford and District Tramways fail to meet their obligations in the way of rent, the Corporation shall be entitled to take possession of the tramways on the terms of purchase provided by section 43 of the Tramways Act, 1870, which, in other words, represents the then structural value of the undertaking, less depreciation, irrespective of whether the line pays or not. Under those circumstances, therefore, it is to the Corporation's interest that the line should be capable of being worked at a profit, and it is essential that the system selected should ensure this. There have been no reliable figures of working expenses presented up to the present by the Dolter Company, so I am of opinion that your Corporation should hesitate before coming to a decision, especially having regard to the fact that the tramway company cannot possibly commence any construction for at least six months. Another reason I suggest for delay is that the Hastings Tramway Company are under an agreement with the Dolter Company whereby the former are bound to take over the system on January 12th next, should the system comply with the terms of the Dolter Company's guarantee. It would appear wise, therefore, if your Corporation would await the decision of the Hastings Tramway Company, who have been carefully watching the working of the system for the last twelve months, and have collected information (impossible to obtain by a casual inspection) as to whether or not they consider the Dolter Company have carried out their obligations. It cannot be expected, nor do I consider it would be reasonable to suggest, that your Corporation should be called upon to give a decision on an important matter of this sort without first receiving the best technical advice; neither would it be reasonable for them to be asked to bear the burden of a decision which might result in Oxford possessing permanently an unsatisfactory system of tramways. I therefore strongly advise that advantage be taken of the protective clause afforded by the Act of 1907, and to say that on the advice of their consulting engineer the Corporation are of opinion the line at Hastings has not worked satisfactorily for the last six months. This is no injustice to the Oxford Tramways Company, as obviously they are as much interested in obtaining the best possible system as the Corporation. Upon the Corporation taking up this attitude the onus is then on the Dolter Company to show that the line has been working satisfactorily in Great Britain for the last six months, and they are entitled to ask for the appointment of an arbitrator to decide this question. If your technical adviser is wrong they have nothing to fear. I advise your Corporation to adopt this course, thus placing the responsibility of choice of system upon the arbitrator and thereby obtaining relief from a responsibility of a highly technical character, which I do not think they ought to be subject to criticism for hereafter."

SPALDING: *Urban Council Surcharge.*—The surcharge of £66 upon the members of the Urban Council (see ELECTRICAL ENGINEERING, January 2nd, 1908, p. 28), has now been withdrawn.

SUNDERLAND: *Electricity Station Extensions.*—On Monday afternoon last, the new turbo-generator and boilers and stoking equipment were put into use for the first time. The turbo-generator has cost £10,551, and is of 2,000 kilowatts capacity, and works at 1,500 revs. per min. The boiler and plant have cost £15,708, and the total extensions, including switchboards, &c., have cost £41,600.

SWANSEA: *Demand for Electricity.*—At the ordinary meeting of the Swansea Electricity Committee on Thursday the engineer reported an increase in the consumption of electricity, and the Chairman (Colonel Sinclair) said if the same rate of progress was made next quarter the annual results should be most satisfactory, notwithstanding that the newer pattern lamps reduced the consumption by one-third. The London & North-Western Railway Co. asked for terms for electrically lighting its sidings. It was said the mains would cost from £425 to £570, while the number of lamps required would only be eight, but as these would be burning all night they would give an excellent total. The engineer said he hoped soon to obtain an order for electrically lighting the Midland Station. The committee decided to have further information.

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TUNBRIDGE WELLS: *Municipal Electric Lighting.*—The Tunbridge Wells Town Council, at its meeting yesterday, took the control of public lighting from the Electric Lighting Committee and placed it with the Watch Committee. It was contended that the former committee, being in the position of buyers and sellers, had carried on an extravagant system of public lighting, which had increased the cost to the ratepayers by £2,000 per annum, as compared with twelve years ago, when gas was exclusively used. It was declared that the Electric Lighting Committee had bolstered up the "profits" of the municipal undertaking by this policy.

YORK: *Corporation Electricity Show-rooms.*—The Electricity Committee have decided to open premises in the city for the exhibition of electric light fittings, &c. This course has been adopted in spite of a protest from the electric contracting firms of the city.

TENDERS INVITED AND PROSPECTIVE BUSINESS

AUSTRALIA.—In reference to the notice on page 953 of our issue for December 12th, Mr. J. Cresswell, the Board of Trade correspondent at Adelaide, has forwarded a copy of the specification and conditions relating to the supply and delivery to the Municipal Tramways Trust, Adelaide, of special work, points and crossings for tramways. Sealed tenders, endorsed "Tender for Special Work," must reach the Chairman, Municipal Tramways Trust, 8 King William Street, Adelaide, by noon on February 11th, 1908. Tenders must be accompanied by a preliminary deposit equal to one per cent. of the total amount of the tender. The specification and conditions may be examined by British manufacturers at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, E.C.

The Victorian Postmaster-General's department invites tenders by May 26th, 1908, for the supply of one common battery switchboard of thirty sections, complete with frames, racks, power plant, and parts; also for 3,000 telephone wall sets; 1,000 telephone table sets; 150 extension switches, complete; 10 switchboards, for 2 and 6 lines; 50 switchboards, for 3 and 10 lines; 10 switchboards, for 6 and 20 lines; 10 switchboards, for 8 and 50 lines; 200 telephone wall sets, for party lines; and 100 telephone wall sets, for party lines. A copy of the specification may be seen at the Commercial Intelligence Department of the Board of Trade, 73 Basinghall Street, London, E.C.

News received by the Australian mail, which arrived in London on Monday, states that the Postmaster-General has been authorised by the Commonwealth Cabinet to call for tenders at once for the installation of wireless telegraphy on several places round the coast of Australia. The places to be linked up are King's Island and Tasmania, Rottnest and some convenient centre on the North-West coast, and Port Moresby and Yorke's Peninsula. The tenderers will be required to sell the Australian rights of their system right out to the Commonwealth Government.

BANGOR.—A Local Government Board inquiry was held last week into an application by the Corporation for sanction to borrow £1,000 for the purposes of the electrical undertaking.

BARNES.—The Council invite tenders for the delivery and erection at the Council's depôt, High Street, Mortlake, London, S.W., of a two-ton electric locomotive crane. Full particulars from the Engineer's and Surveyor's office, High Street, Mortlake, to whom tenders should be sent by January 13th.

BEDFORD.—Some extensions to the mains are to be carried out.

BUENOS AYRES.—The *Review of the River Plate* states that the Buenos Ayres Municipality are calling for tenders for a period of six months—May 1st, 1908—for the construction of two tube railways, and also for the renting and working of same when built. Full particulars can be obtained in the Argentine Legation in the following cities:—London, Paris, Berlin, Brussels, Rome, and New York.

BURY.—On Friday the Town Council adopted a resolution of the General Purposes Committee that a scheme be carried out for the laying down of electricity generating plant at Chamber Hall for giving a supply on the alternating current system. The immediate estimated capital expenditure will be £70,000, with a possible subsequent expenditure of £15,000.

EDINBURGH SCHOOL BOARD.—The Board are prepared to receive estimates for an electric light installation at Portobello Higher Grade School. Specifications may be obtained at the office of Mr. George Thompson, 11 Randolph Place, and tenders to the Clerk, School Board Offices, Castle Terrace, Edinburgh, by January 11th.

FINCHLEY.—Tenders are invited for the supply and erection of a 350 kw. high speed engine and dynamo combined, together with spare parts. Particulars from the Electrical Engineer (Mr. E. Calvert), Electricity Works, Squire's Lane, Finchley, N. (fee £2 2s., returnable), and tenders to the Town Clerk by January 20th.

GLASGOW.—The Corporation invite tenders for the supply of a 4,000 kw. turbo-alternator running at 750 r.p.m. Copies of the specification and form of tender may be obtained on application to Mr. W. W. Lackie, engineer, 75, Waterloo Street, Glasgow (fee two guineas, returnable), and tenders to the Town Clerk by January 14th. (See advertisement last week.)

ILFORD.—Tenders are required for the supply of feeder cable. Specifications, conditions, &c., from Mr. A. H. Shaw, Electrical Engineer to the Council, and tenders to the Town Clerk by January 14th.

INDIA.—Tenders are invited by the Bengal and North-Western Railway Co. for 15,000 incandescent lamps. Specifications may be obtained at the company's London offices, price 10s. (not returnable), and tenders should be addressed to the Managing Director, 257 Gresham House, Old Broad Street, E.C.

KILKENNY.—The Joint Committee of Management of the Kilkenny and District Lunatic Asylum invite tenders for (1) suction gas plant, gas engines, and generators; (2) accumulators, switchboard, mains, &c. Plans may be inspected by appointment at the Asylum or at the office of the consulting engineer, Mr. L. J. Lawless, 27 Castlewood Avenue, Rathmines, Dublin, from whom copies of the general conditions, &c. may be obtained (fee, three guineas, returnable). Tenders to the Resident Medical Superintendent by January 18th.

LEYTON.—The Urban District Council, at their last meeting, decided to fix three arc lamps in Church Lane, Leytonstone. The annual cost will be £21 each. These will replace five electric incandescent lamps costing £4 3s. 6d. each. The additional premises recently acquired in connection with the electricity undertaking are to be fitted up at a cost, including telephones, of £138 and £126. In reference to the decision of the Council some time ago to convert the arc lamps in High Road, Leyton, into flame arc lamps, the Engineer was empowered to acept offers of flame arc lamp manufacturers to erect three lamps on trial. The lamps must be capable of burning 37 hours with one trimming, to take nine amperes, and, if possible, to burn four in series on 150 volts.

LIMERICK.—The Board of Guardians is considering the advisability of erecting a sanatorium for consumptives, which will be electrically lighted.

LONDON: *London County Council.*—Tenders are invited for the supply and delivery of about 500 tons of steel slot rails and about 190 tons of conductor rails, required for the reconstruction on the underground conduit system of electric traction of certain sections of the Council's tramways. The rails must be of British manufacture. Full particulars, forms of tenders, &c., from the Chief Engineer to the Council, Mr. Maurice Fitzmaurice (fee £2, returnable), and tenders to the Clerk to the Council by January 21st.

Camberwell.—Tenders are invited by the Borough Council for electric lamps, among other stores; also the maintenance of private telephones and electric bells. Particulars, forms of tender, &c., from Mr. William Oxtoby, Borough Engineer, Town Hall, Camberwell, S.E., by specifying sections desired. Tenders to the Town Clerk by January 20th.

MANCHESTER.—The Corporation Tramways Department invite tenders for the following machine tools: car wheel turning lathe, self-acting and screw-cutting lathe, and high-speed vertical drilling machine. Particulars from the General Manager, 55 Piccadilly, to whom tenders by January 14th.

MARSEILLES EXHIBITION.—A Paris firm, contractors for luminous decorations and art lighting, who are concerned in work of this character to be done at the Electrical Exhibition at Marseilles next year, are desirous of obtaining novelties of all kinds in connection with their industry in the way of lamps, lamp stands, conductors, reflectors, decorative shades, &c. They will be glad to receive samples, catalogues, or descriptive notices from British makers, and to be informed what quantities of the goods named makers would be prepared to place gratuitously at their disposal during the exhibition in exchange for the advertisement which the makers would have from the display of their wares. For further particulars manufacturers should apply to the Secretary of the British Chamber of Commerce, 17 Boulevard de la Madeleine, Paris.

PLYMOUTH.—The Plymouth Corporation is prepared to receive tenders for the supply of the undermentioned stores during the twelve months ending March 31st, 1909:—Arc lamp carbons, electricity meters, transformers, cables (paper insulated), lubricating oils, &c., engine waste, &c. Full particulars from Mr. E. G. Okell, Borough Electrical Engineer (fee, ten shillings for each specification, returnable), to whom tenders by January 23rd.

ROTHERHAM.—The Corporation invite tenders for the supply of tramway rails, fish-plates, tie-bars, bolts and nuts, and special trackwork, to be delivered in Rotherham. Speci-

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fications, &c. (fee one guinea, returnable), from the Borough Engineer, and tenders to the Town Clerk by January 17th.

SOUTH AFRICA: *Kroonstad.*—Tenders will shortly be invited for generating plant by the municipality.

VIENNA.—Preparations are being made for the issue of a loan of from £10,000,000 to £12,000,000 for the extension of the tramways and electric lighting system, in addition to a large number of other public works.

TENDERS RECEIVED AND ACCEPTED

CARDIFF.—Messrs. Bruce Peebles & Co., Ltd., have received from the Cardiff Corporation an order for a 250 kw. Peebles La Cour motor converter, this being a duplicate of the unit previously ordered.

DARWEN.—The Electrical Engineer having tested coal required for the local electricity works, the Town Council on Monday decided to accept the tender of the Clifton & Kearsley Coal Co. for a period of six months for the supply of coal to these works.

LEYTON.—The Urban District Council has received the following tenders for the supply of cables for extensions to mains:—Lahmeyer Electrical Co., Ltd. (accepted), £1,785 10s.; Western Electric Co., £1,872 10s. 3d.; British Insulated and Helsby Cables, Ltd., Lancs, £1,904 13s. 4d.; Johnson and Phillips, £1,909 10s.; Siemens Bros. & Co., Ltd., £1,910 11s. 6d.; W. T. Henley's Telegraph Works Co., £1,924; St. Helens Cable & Rubber Co., £1,947; Callender's Cable & Construction Co., Ltd., £1,955 10s.

The tender of Mountain & Gibson, Ltd., has been accepted for the supply of car wheels at £3 17s. 6d. each, wheel tyres at £1 17s. 6d., and wheel centres at £2 each, a reduction of 1s. per tyre being made for 2-in. tyres.

The following tenders have also been received for the supply of 100 public lighting lanterns:—W. Edgar, £2 9s. 5d. per lamp, or £246 5s. per hundred; Electrical Co., Ltd., £525 per hundred; W. Lucy & Co., Ltd., £240 16s. per hundred; General Electric Co., Ltd., £250 per hundred; Crown Lamp Works, £360 per hundred. The tenders were referred to the Electric Lighting Committee for consideration.

LONDON: *Stepney.*—Messrs. Bruce Peebles & Co., Ltd., have secured, through Messrs. Willans and Robinson, the Stepney Borough Council's order for a 200 kw. 6,000-volt 50-cycle three-phase turbo-alternator, to be driven at 500 r.p.m. by Messrs. Willans & Robinson's steam turbine.

Woolwich.—The Borough Council has decided to purchase a spare set of links for the chain grates of the boilers at Plumstead works from Messrs. Babcock & Wilcox for £27. The quotation of the Oliver Arc Lamp Co., Ltd., for the annual supply of 35,000 pairs of "Oriflame" arc lamp carbons for continuous current supply at £96 5s., and 10,000 pairs for alternating current supply, at £28 10s., has been accepted.

METROPOLITAN ASYLUMS BOARD.—An agreement has been entered into with the Electrical Power Storage Co., Ltd., to maintain the storage battery at Brook Hospital, Woolwich, for seven years from September 29th, 1907, at an annual sum of £70.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Son, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars net c.i.f. port of arrival, quoted on Tuesday night, was £64 10s. to £65 10s. per ton (last week, £63 10s. to £64 10s. per ton).

LIQUIDATIONS, BANKRUPTCIES, &c.—The Electric Power Development Co., Ltd., is to be wound up voluntarily. Claims to Mr. G. R. Bostock, 21 Ironmonger Lane, London, E.C., by February 29th.

A meeting of the Phodene Electrical Co., Ltd., will be held at 66 Victoria Street, London, S.W., on February 4th, at 12 noon, for the purpose of hearing the liquidator's account of the winding up.

A meeting of Electrical Improvements, Ltd., will be held at 44 Parliament Street, Nottingham, on February 17th, at 11 a.m., to hear the liquidator's account of the winding-up.

The discharge of Thomas Edward Morgan, electrical engineer, 367 Eccleshall Road, Sheffield, has been suspended for two years, as from December 5th, 1909.

THE WILKINSON FEED WATER HEATER.—From the commencement of this year the London and district agency for the above apparatus has been transferred from Messrs. Hall & Co. to Messrs. J. L. Cateaux & Co., of 10 Bush Lane, Cannon Street, E.C. Although these heaters are of recent design, we understand that a large and rapidly increasing business is now being done, both at home and abroad. Amongst the recent orders received may be mentioned the following:—Messrs. Pilkington Bros., St. Helens; The Hucknall Torkard Collieries Co., nr. Nottingham; The Calico Printers' Association; The Associated Portland Cement Co.; Messrs. Pease & Partners, Stockton; Messrs. Clarke, Chapman & Co., Messrs. Goodwin & Co. (the two latter being repeat orders); the electricity works of Blackpool, Blackburn, Londonderry, Bedford, Ashton-under-Lyne, and repeat orders from Luton and Wakefield electricity works.

COMPANIES' MEETINGS AND REPORTS

BURMAH ELECTRIC TRAMWAYS AND LIGHTING.—The report for the year ended July 31st last states that the receipts have barely covered the expenditure, in spite of the fact that the outgoings for current expenses have not appreciably increased. The great exodus of population due to the continuance of the plague is stated to be responsible for a decrease in the receipts of about £1,000. Nevertheless, the directors think that this is less than might reasonably have been expected, and that it indicates the usefulness of the undertaking, which may be expected to develop with a return to normal conditions. This view is upheld by the fact that since August last, when the plague was reported to have ceased, an improvement in the receipts has been manifested. The difficulty of the coal problem still continues. No coal has yet made its appearance in Mandalay, and the company has still to rely upon wood for their heating power, and for this reason it has been impossible to effect any reduction in the charges for power, which continue abnormally high. In other directions some economies have been made. Notwithstanding the unlooked for check due to the plague from February, 1906, until August, 1907, a very large number of riders, about 50,000 per week, continued to use the tramways, so that the report states it is evident that the want of expansion was not due to any hostility to the tramways, but to circumstances entirely apart.

At the meeting on Tuesday last week, the report and accounts were adopted.

LONDON SOUTHERN TRAMWAYS.—At an extraordinary general meeting on Friday, the secretary was authorised to distribute the balance of the funds available to the shareholders in connection with the sale of the undertaking to the London County Council. Mr. W. M. Murphy presided. The accounts showed that, after paying the debenture holders and the creditors, there was a balance remaining of £10,162 for division among the shareholders, or £1 2s. 7d. per share. We gave a full statement of the position of the company's affairs in our issue for December 19th.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION.—At an extraordinary general meeting on Tuesday, the following resolutions, already passed by the shareholders, were confirmed:—"(1) That by virtue of the powers contained in the Companies Acts 1867 and 1877 and the company's regulations, the conditions contained in the memorandum of association be modified by the reduction of the existing nominal capital of the company from the sum of £325,000 to the sum of £260,000, thus reducing the capital of the company by £65,000, and that such reduction be carried into effect by the alteration of the 65,000 shares of £5 each now forming the capital of the company into 65,000 shares of £4 each. (2) That in accordance with the above resolution the capital of the company shall henceforth stand as follows, namely, the nominal capital of the company shall be £260,000, divided into 65,000 shares of £4 each." During the course of a short discussion it was stated that the refuse destructor has been dismantled.

POCKET-BOOKS, CALENDARS, Etc.

Copies of a pocket diary for 1908, with a full page for each day, in addition to space for memoranda, are being distributed by Messrs. Mountain and Gibson, Ltd., of Bury. A number of interesting illustrations of different types of tramway and railway trucks of the firm's manufacture are included, together with views of complete cars to which these are fitted.

The Consolidated Accessories Co. send out a card with the season's greetings, giving figures showing the increasing sales of their "Peacock" tramway brake outfits. The design of the card includes three black and white drawings, showing the action of the brake gear and with a spirited representative of the bird from which the apparatus takes its name, perched upon the brake handle. This is repeated three times in varying sizes, and is decoratively most effective.

The Western Electric Co. have issued a wall calendar embellished with illustrations of various forms of telephone apparatus, sections of cables, and other articles of their manufacture.

Telegraph Traffic.—The past week has been rather full of incidents in the telegraphic world, there being several interruptions to record. The Ceuta-Tangier cable was put into working order again on the 3rd inst., it having ceased working on December 6th last. Trouble has occurred between Rome and Constantinople; this land-line route gave out on the 1st inst. The "Via Fao" route was interrupted on the 3rd inst., and there is also an interruption between Bagdad and Bassorah. The cables between Scotland and the Orkney Islands, and Scotland and the Shetland Islands, ceased working on the 2nd inst., and, as these cables form part of the means of communication with Iceland, it now becomes necessary to post messages for the Orkney, Shetland, Faroe Islands, and Iceland, from Scotland to the Orkney Islands, and messages are consequently subject to delay.

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APPOINTMENTS AND PERSONAL NOTES

Mr. Keats, Acting Electrical Engineer to the Woolwich Borough Council, has been appointed Electrical Engineer at a commencing salary of £325 per annum, rising by annual increments of £25 to £400.

The Darwen Electricity Committee decided on Monday to give the electrical engineer, Mr. C. Fawcett, an increase of salary from £250 to £275 from New Year's Day, 1908, and a further increase to £300 per year from January 1st, 1910.

Mr. Harry Heys, assistant clerk at the Burnley Electricity Works, has been appointed chief clerk at the Mansfield Electricity Works.

The Nelson Electricity Committee has decided that the salary of Mr. Nayler, Assistant Electrical Engineer, be increased from 45s. to 50s. per week.

Mr. J. D. Caird, of Aberdeen, was on Friday appointed Traffic Superintendent of the Halifax Co.'s Tramways at a salary of £250, rising to £350 per annum.

The Electricity Committee of the Manchester Corporation have recommended that Mr. S. L. Pearce, Chief Electrical Engineer, be reappointed for four years, the salary for the first two years to be £1,100 per annum, and for the last two years £1,200 per annum, Mr. Pearce to devote the whole of his time to the duties of the position.

On his transfer to the Newcastle district, Mr. Callaghan, Assistant Engineer in the Darlington postal district, has been presented with a gold ring and a silver mounted pipe by the Darlington telegraph staff.

No less than 200 applications were made for the post of City Electrical Engineer at Carlisle, the salary being £300 a year, with annual increases of £20 to a maximum of £400. The following have been selected to appear before the committee:—Mr. T. S. Allen, Plymouth; Mr. W. W. Alston, West Bromwich; Mr. O. F. Francis, Kirkcaldy; Mr. C. F. McTomes, Gravesend; Mr. B. S. Hornby, Bolton; and Mr. C. L. E. Stewart, Rochdale. At the meeting on Tuesday, Mr. Francis was unanimously elected to the appointment.

We learn that Mr. F. J. Moffett and Mr. N. B. Rosher, who have until recently been engineers on the staff of Messrs. Preece & Cardew, have commenced to practice as consulting and inspecting engineers at Union Chambers, Temple Row, Birmingham. They intend to devote special attention to the electrical equipment of works and factories, and also to the inspection and testing of all kinds of engineering plant and material, several of the leading London consultants having already appointed them as their inspecting engineers in the Midlands and Lancashire. Mr. Rosher held the post of resident engineer for the building and equipment of Messrs. Siemens' Dynamo Works, Stafford, and, under Messrs. Preece & Cardew, for the electrical equipment of H.M. Dockyards at Chatham and Simon's Bay, S. Africa. Mr. Moffett has had a long and varied experience of Colonial work.

NEW COMPANIES

BRITISH ELECTRICS (MOSELEY'S PATENTS).—This company was registered on December 31st, 1907, with a capital of £10,000 in £1 shares, to acquire and turn to account inventions relating to the manufacture of electric, magnetic, telegraphic, telephonic, and other appliances, and certain patent rights and other property referred to in an agreement dated November 19th, 1907, between W. Moseley and F. de H. Larpent, and with a view thereto to adopt an agreement with the said F. de H. Larpent. The subscribers are:—J. J. Ireland, A. G. Hastings, A. Klein, C. D. Moggridge, R. H. Peren, H. E. Luker, J. H. East. No initial public issue. The number of directors is not to be less than three nor more than five: the first is W. Moseley and others to be appointed by the subscribers. Remuneration, £100 each per annum (chairman, £150), and 10 per cent. of the profits remaining in any year after 10 per cent. dividend has been paid.

CHECKOGRAM (1908).—This company was registered on January 3rd, with a capital of £51,000 in £1 shares, to acquire the undertaking of Checkogram, Ltd. (incorporated in 1904), to adopt an agreement with the said company and its liquidator, and to carry on the business of manufacturers of and dealers in mechanical and electrical appliances for delivering, receiving, counting, checking, or other operations and mechanical and electrical indicators, turnstiles, gates, tickets, checks, perforating and stamping presses, lamps, alarms, contact makers, boxes, frames, cases, fibre, vulcanised fibre, vulcanite and the like, electricians, suppliers of electric or other power, engineers, &c. The subscribers are:—W. B. Purefoy, W. Leon, Col. C. W. Cox, Capt. H. F. Darell, W. Slark, J. M. Cobban, P. H. Edwards. No initial public issue. The number of directors is not to be less than three, nor more than seven; the first are W. B. Purefoy, W. M. Leon, C. W. Cox, and Capt. H. F. Darell. Qualification, £500 shares or stock. Remuneration, £400 per annum, and not more than £600 out of the surplus profits remaining in any year after providing for reserve fund and for 20 per cent. on the ordinary shares, dividend. Registered office, 150 Oxford Street, W.

I. HARRIS & SONS.—This company was registered on December 28th, with a capital of £1,000 in £1 shares, to acquire the business of a dealer in talking machines and electrical and optical goods carried on by B. Harris at 4 Blue Boar Court, Manchester, as I. Harris & Sons, and to carry on the same and the business of manufacturers of and dealers in lubricating and other oils, indiarubber, &c. No initial public issue. Table "A" applies. The first directors are B. Harris and A. Harris. Registered office: 4 Blue Boar Court, Manchester.

MISCELLANEOUS CITY NOTES

CHILI TELEPHONE CO.—The usual interim dividend for the half-year ended September 30th, at the rate of six per cent. per annum free of income tax, has been declared.

CITY OF LONDON ELECTRIC LIGHTING CO.—Warrants in payment of the interest on this company's £400,000 5 per cent. and £300,000 4½ per cent. second debenture stock for the half-year to December 31st, 1907, have been duly posted.

CITY OF WELLINGTON ELECTRIC LIGHT & POWER CO.—As a consequence of the purchase of the undertaking of this company by the municipality, subscriptions are being invited at par for four per cent. debentures to the amount of £147,500 through the Union Bank of Australia. The list closes on Saturday. Although issued on behalf of the company, the issue is secured upon the city rateable value.

NEW PUBLICATIONS

"Science Abstracts." December, 1907. Section A, Physics; Section B, Electrical Engineering. (London: E. & F. Spon, Ltd.) 1s. 6d. each.

"The Mechanical World" Pocket Diary and Year Book for 1908. (Manchester: Emmott & Co., Ltd.) 6d. net.

"The Mechanical World" Electrical Pocket Book for 1908. (Manchester: Emmott & Co., Ltd.) 6d.

Large Gas Engines in Germany.—We have received from Mr. Leonard Andrews, of The Key Engineering Co. a large framed copy of the group that was taken at the works of Messrs. Ehrhardt and Sehmer at Saarbrucken, on the occasion of the visit of a party of English engineers to the Continent in October last, to inspect some notable installations of large gas engines and electrical plant. An accompanying picture represents the largest of the gas engines inspected during the tour.

New York Traction Companies Receivership.—The receivers for the Metropolitan Street Railway Co. and New York City Railway Co., who were appointed in August, have applied to the United States Circuit Court for instruction regarding the operation of the Third Avenue Railway Co., one of the affiliated undertakings. In a report to Judge Lacombe, which is given in the *Street Railway Journal*, it is stated that the Third Avenue Railroad was leased in April, 1900, to the Metropolitan Company for a term of 999 years. The latter corporation was thereby obliged to pay a quarterly dividend upon the Third Avenue capital stock of 6 per cent. from 1906 to 1910. The quarterly dividend due October, 1907, amounting to $239,937, was, by order of Judge Lacombe, defaulted. The lease also stated that the Third Avenue had executed, or was about to execute to the Morton Trust Company, as trustee, a "first consolidated mortgage" to secure payment of bonds amounting to $35,000,000, and that the Metropolitan Company guaranteed the prompt payment of interest and principal. There is now outstanding $37,560,000 of the bonds referred to, with a semi-annual interest at the rate of 4 per cent. and that on January 1st the sum of $751,200 will be due. Having no money to pay such interest, the receivers ask the court for instructions. There is also outstanding a prior issue of bonds by the Third Avenue, amounting to $5,000,000, bearing 5 per cent. interest, which constitutes a prior lien upon the property to the first consolidated mortgage, the petition says. At present the operation of the Third Avenue Railroad costs about $1,300,000 more than its receipts from all sources. Further, the receivers think there is no reason to expect an increase in the gross earnings sufficient to offset the increase in operating expenses which may reasonably be anticipated owing to the tendency toward higher prices for material and labour. Figures are also given showing a decrease in the gross earnings between 1896 and 1907 from $2,628,628 to $2,098,705. This result is mainly attributed to fraudulent use of the system of transfers, which is regarded as inevitable in the present state of the law on this point. With the operation of the Third Avenue Railroad as a separate system, the receivers believe that the earnings would show a substantial gain. At present, however, the receivers are absolutely without means to pay rent and interest, the large proportion of which has not been paid since 1900, and amounts to $330,000 per annum. As the result of the working of the line since the date of the appointment of the receivers until November 30th, 1907, there is a cash balance of $257,188, but this would barely suffice to meet the indispensable requirements for December, especially in view of the fact that with the advance of the winter months the daily earnings show material diminution.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906 %	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£				
Bournemouth & Poole E. S. Co. Ltd.	10	7	5/-*	9½—10½	
Do. 4½% Cum. Pref.	10	4½	4½*	9½—10	
Do. 6% Cum. Second Pref.	10	6	6%	9⅝—10⅜	
Do. 4½% Debenture, Red.	Stock	4½	4½%	98—101 xd	
Bromley (Kent) E. L. & Power Co., Ltd.	5	5½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	95—98	
Brompton & Kensington E. S. Co., Ltd.	5	10	4½%	7—8	
Do. 7% Cum. Pref.	5	7	7%*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	96—99	
Ch. Cross, W. E. & City E. S. Co.	5	5	5%*	3¾—4⅜	
Do. 4½% Cum. Pref.	5	4½	2½%*	4—4½	+½
Do. 4% Deb. Red	Stock	4	4%	95—98 xd	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	4—4½ xd	+½
Chelsea Electric Supply Co., Ltd.	5	4½	2/-*	3¼—4¼	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103 xd	
City of London Elec. Lt. Co., Ltd.	10	6	5%*	9½—10½	
Do. 6% Cum. Pref.	10	6	6%*	11—12	
Do. 5% Deb. Red	Stock	5	5%	120—123 xd	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	94—97 xd	+1
City of Durham E. P. Dis. Co.	5	4	2/1%*	3½—4¼	
Do. 5% Pref.	5	5	5%*	4⅝—4⅞	
County of London Elect. Sup. Co. Ld.	10	5	4%*	6½—7½	
Do. 6% Cum. Pref.	10	6	6%*	10½—11	
Do. 4½% Deb. Red	Stock	4½	4½%	103—106 xd	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	95—98	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅜—⅝	
Do. 6% Cum. Pref.	5	3½	—	¾—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	70—80	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4½—5	
Do. 5% Cum. Pref.	5	5	2/6*	4⅝—5⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%*	96—99	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6⅜—6⅞	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E. L. Co.	5	10	5/-*	8—9	
Do. Red	Stock	4	4%*	95—98	
Kens & N'tng Hill E. L. Cos. Db. Rd.	Stock	4	4%*	96—99	−2
London Electric Supply Corporation	3	4	2/4½d*	1¼—1¾	
Do. 6% Pref.	5	6	6%*	4—4½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	87—91 xd	
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	5⅜—5¾	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅝—5⅛ xd	+¼
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	100—104 xd	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90 xd	
Midland E. Corp. for P. Dist. 1st Mt. D.	100 & 500	4½	4½%	94—97 xd	−2½
Newcastle & Dist. E. L. Co., £9 paid	10	5	3/7½d.*	8½—9½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99 xd	
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6½—6¾	
Do. £2 Pm.	5	8	1/4¾d*	6¼—6¾	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5⅛	
Do. 10/- Pm.	5	5	1/4¾d	5—5⅛	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	6%*	10½—11½	
Oxford Electric Co., Ltd.	5	7	2/6*	5½—6	
Do. 4% Deb. Red	Stock	4	4%*	95—97	
St. James and Pall Mall E. L. Co. Ld.	5	10	5/-*	7¼—8¼	
Do. 7% Non-Cum. Pref.	5	7	3/6*	6½—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90 xd	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—1½	
Do. 4% Deb. Red	Stock	4	4/-*	71—75	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2½—3	
South Metropolitan E. L. & P. Co.	1	2½	6d*	⅛—⅜	
Do. 7% Cum. Pref.	1	7	8¾d.*	1—1⅛	+1/16
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1½—2¼	
Do. 5% Cum. Pref.	5	5	2/6*	1¾—2¾	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	5%*	7¾—8¾	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅝—5¼ xd	+¼
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%*	89—92	
Central London	Stock	4	3%*	64—67	+2
Do. 4% Preferred	Stock	4	4%*	84—86	+1
Do. Deferred	Stock	4	—	44—47	+3
Do. 4% Debentures	Stock	4	4%*	101—104	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	72—76 xd	
City and South London Cons.	Stock	2⅛	2¼%	44—46	+1
Do. 4% Perp. Deb.	Stock	4	4%	101—104	+1
Do. 5% Perp. Pref. 1891	Stock	5	5%*	116—119	
Do. 5% Perp. Pref. 1896	Stock	5	5%*	113—116	
Do. 5% Perp. Pref. 1901	Stock	5	5%*	113—116	
Great Northern & City Pref. "A"	10	4	11½d.	1⅜—2¼	+⅛
Gt. Northern, Piccadilly & Brompton	10	4	4/-*	4—5	
Do. 4% Perp. Deb.	Stock	4	4%	78—82 xd	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1½%*	43½—44½	+5
Do. 3½% Preference	Stock	3½	3½%*	86—89	+1
Do. 3½% "A" Pref.	Stock	3½	3½%*	77—80	
Do. 3½% Convertible Pref.	Stock	3½	3½%*	73—76	+1
Metropolitan District	Stock	nil	—	10½—11½	+2
Do. 6% Perp. Deb.	Stock	6	6%	102—107 xd	+2
Do. 4% Pref. Deb.	Stock	4	4%	68—73 xd	
Do. Extension Pref. (5%)	Stock	nil	—	15—25	+5
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	—	47—52	
Underground Elec. Railways Co of London 5% Profit Shg. Sec. Notes	Various	5	5%	35—39	
Whitechapel and Bow 4% Deb.	Stock	4	4%	103—105 xd	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	1⅛—1⅜	
Do. 5% Cum. Pref.	1	5	5%	1⅜—1½ xd	
Do. 4½% Deb. Red.	Stock	4½	4½%	91—95	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	92—95 xd	+2
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	5—5½	
Do. 5% Perp. Deb.	Stock	5	5%	90—93	
Do. 4½% 2nd Deb.	Stock	4½	4½%	69—74	−1
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4¼—4¾	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	96—99	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906 %	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£				
Dublin United Trams Co.	10	6	6%*	13—14	+½
Do. 6% Pref.	10	6	6%*	12⅜—13⅜	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅜—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63 xd	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	92—95 xd	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7¼—8½ xd	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—84	+1
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	95—98	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1⅛—1⅜	
Do. 5% Cum. Pref.	1	5	6d*	1⅛—1⅜	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	91—94 xd	
National Elec. Construction Co. Ltd.	1	10	2/-	1⅛—1⅜	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	¾—1¾	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅛—⅜	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92 xd	−1
Potteries Electric Traction Co. Ltd.	1	4	9¾d*	⅝—⅞	
Do. 5% Cum. Pref.	1	5	5%*	¾—⅞	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3½	4%	4⅜—5⅛	
Do. 6% Cum. Pref.	10	6	6%	10—11 xd	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6¾d.*	¾—1⅛	
Do. 4% Deb. Red.	Stock	—	4%	78—82 xd	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	74—78 xd	−3
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1¼	
Do. 6% Cum. Pref.	5	nil	—	3⅛—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	78—81 xd	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	30/-	57—60	+2
Do. 6% Pref. Ord.	Stock	6	3%	100—102	+1
Do. Def. Ord.	Stock	1¾	—	16¾—17½	+¾
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	80—84 xd	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3½	
Do. 10% Cum. Pref.	5	10	5/-*	8¼—8½	
Do. 4½% Debs.	50	4½	4½%	97—100 xd	−1
Direct United States Cable Co. Ltd.	20	4½	4½%	13½—14	+¼
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	99—101 xd	−1
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	5/-	12⅝—12¾	
Do. 4% Mort. Deb. Perp.	Stock	4	4%*	99⅛—102½	
Eastern Telegraph Co.	Stock	5⅔	3⅔%	130—135	
Do. 3½% Pref.	Stock	3½	17/6	83—86	
Do. 4% Mort. Deb.	Stock	4	4%	99—102	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	30½—32½	
Indo-European Telegraph Co. Ltd.	25	13	65/-	52—55	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	+1/16
National Telephone Co., Ltd., Pref.	Stock	6	6%*	110—112	+1
Do. Deferred	Stock	5½	6%*	107½—109½	+1
Do. 6% Cum. 1st Pref.	10	6	6%*	10½—12½	
Do. 6% Cum. 2nd Pref.	10	6	6%*	10—12	
Do. 5% 3rd Pref.	5	5	5%*	5⅛—5⅜	+1/16
Do. 3½% Deb. Red	Stock	3½	3½%	96—98 xd	
Do. 4% Deb. Red.	Stock	4	4%	98—100 xd	
West African Telegraph Co. Ltd.	10	4	4/-	10—10½	
Western Telegraph Co., Ltd.	10	7	6%	12⅝—13⅝	
Do. 4% Deb.	Stock	4	4%	97—100 xd	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅛—⅜	
Do. 6% Cum. Pref.	1	6	7½d	⅝—1⅛	
Babcock & Wilcox, Ord.	1	20	1/7½*	3½—3¾	
Do. 6% Pref.	1	6	7½d	1⅛—1⅜	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6½—6¾	
Do. 6% Cum. Pref.	5	6	3/-*	5⅝—6¼	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	100—103 xd	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%*	85—89	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	¾—1⅛	
Do. 4% Mort. Deb. Red.	Stock	4	4%	40—50 xd	
Brush Electrical Engineering Co.	2	nil	—	0—½	
Do. 6% Pref.	2	nil	—	¼—¾	−⅛
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	83—86	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66 xd	
Callender's Cable and Const. Co., Ld.	5	15	15/-	9½—10¼	
Do. 5% Cum. Pref.	5	5	5%	5¼—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	104—106 xd	
Consolidated Electrical Co., Ltd.	1	3	8¾d*	7/16—9/16	
Crompton & Co., Ltd.	3	5	5%	1⅝—1⅞	−1/16
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	94—97 xd	−2
Dick, Kerr & Co., Ltd.	1	10	2/-*	1⅛—1⅜	
Do. 6% Cum. Pref.	1	6	7½d	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	99—102 xd	
Edison & Swan United "A."	5	4½	2/6	2—2⅛	
Do. do (fully paid)	5	4½	4/2	1⅞—2¼	
Do. 4% Deb. Red.	Stock	4	4%	78—81 xd	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	¼—⅜	
Do. 7% Cum. Pref.	2	7	—	⅝—1⅛	
Do. 4% 1st Mort. Deb.	Stock	4	4%*	59—64	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7¾—8¼ xd	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	10¼—11¼	
Do. 4½% Cum. Pref.	5	4½	2/-*	4⅞—5⅜	−⅛
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	101½—106½	+½
I. R. & G. P. Co., Ltd.	10	10	10%	14½—15½ xd	
Do. 4% Deb. Red.	100	4	4%*	96—98	
Tel. Const. & Maintenance Co.	12	15	5%*	28½—30½	
Do. 4% Deb. Bds. Red	100	4	4%	99—102 xd	−1
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9 xd	
Willans & Robinson, Ord. Shres	1	nil	1/-	¾—1¼	
Do. 6% Cum. Pref.	5	nil	6%	3½—2¾	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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SUMMARY

The trial of the signalman, for manslaughter, in connection with the accident on the Metropolitan Railway at West Hampstead station last October, took place on Friday. The prisoner was acquitted. (Page 70.)

The cruiser *Kleber*, stationed at Casa Blanca, has succeeded in transmitting wireless telegraph messages to the Paris Eiffel Tower, a distance of 1,200 miles. (Page 71.)

Reviews of the following books appear in this issue:—"The Patents and Designs Act, 1907," by J. Roberts and H. Fletcher Moulton; "The *Mechanical World* Pocket Diary and Year-book," "The *Mechanical World* Electrical Pocket Book," Fowler's "Mechanical Engineers' Pocket Book," "The Science Year-Book." (Page 71.)

A correspondent makes some inquiries relating to the use of Osram lamps for street lighting. (Page 72.)

A Paper by Mr. J. F. C. Snell, read before the Institution of Electrical Engineers last week, reviewed the whole question of the cost of electric power supply. The first part of the Paper gave results of a large number of independent plants, and included many useful tables and data, some of which showed that in many cases it would be useless to attempt to supply from a central station at as low a price as the works could reach with their own generating plant. Most discussion was directed, however, to the latter part, in which a formidable array of figures were marshalled in support of the contention that a large number of electricity works were charging a lower price for electric power supply than that at which it could be generated and distributed, when due account was taken of the capital charges. He concluded with the recommendation that the expenditure on extensions to many smaller electricity works should be stopped, and that power should be supplied from large central stations owned either by power companies, county councils, or jointly by municipal authorities. In the course of the Paper, the author expressed himself strongly in favour of supply of alternating current to works, and emphasised the saving in having static transformer sub-stations instead of A.C.: D.C. sub-stations, and in this he was strongly supported by Mr. J. Rider, who opened the discussion, and expressed himself generally in accordance with the author's views on other points also. Mr. A. M. Taylor complained that no account was taken of the cost of distribution from the sub-stations, and that consequently the Paper was not applicable to the case of the small power user. Mr. A. H. Seabrook criticised several figures in the Paper, more particularly those relating to the capital cost of sub-stations and the cost of transforming the energy in them, both of which, he considered, were over-estimated. Mr. J. H. Jeckell also characterised as too

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high the cost given for transformer sub-stations, and he did not think it correct to debit the power consumer with the capital costs of the lighting station. Mr. W. H. PATCHELL added some useful information with regard to the power consumption of private plants, and incidentally pointed out that much capital in mains would be saved when the use of metallic filament lamps would render it no longer necessary to regulate the pressure for lighting within the present close Board of Trade limits. The discussion was adjourned, and will be continued to-night in the meeting hall of the Institution of Mechanical Engineers. At the Dublin Local Section the Paper was also discussed. Mr. TOMLINSON gave the estimated costs in the case of a peat utilisation scheme he was engaged upon; Mr. RUDDLE, Mr. KETTLE, and Mr. SHEARDOWN criticised Mr. Snell's figures, and, together with Mr. Tomlinson, asked for further information as to the precise process by which he obtained them. (Page 73.)

A NEW petrol-electric omnibus has been put into service in London by Messrs. T. Tilling & Co., Ltd., and a trial trip was made from London to Dartford to the works of the makers, Messrs. J. & E. Hall & Co., last Thursday. The electrical equipment is on the Stevens' system. A 30-h.p. "Hallford" engine drives an interpolar dynamo, which supplies current to two motors, one of which drives each back wheel through worm gearing. A controller enables the motors to be connected in series or parallel. No series resistances are used, but the field of the generator can be varied. (Page 83.)

A DEMONSTRATION of the action of the Warner non-parallel axle tramcar truck was given on Friday last at the West Ham Corporation Tramway Depôt. (Page 88.)

AT the meeting of the Institution of Electrical Engineers on Thursday, it was announced that the Council had unanimously elected Col. R. E. B. CROMPTON (a Past President) as President for the remainder of the session. Col. Crompton took the chair after this announcement by Mr. C. P. SPARKS, the senior Vice-President, and in a short speech referred to the great loss which not only the institution, but the whole of the electrical industry, had sustained in the death of LORD KELVIN. He thanked the institution for electing him to fill the gap, and said he would do his best to make the session a success, although he was an old man and not so vigorous as he had been. (Page 89.)

AN electrically propelled fire escape of large size, with a telescopic ladder extending to about 90 ft., has recently been put into service at Liverpool. Two motors driving the front wheels are employed, and the battery is mounted directly over the fore carriage. Electrical power is used for erecting the ladder. (Page 89.)

MR. H. HENDERSON, in his Paper read before the Newcastle Local Section of the Institution of Electrical Engineers last Monday, described the equipment of the North-Eastern Railway Co.'s new goods warehouse at New Bridge Street, Newcastle, which utilises to the full the advantages obtainable, especially in the way of compactness of arrangement, by the use of electrically driven apparatus, and described some interesting forms of overhead revolving jib and other cranes, capstans, and wagon hoists. A number of speakers took part in the discussion, and a good deal of interest was shown, especially in the design of the capstan gear. (Page 91.)

MR. G. W. WORRALL read a paper on Tuesday last, at the Manchester Local Section of the Institution of Electrical Engineers, on magnetic oscillations in alternators, in which an account was given of the continuation of a series of experiments described in a previous Paper. A distinction was made between magnetic oscillations due to a pulsation in the magnitude of the flux and "to and fro" movements of the flux, and the conditions under which each in a maximum were investigated. Several oscillograms showing ripples in the P.D. wave, due to these causes, were shown. (Page 95.)

MR. S. W. BAYNES, the Electrical Engineer to the Borough of St. Pancras, has reported to his Council, advising opposition to the London Electric Power Bills, especially on the ground that the passing of either of the Bills would put the companies in a position to supply power in the St. Pancras area. (Page 98.)

ON Wednesday night of last week a Paper on "Electrical Measuring Instruments, and Some of their Weaknesses," was read before the Association of Engineers-in-Charge, by Mr. K. EDGCUMBE, in which the author pointed out that purchasers often did not state the most suitable range, when ordering instruments. He also then dealt with instruments with hold-back springs and a false zero, and remarked that in the testing of glow lamps, it was a waste of time to measure input correctly to 1 per cent. when determinations of candle-power cannot be relied on to about 5 per cent. The moving coil pattern of instrument was recommended for continuous currents, and the moving iron type for alternating currents. A list was given of the accuracies that could be legitimately demanded in the case of various types of switchboard instruments. (Page 99.)

UNDER "Electrical Science, British and American," appear notes on a platinum thermometer for measuring gas-engine temperatures, and on certain properties of selenium. In the Papers abstracted in the Continental section, KURZ discusses the effect of radioactive matter in the atmosphere upon measuring instruments; BLONDIN summarises the present state of the question of nitrogen fixation; and CHAUMAT describes a process for the electrical reduction of indigo. (Page 100.)

UNDER "Electrochemistry" reference is made to methods of electro-plating for obtaining firm and adherent deposits, also special methods in connection with nickel, brass, gold and silver. Experiments with the electrolysis of lead sulphide and a fused lead electrolyte are described, the current efficiency, however, hardly seems sufficiently high for the process to be a success. (Page 101.)

AMONG the specifications published by the Patent Office on Thursday last is one by the BRITISH THOMSON-HOUSTON CO. & DALTON, relating to improvements in the method of control of the electrodes of arc lamps of the converging carbon, or the parallel electrode type. Another specification by KANDO relates to the control of electric motors, or a number of motors, by a specially arranged resistance. C. G. NOBBS and C. G. NOBBS, Jun., have patented a radiator in which the water is boiled by the use of electric iron coil resistances, in the water chamber. Messrs. HOOKHAM & SPRAGUE have an improved method of regulating the train wheels for electricity meters, which ensures correctness of reading of the dials. A patent by POULSEN covers a system of receiving wireless signals. The ATELIERS-THOMSON-HOUSTON have improvements in the commutation of dynamo electric machines. Among the patents which expire during the current week are two of electrical interest, one by THWAITES & CAWLEY relates to a system of electric haulage for use on canals and other waterways, and which expires on January 18th; the other by G. H. WHITTINGHAM relates to an automatic device for removing resistance when starting motors, and replacing when the current is shut off the motor. (Page 102.)

THE Adelaide Electric Supply Co. are to supply the power for the working of the municipal tramways. The Bournemouth Corporation have appealed at the Quarter Sessions against the assessment of the poor

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rate on their tramways system in Poole; the Recorder dismissed the appeal with costs. Brentford Council are not to oppose the Bill for running electric cars across the bridge. At Burton-on-Trent, the advantages of supplying power on the restricted hours principle has been shown in the electricity accounts, as many more units have been sold, although the peak load has practically remained stationary. The Camberwell Borough Council have sent a deputation to the Board of Trade complaining that the County of London Electric Supply Co. did not produce accounts showing the true position with regard to the Camberwell portion of the undertaking. Liverpool has constituted a record for the traffic receipts of its electric tramways. The Hackney Borough Council are inviting tenders for the loan of £34,265, of which £31,815 is required for electricity purposes. At Melbourne, by a fire at the post office stores, the department has lost £20,000 in copper wire and telephone apparatus. The Board of Trade have allowed overhead mains to be used in Merthyr for street lighting purposes. A town meeting of ratepayers of Morecambe have decided against purchasing the tramways in the town, and a poll will also be taken in Belfast with regard to the Bill for purchasing the Cavehill and Whitewell tramway system, to which there is much opposition. (Pages 103 to 105.)

TENDERS are invited by the Australian Postmaster-General's Department for a considerable quantity of telephone material, and also for wireless telegraph apparatus. The Cardiff Corporation requires a 500 kw. motor-generator, the Wimbledon Corporation a 1,000 kw. turbo-alternator, and the Yarmouth Corporation a 400 kw. continuous current traction generator. The East Ham tramways manager is to obtain quotations for top covers to five tramcars, and the London County Council invite tenders for the roadwork in connection with the reconstruction of the Caledonian Road and Seven Sisters Road horse tramways. New telegraph lines are to be constructed in Spain, and further extensions to electrical works are to be carried out in South Africa. Mr. O. F. Francis, of Kirkcaldy, who had been appointed electrical engineer to the Carlisle Corporation, has decided not to accept the appointment in view of an offer from the Kirkcaldy Corporation. The Carlisle appointment is to be offered to Mr. Allen, of Plymouth, who was second on the list of selected candidates. A circular has been issued to the shareholders of the British Westinghouse Electric and Manufacturing Co. dealing with the financial position. It is stated that the eleven months of 1907 to November show a trading profit of £76,000, and a net profit of £17,780, after meeting interest on loans and debenture interest. (Pages 105 to 108.)

IT is to-day almost a truism that the chief engineer and the successful consulting engineer must be able to view every problem, not only from the engineering, but also from the commercial aspect; yet there are constant examples of mistakes—sometimes of a serious nature—due to insufficient importance being attached to one or other of these two points of view. Mr. J. F. C. SNELL'S Paper, read at the Institution of Electrical Engineers last Thursday, is a veritable lesson in modern-day commercial electrical engineering. It deals with matters of a purely technical character, and attaches to each its due importance as an item in a revenue-earning undertaking. The folly of taking for granted that economies are necessarily effected in a manufacturing works by the substitution of power from the mains for independent generating plant, is made as apparent as the necessity for centralisation in general power supply, and the impossibility of approaching the most economical results with a multiplicity of small public generating stations. Mr. Snell's arguments are based on sound and logical reasoning, but, while agreeing with the majority of his conclusions, we feel bound to express the opinion that in one respect his deductions need correction. He gives a timely word of warning against the tendency of reducing to too low a point the prices charged by electricity works for power supply, but he forgets that if the prices charged by existing electricity works were consistently worked out on the basis he gives as correct, the growth of the power load would be so slow a process that the modification of existing generating stations to the most economical working conditions would, in some cases, be indefinitely deferred. If an electricity works manager had only to look forward to, say, a 10 per cent. increase in his output, there is no doubt that, in many of the cases in which Mr. Snell's "correct" charges for power are higher than the actual tariff, the result of the power load increasing more rapidly than the lighting load would mean a decrease in the percentage profit of the undertaking. But those who are responsible for the management of the undertaking must look further forward than this. As Mr. Snell himself points out, a works designed to furnish power on a large scale can supply at much lower prices than those which he characterises as too low. Where, therefore, there is a clear prospect of acquiring a load of such a nature as to enable this ideal to be attained, and to justify the equipment of the works being modified to supply the increased demand on the most economical basis, it would be wrong policy to keep prices up to a value that would be an effectual bar to the desired result. To this extent Mr. Snell's conclusions are at fault.

THE snowstorm last week was not heavy, but unfortunately the air at the time was at that particular temperature which causes the snow to cling to the wires, and to weight them to such an extent as to pull them down, and a large number of interrupted circuits was the result. The south of England was the chief sufferer; many telegraph and trunk telephone wires were interrupted, and the Kent district of the Metropolitan telephone area was also so badly affected that many of the subscribers' lines have not yet been restored. Another serious result was that several overhead fire-alarm wires in the metropolis were pulled down, and a number of false calls were received by the Fire Brigade, who turned out several times to no purpose. This last-mentioned inconvenience, however, is difficult to explain, for every modern and properly constructed fire-alarm system should be so arranged that the signal representing a fire call and that due to earthed wires are perfectly distinguishable. The case is one calling for investigation. As to the telegraph and trunk telephone lines, the delay in traffic that was caused will doubtless result in a resumption of the campaign for additional underground lines, in which the various Chambers of Commerce are usually particularly active. Now that the use of distributed inductance has been proved an effective means of neutralising the effect of capacity on long distance lines, and of rendering possible the use of a smaller conductor than would otherwise have been necessary, we trust that there will soon be a great extension of underground main telegraph and telephone lines. The extra first cost of these has, of course, still to be taken into account, as the large

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majority of new lines can simply be added on existing poles. On the other hand, there should be a substantial saving in maintenance with underground lines, and they need not always be laid in quite such an expensive manner as the present underground trunk cables. The method now employed is so perfectly reliable that, of course, there must be some disinclination to modify it, but still it is quite probable that a less costly and equally efficient system could now be evolved, with the experience which the Post Office engineers must now possess.

THE story of the collision at West Hampstead station of the Metropolitan Railway last October, which was told by those concerned in the working of the trains at the inquest, at the Board of Trade inquiry, and again before a police magistrate, was once more repeated in the Central Criminal Court on Friday, when the signalman at West Hampstead was on his trial for manslaughter. Although the question of whether the unfortunate man actually tampered with the release box of the signalling instruments was never satisfactorily settled, it was admitted on both sides that the death of the three men in the train was due to the signalman's negligence, and that he had broken rules which, if kept, would have prevented the catastrophe; and even the prisoner's counsel virtually admitted that the man had told a lying story in the witness box. The "seventeen movements" which, it was said by his counsel, the prisoner had to perform "between each train," were given an exaggerated importance. It was not possible by performing one of these seventeen "movements" incorrectly to cause any more serious result than the stopping of a train, and such a mistake could not have caused the disaster. The fine point to be settled by the jury was whether the negligence could be described as "gross and culpable," and the result was that they gave the man the benefit of some doubt which appears to have arisen in their minds. They were doubtless considerably influenced in their decision by the judge, who almost directed them to return a verdict of not guilty; in doing so he was assuming a grave responsibility, for the fact that the signalman will not have to take the full consequences of his serious negligence cannot but have a bad moral effect on others in whose hands the safety of the travelling public may rest. The verdict comes as a strange contrast to a sentence passed by the same judge, in a case heard the previous day. He imposed a heavy sentence of imprisonment on a motor-car driver who had been unsuccessful in avoiding an old woman wandering about in the public road.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, JANUARY 16TH.

Royal Society.

4.30 p.m. Meeting at Burlington House, Piccadilly. Among the Papers down for reading are the following:—(1) "Alternate Current Measurement," by Dr. W. E. Sumpner, communicated by Prof. John Perry, F.R.S.; (2) "The Conversion of Diamond into Coke in High Vacuum by Cathode Rays," by Hon. C. A. Parsons, F.R.S., and A. A. Campbell Swinton; (3) "Preliminary Note on Certain Phenomena of the Electric Discharge through Rarefied Nitrogen," by Dr. G. J. Burch, F.R.S., J. E. Marsh, F.R.S., and R. de J. F. Struthers.

Union Electric Co.

7 p.m. Staff dinner at the Café Royal, Regent Street, London.

Rugby Engineering Society.

8 p.m. Ordinary meeting. Paper to be read:—"The British Locomotive," by A. W. S. Graeme.

Institution of Electrical Engineers.

8 p.m. Extra meeting at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W. The discussion upon Mr. J. F. C. Snell's Paper, "Cost of Electrical Power for Industrial Purposes," will be continued.

FRIDAY, JANUARY 17TH.

Royal Institution.

9 p.m. Evening Discourse by Prof. T. E. Thorpe, F.R.S., on "The Centenary of Davy's Discovery of the Metals of the Alkalis."

SATURDAY, JANUARY 18TH.

Institution of Electrical Engineers: Students' Section.

10 a.m. Visit to the works of Messrs. Elliott Bros. & Co., Lewisham.

Royal Institution.

3 p.m. Afternoon Lecture I., on "The Electrification of Railways," by Prof. Gisbert Kapp.

THURSDAY, JANUARY 23RD.

Institution of Electrical Engineers: Leeds Local Section.

7.15 p.m. Meeting at the University, Leeds. Paper to be read:—"Notes on the Development of Turbo-Alternators, by Dr. Pohl.

Institution of Electrical Engineers.

8 p.m. Meeting at the Institution of Civil Engineers, 25 Great George Street, London, S.W. Paper to be read:—"Standard Performances of Electrical Machinery," by Rudolph Goldschmidt.

FRIDAY, JANUARY 24TH.

Physical Society.

5 p.m. Ordinary meeting.

SATURDAY, JANUARY 25TH.

Royal Institution.

3 p.m. Afternoon Lecture II., on "The Electrification of Railways," by Prof. Gisbert Kapp.

THE WEST HAMPSTEAD ACCIDENT

THE trial of William John Hollis, signalman on the Metropolitan Railway, for manslaughter of the three men who lost their lives owing to the collision between two electric trains at West Hampstead on the morning of October 26th last, came on at the Central Criminal Court on Friday before Mr. Justice Bigham.

Mr. R. D. Muir, for the Public Prosecutor, with whom was Mr. Arthur Gill, opened the case and submitted that there had been a wholesale neglect of rules on the part of the prisoner, and that if these rules had been obeyed the accident would not have happened. The prisoner had attempted to account for his negligence by declaring that a certain electrical instrument had failed to work, but there were inconsistencies in his attempts to substantiate the statement, and the prosecution alleged that there were three distinct untruths in his account of how the accident had taken place. Counsel then detailed the circumstances of the accident, which were fully reported in ELECTRICAL ENGINEERING, Vol. II., pages 672 and 685, pointing out particularly how Hollis, according to his own account, had thought he had heard the train in question pass in the fog, and had "offered" it to Boggis, the signalman at Kilburn, who had accepted it, whereas Boggis had sworn that it had never been offered to him. The incorrect method of entering the times of the trains in the book was also mentioned. Evidence was then called, and E. Boggis, signalman at Kilburn, deposed as to not having been offered the Willesden Green train of Hollis. J. Spittle, driver of the Willesden train, said that the starting signal had not been lowered until after the collision; and Benjamin Smith, driver of the oncoming train, gave his account of what had occurred. Edward Lyon, chief traffic inspector, and William Fitch, station foreman at West Hampstead, also gave evidence; and William Shepherd, the signalman who relieved Hollis after the accident, said that although the prisoner had told him that the disc instrument had broken down, it had worked quite well when he had tested it. Edward Phillips, engineer to the Metropolitan Railway, also said that there was nothing in the instrument to account for any failure; he considered that the release box must have been used. His theory was that Hollis had forgotten the train, and thought he had started it off, because the disc still indicated "train on line." He thought that he must have pulled back the lever prematurely. Then by some means he got to the release box and released the instrument. In reply to the Judge, witness said that in his opinion the negligence lay in not ascertaining whether the line was clear by personal observation.

The prisoner gave evidence on his behalf. He said that he had accepted the Willesden Green train, and it came into the station. He then offered it to Boggis, by whom it was accepted. He pulled off the starting signal, and immediately the disc

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showed line clear. He then accepted the Neasden train from Finchley Road. Witness denied having in any way tampered with the release box. Mr. Jenkins, for the defence, in addressing the jury, said that the fact the prisoner was lying did not prove the case against him. Having regard to the numerous duties he had to perform, a signalman might well make a mistake. He had three or four discs to look after, and no less than seventeen movements to perform between each train.

Mr. Justice Bigham, in summing up, said that what the jury had to determine was whether the deaths of these people were due to the gross and culpable negligence of the defendant. His own opinion was that Hollis was careless, that he ought to have known, and if he had taken proper precautions he would have known that the Willesden train was in the station at the time he permitted the Neasden train to come into the station, and that the story he had told that day was a story of made-up excuses. Nevertheless, the best of us made mistakes and were negligent at times, but an occasional act of negligence, even though it resulted in death, ought not to bring upon a man the terrible consequences of a conviction for manslaughter.

The jury found the prisoner not guilty, and he was discharged.

Institution Glasgow Local Section.—The annual smoking concert takes place on Saturday, February 1st. Tickets (1s. each) can be obtained from the hon. local secretary, Mr. J. E. Sayers, 157 West George Street, Glasgow.

Paris-Morocco Wireless Telegraphy.—Wireless telegraphy has been established between Casa Blanca and Paris. On January 12th, at midnight, a telegram was received for the first time at the Eiffel Tower from Casa Blanca. The telegram was sent from the armoured cruiser *Kleber*, and announced the arrival of the vessel and the landing of the engineers. Henceforth there will be direct communication between Casa Blanca and Paris. The distance between the two places in a straight line is 1,900 kilometres, or 1,200 miles.

The Glasgow Tramway Accident.—Colonel Yorke, of the Board of Trade, held an inquiry at Glasgow, on Tuesday, into the cause of the runaway tramcar accident which took place on January 3rd, and which has resulted in the death of two persons and serious injuries to twelve other people. It was stated that the cars were inspected carefully every third night, and that this particular car was inspected on January 1st, and was found to be in perfect order. The conductor of the car said that he and the deceased driver took over the car at 5 p.m. on the afternoon of the accident, and had done three journeys previous to the car running away, and everything was in order. When they were about to commence the down-hill journey, they found the reversing handle would not come off. A timekeeper, another driver, and a motor inspector all tried it, but it remained fast. At the top of the steep hill in Hill Street, the car was under control, but a moment or two later the driver lost control. The conductor did not apply the hand brake, as he thought it might prevent the working of the magnetic brake, and he was not supposed to apply the brakes without instructions from his driver. He applied the brakes at Glasgow Cross, and managed to stop the car. It was afterwards demonstrated that the car was under complete braking control except for the reversing handle, and there was nothing in the condition of the car to account for the accident. The inquiry was closed, and Colonel Yorke will issue his report in due course.

Claim Against the London United Tramways, Ltd.—In the King's Bench Division on Monday, Mr. Justice Jelf delivered considered judgment in the case of Zick *v.* the London United Tramways Co., Ltd. This was an action by the plaintiff, a furniture dealer, of 84 Merton High Street, Wimbledon, for damages for trespass. On behalf of the Tramway Company it was maintained that they were authorised under an Act of Parliament to acquire the forecourt of the plaintiff's premises for the widening of the roadway. On May 25th, 1905, they served notice upon the mortgagees, who were in possession of the forecourt, for the purpose of their interest. On the date the plaintiff was not the occupier, and had no interest in the premises, but notwithstanding the service of this notice, the mortgagees purported to grant an interest to the plaintiff by means of an agreement of tenancy. Plaintiff contended that the defendants were liable to him for damages for trespass, and that he was entitled, under the Lands Clauses Act, to compensation for the compulsory taking of the forecourt as regarded his interest in the premises down to March 14th, 1903; and, on the other hand, the defendants submitted that after the date of the service of the notice to treat for the purchase of the forecourt the landlord could not create any fresh tenancy, and that the original tenancy had been surrendered by the operation of the law on the ground of the new tenancy. On the date of the alleged trespass, therefore, the plaintiff had no interest. The plaintiff did not hold under the original tenancy, and this new tenancy was invalid against the defendants. His Lordship held that the plaintiff had a *prima facie* title, and that the defendants had failed to displace it. He therefore gave judgment for the plaintiff for 40s. damages and costs, and declared that he was entitled to benefit under the Lands Clauses Act for his interest for the period ending March 14th, 1908.

REVIEWS OF BOOKS

The Patents and Designs Act, 1907. By James Roberts and H. Fletcher Moulton. 128 pp. 9½ in. by 6 in. (London: Butterworth & Co.). 4s.

IT is often said that an Act of Parliament can never be rightly interpreted until a few actions under its provisions have been decided in the law courts, and until one or two important cases at least have been the subject of appeal to the House of Lords. In the interval that must of necessity precede this complete interpretation, such books as the one under review are of extreme utility. Generally speaking, the Patents Act of 1907, which came into force on January 1st, 1908, is clearly drafted, but the authors of the present treatise point out some pitfalls by which the unwary may be entrapped, and some short clauses which it is of considerable importance not to overlook. Among these may be mentioned No. 33, which provides that although a patentee can always obtain an injunction against an infringer of his patent, he is not entitled to recover damages from any defendant who proves that he was not aware, and had not reasonable means of making himself aware of the existence of the patent. The remainder of this clause *may* be taken to imply that marking the patented article with the word patented or patent, together with the number and date of the patent, is sufficient notice to any potential "innocent" infringer; but the authors are not quite satisfied that this is the proper construction to be placed upon it. Moreover, this marking will obviously not enable the patentee to obtain damages for infringement which takes place before he has himself started the manufacture of the article in question, and it will thus be to his advantage to publish a notice announcing his invention in his technical journal, as the printed specification obtainable at the Patent Office will not necessarily be seen by all who are at work in the same direction. Fortunately, as the authors point out, the onus of proving absence of "reasonable means" of knowledge will rest with the defendant, who can be cross-examined if the case comes before the court.

On the question of compulsory licences, the authors point out that the provisions for these in the Act of 1902 proved to be practically a "dead letter." They do not commit themselves to any definite opinions as to whether the new Act will be more workable in this respect. Their comment on the section which provides for the revocation of a patent worked exclusively outside the United Kingdom is also guarded, but the meaning of the section is clearly explained, and, in the note to it, the interesting fact is stated that, out of 14,700 patents issued in 1906, 6,500 were granted to foreigners.

Those who are entering into agreements for the sale of patents or issue of licences should read the note in this book to Section 38, the section which makes it unlawful to make certain restrictions a condition of the sale or licence. It is pointed out that an extremely broad interpretation could be placed upon this, and, as it is an entirely new clause, particular attention should be directed to it.

We have said enough to show that Messrs. Roberts and Fletcher Moulton's book will be of great assistance to all who have to do with matters concerning patents. The book was published before the end of last year, and before the issue of the Patent Office rules under the new Act, and thus it happens, unfortunately, that the forms which the patentee and others have to make use of are all referred to by their old reference letters. This can, however, easily be corrected in the second edition of the work, which will doubtless soon become necessary.

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"The Mechanical World" Pocket Diary and Year Book for 1908. 295 pp. 6¼ ins. by 4 ins. 60 illustrations. (Manchester: Emmott & Co.) 6d.

OWING to the introduction this year of a separate pocket-book dealing with electrical matters, it has been possible to omit the notes on electrical transmission of power, which formed a feature of previous editions of *The Mechanical World* Pocket Diary, and therefore to find room for a certain amount of fresh matter. This has enabled new sections to be added dealing with condensing plant, superheating, and friction clutches, while the information relating to reverberatory and reheating furnaces has been rewritten and extended. A few new tables have also been added. About half of the 130 pages of engineering information is devoted to matters connected with steam and steam engines, and the remainder, after short sections on gas and oil engines, relates to strength of materials, gearing, and other matters of general interest to engineers. Altogether the book, which for its size contains a good deal of useful matter, is an excellent sixpennyworth.

The Mechanical World Electrical Pocket Book for 1908. 176 pp. 6¼ in. by 4 in. 50 illustrations. (Manchester: Emmott & Co.) 6d.

THIS new addition to the many portable storehouses of information is a companion volume to the "Mechanical World Pocket Diary and Year Book," and is arranged in similar form, with engineering information at the earlier part of the book, while the latter portion forms a diary. The purely electrical section is mainly of a practical nature, and, on the whole, the proportion between the tabular, the obvious, and the descriptive has been well maintained, and the compilation being a new one does not suffer as many do from lack of courage on the part of the reviser as regards replacing the historical by the up to date. After the preliminary dealing with C.G.S. units, grouping of battery cells, the dynamo and motor are rapidly introduced, and a section deals with alternating currents in a brief way. Matter of a more practical nature follows, including a useful table of the approximate horse-power required to drive various classes of machinery, and hints on the management of dynamos and motors, with table of dynamo and motor defects and remedies; sections on wiring and instruments follow. Among the pages on electric lamps and lighting, various typical forms of arc lamp are described. Short sections deal with electric welding, electric cranes, and electric pumping. Following the electrical section are some notes of motive power and gearing, and some general tables.

Fowler's Mechanical Engineers' Pocket Book, 1908. Tenth edition. 675 pp. 6¼ by 3¾ in. (Manchester: Scientific Publishing Co.). Cloth 1s. 6d., leather 2s. 6d.

IN the latest edition of this popular annual for engineers, both general and electrical, the contents have been thoroughly revised, and it has been found necessary to leave out a good deal of matter connected with machine tools and processes, and buildings and materials, to make room for a much more extensive and comprehensive section on steam boilers and engines. A new section on pumps and pumping machinery has also been added. The volume exceeds previous editions by over 100 pages. The new section dealing with steam turbines forms a complete classification of all the principal types now in use, and a general description is given of the peculiarities of construction, the different effects of the vacuum, superheat, of initial steam pressure, and effects of load. This section will be of interest to engineers in charge of large lighting plants, where these types of plant have been installed. In addition to its utility as a general book of reference it is invaluable, treating, as it does, on almost every kind and detail of general engineering.

The Science Year Book, 1908: Diary, Directory, and Scientific Summary. 500 pp. 9¼ in. by 6 in. (London: King, Sell & Olding.) 5s.

THE 1908 issue of the "Science Year Book," edited by Major B. F. S. Baden-Powell, repeats the useful features of its predecessors, including the convenient form of calendar, directory of public institutions, scientific societies, &c. A quantity of useful tables and information are given, dealing to a large extent with astronomy, and this section has been revised and brought up to date. A brief summary of scientific progress during 1907 is included, but the wide field covered in a small space prevents this being more than very superficial. The list of technical journals contains several mistakes. Some additional notices have been added to the biographical directory. The latter part of the volume forms a diary with a whole page for each day.

Institution Manchester Local Section.—The meeting announced on the syllabus for January 21st, when Mr. C. H. K. Chamen was to have read a Paper on "High Voltage Transmission and Distribution," has, owing to unforeseen circumstances, been cancelled, and consequently no meeting will now be held on that date.

CORRESPONDENCE

OSRAM LAMPS FOR STREET LIGHTING.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—With reference to the description of Eastbourne Electricity Works appearing in your current issue, it is stated, on page 55, that Osram lamps are being used to replace alternating current arc lamps for street lighting. I believe this plan will be largely followed in the near future, so it would be very interesting, if you could give particulars and illustrations of the arc lamp-posts fitted with Osram lamps, and the precise reasons that brought about this change.

I look forward to doing the same here, because Osram lamps throw the light in a horizontal direction, so lend themselves with more advantage to outdoor lighting than interior lighting. Again, when made in 100 or 200 c.p. sizes the filaments will not be so fragile, and their cost ought to be comparatively less than that for the smaller sizes, as their manufacture would involve less delicate work.

Jan. 10th, 1908. MANAGER.

[Our correspondent has slightly misunderstood the arrangement for the addition of brackets to the arc lamp-posts at Eastbourne. The Osram lamps are merely used as half-night lamps, and do not replace the arcs. Osram lamps alone are, however, being increasingly used in the 100 c.p. size for street lighting. A notable example is Exeter, where this has been done for nearly two years, and the average life has been found to be about 1,200 hours. The 100 c.p. Osram lamp is now made up to 130 volts, and consumes 105 watts. A 200-volt 100-c.p. lamp will be on the market in a month or two. There is a little difficulty in obtaining quick deliveries of large quantities of 100 c.p. lamps, but this will disappear as soon as the arrangements for manufacture in this country are completed. We believe the 100 c.p. lamp is listed at 8s.—ED. E.E.]

German Government Wireless Telegraph Monopoly.—A Bill was introduced last week into the Reichstag amending the Telegraph Law of 1892. It provides that plant for the transmission of messages without the use of wires shall not be erected or worked except with the consent of the Government.

Faraday House.—The following special courses of lectures have been arranged:—"Electrical Legislation," by Mr. Robert Hammond; commenced January 15th; "Dynamo Design," by Professor C. A. Carus-Wilson, commencing January 20th; and "Secondary Batteries," by Mr. W. R. Cooper; commenced January 14th.

Telefunken System of Wireless Telegraphy.—A Reuter telegram from Nauen states that great improvements have been made in the station there. The experiments already made this year show quite exceptionally good results. Telegrams have been received at Nauen from a small portable military station at Kornenburg, near Vienna, whilst the steamship *Cap Blanco*, of the Hamburg South American line, on the voyage from Hamburg to Buenos Ayres daily received telegraphic news from Nauen. The last telegram reached her at Teneriffe, when she was eight days out from Hamburg. The distance to Teneriffe is about 2,300 miles.

Disregard of Tramway Regulations.—A sequel to the tramway accident at the junction of City Road and Old Street on December 28th (ELECTRICAL ENGINEERING, January 2nd, p. 18) was the appearance before the magistrate at Old Street police court on Saturday, of the driver of the electric car which smashed into a horse-drawn car. The charge preferred against him was that he crossed the City Road at this point at a speed of about 10 miles per hour, whereas the Board of Trade Regulations stipulate a compulsory stop there. The defendant, in giving evidence on his own behalf, said he applied the magnetic brake according to directions when approaching the crossing in question, but the brake failed to act. Before he could apply the hand brake he had collided with the horse car. The magistrate came to the conclusion that there had been some carelessness on the part of the driver, and fined him ten shillings and two shillings costs.

Telegraph Traffic.—The West India and Panama Telegraph Company have again been unfortunate, as we have to record the interruption of their cable between Trinidad and Demerara on the 8th instant. This will be repaired by their own steamer, the *Henry Holmes*. The French company owning the cables between Paramaribo and Cayenne and San Domingo and Curacao also have to undertake repairs, as the latter cable failed on the 11th, but was again carrying traffic on the 15th. Since the Venezuelan Government closed their Curacao-Coro and Curacao Le Guayra sections, they have had to transmit telegrams to Curacao, and there post them to addresses in Venezuela, telegrams having to be fully addressed for this purpose. The Paramaribo-Cayenne cable, like its sister the Cayenne-Salinas cable, is sometimes interrupted for a year or more at a time. The French company also have their own repairing vessel on the spot. No news has yet come to hand of the repair of the Brest-Dakar cable, in connection with the repair of which great difficulties are being experienced. The *via* Fao route has also again been in difficulties, and was inoperative on the 11th inst.

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COST OF ELECTRICAL POWER FOR INDUSTRIAL PURPOSES

A PAPER read by Mr. John F. C. Snell before the Institution of Electrical Engineers last Thursday dealt with the commercial aspects of electric power supply from the engineer's point of view. In introducing the subject, the author enunciated four axioms :—

1. There is generally a critical load factor and size of plant within which no outside supply can hope to compete with a user's local plant; *i.e.*, at and beyond this critical point a user can produce more cheaply from his own plant.
2. Whatever the pressure of transmission, or whether by underground cables or overhead lines, there is a real limit to the economical radius of distribution from any power station, which is much less than is usually advanced by power company promoters.
3. Minimum outlay of capital, which is indispensable in power supply, can only be obtained in the power house by the centralisation of large units. But this can be neutralised in any particular case, and the capital per kilowatt raised beyond the critical value, by attempting tranmission over too great a distance.
4. Successful power supply depends upon—(*a*) the geographical positions of the user and supplier, because the capital cost of the supplier's plant, *plus* transmission and transformation, may exceed the capital cost of the user's own plant; and (*b*) the resultant diversity factor arising from multiplicity of industries. Arising from this latter point, great care has to be exercised in the districts where the industries are all practically of one nature, for the diversity factor will be almost *nil* in such cases.

Referring briefly to lighting, Mr. Snell pointed out that the effect of power supply super-added to lighting supply must of necessity reduce the general cost of production, because of the greater resultant diversity factor and consequent improved load factor. In this country he estimated that 2d. per unit may eventually be reached, as an average cost of lighting units. This reduction of price, he added, cannot be compared with the importance of a probable reduction of energy per candle-power from 4 watts to, say, 1·5 watts. Moreover, the price of lighting must always be considerably in excess of average power prices, both because of its lower load factor and also of the greater cost of low-tension distribution systems and requisite service connections

In the first part of his Paper the author examined the alternative sources of power supply to that furnished by an electric power company or other large central electricity supply authority. Table I. sets forth the cost at various load factors of gas engines supplied with town gas, suction gas engines, oil engines, and small local steam plants of from 20 to 100 h.p. with generators and auxiliaries. These figures have been obtained from actual users; they are not merely test figures, which afford no real criteria of the commercial working of such plants, nor are they figures of obsolete engines, which would be unfair to take as a basis.

TABLE I.

Ascertained Cost of Power per Unit Generated for Independent Installations up to 100 H.P.

Annual Load Factor	Equivalent Hours per Annum.	Town Gas at 2s. per 1,000 cub. ft.	Suction or Producer Gas.	Oil.	Steam.	Average Costs.
Per cent.		d.	d.	d.	d.	d.
10	876	1·423	1·520	1·286	1·322	1·388
15	1,314	1·210	1·270	0·972	1·031	1·121
20	1,752	1·090	1·040	0·813	0·876	0·954
25	2,190	1·007	0·904	0·715	0·806	0·879
30	2,628	0·944	0·812	0·650	0·705	0·778
35	3,066	0·892	0·744	0·600	0·646	0·720
40	3,504	0·844	0·694	0·563	0·598	0·675
50	4,380	0·791	0·625	0·511	0·542	0·617
60	5,256	0·745	0·576	0·475	0·498	0·574
70	6,132	0·706	0·540	0·448	0·460	0·538
80	7,008	0·670	0·514	0·426	0·429	0·500

Town gas is taken at an average price of 2s. per 1,000 cub. ft. In the case of suction or producer gas engines, anthracite coal, it is assumed, costs 22s. per ton, or small peas 10s. per ton; the price of oil is taken at 42s. 6d. per ton. For water an average price of 6d. per 1,000 gallons is reckoned; repairs and lubricating oils are taken from actual figures. The depreciation and interest on capital outlay are taken throughout at 10 per cent. These are the real figures with which manufacturers debit themselves, but it is pointed out that in nearly every case there is no proportionate charge for supervision or general establishment charges, or for rating. Attendance is frequently not debited to the cost of power, and, therefore, on all points the figures given are decidedly fair to these sources of power, and are even somewhat unfair to electricity supply.

Table II. sets out comparative figures for larger and less frequent installations of 100 to 500 h.p.

TABLE II.

Ascertained Cost of Power per Unit Generated for Independent Plant from 100 to 500 H.P. Installed.

Annual Load Factor.	Equivalent Hours per Annum.	Suction or Producer Gas.	Oil.	Steam.	Average Costs.
Per cent.		d.	d.	d.	d.
10	876	1·273	1·007	1·086	1·122
15	1,314	0·944	0·778	0·811	0·844
20	1,752	0·760	0·656	0·673	0·690
25	2,190	0·670	0·584	0·590	0·615
30	2,628	0·596	0·536	0·534	0·555
35	3,066	0·540	0·498	0·494	0·511
40	3,504	0·502	0·469	0·464	0·478
50	4,380	0·447	0·430	0·421	0·433
60	5,256	0·406	0·404	0·393	0·401
70	6,132	0·377	0·382	0·373	0·377
80	7,008	0·358	0·366	0·357	0·360

In the second part of the Paper are given actual statistics of independent tests (mostly by the author himself) of different industrial plants, and a comparison shows that the figures in Tables I and II are, if anything, on the low side.

Graving Docks.—In a certain electrically driven pontoon, which is capable of berthing vessels up to nearly 4,000 tons displacement, the pumps are four in number, and are electrically driven centrifugal pumps, each 18 in. diameter. The following are official figures obtained when actually docking a vessel of 2,600 tons :—

Tons of water pumped	3,875
Maximum head on pumps	27 ft.
Average head on pumps	16 ft.
Time taken to empty	25 minutes
Cost of power supply (outside source) ...	1·375d. per unit
Number of units consumed	123

The actual total cost per ton of vessel docked was :—

Power	0·064d.
Wages, &c.	0·100d.
Interest and depreciation at 10 per cent.	0·159d.
	0·323d.

Another case taken for comparison was that of a graving dock driven by two gas engines, 40 h.p. each, each driving horizontal centrifugal pumps, each 21 in. diameter, with a capacity of 9,320 gallons per minute, with a maximum head of 28 ft. and an average head of 17 ft. The following are the data when docking a vessel of 1,760 tons :—

Tons of water emptied	10,632
Time taken to empty	128 minutes
Cost of gas per 1,000 cub. ft.	1s. 6d.
Gas consumption	4,600 cub. ft.

The actual cost per ton of vessel docked was :—

Power	0·046d.
Wages, &c.	0·412d.
Interest and depreciation at 10 per cent.	0·587d.
	1·045d.

The Paper continued : It will be observed in this comparison that the graving dock represented a much longer run and a better load factor, and yet the cost of docking by gas-driven plant was three times that of electrically driven plant. It is fair to say, however, that the electrically driven plant is of recent design, whereas the gas plant cannot be said to be modern. The author stipulated that during "peak" loads in the restricted winter months, only one-half of the pumps should be worked, the docking on these occasions, therefore, taking approximately twice the usual time. The occasions when this restriction had to be enforced were few.

In the above-cited gas installation, the price being so low per 1,000 cub. ft., it is improbable that any great economy would have been gained from an independent suction or gas-producer plant.

Dock installations require an extensive system of jib and other cranes, capstans, and other auxiliaries. These, however, are so demonstrably better than hydraulic cranes and capstans, both in speed of working and annual cost, that it is unnecessary to dwell upon them The author has been associated with an exten-

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sive application of 3-phase power to travelling jib cranes and capstans, which have been both successful and economical. It it found that plant of this description has a very low annual load factor, consumes but few units, and brings in a very small revenue. Care has, therefore, to be exercised in fixing prices for such a supply.

Shipyards.—A comparison was next made by the author of the actual costs of gas-driven and steam-driven local plant of two neighbouring shipyards. Both the yards were electrically equipped, the local generating plant in the one case being driven by gas engines supplied from the town mains and in the other by modern steam engines.

In the gas-driven plant the following data were given by the authorities themselves, and carefully checked by the author :—

Duration of test, 4 months; ordinary working conditions.
Number of gas engines, 3.
Total b.h.p., 360.
Total kilowatts, 225.
Belt-driven shunt-wound dynamos, 230 volts.
Maximum load recorded on switchboard, 207 kw.
Total units generated, 83,125.
Load factor, 14 per cent.
Cost of gas, 1s. 6d. per 1,000 cub. ft.

The cost of power actually ascertained (but excluding any item of supervision, general establishment charges, or rating of machinery) was as follows :—

	£	s.	d.
Gas, 3,000,828 cub. ft.	225	0	10
Engine and dynamo oils	24	1	7
Water at 6d. per 1,000 gallons	2	0	0
Waste and stores	5	9	10
Repairs (material	5	16	8
Attendance and repairs (labour)	84	12	1
Interest and depreciation at 10 per cent.	60	0	0
Total cost for 4 months	£407	1	0

representing a total cost per unit of 1·173d. It is only fair to point out that the item "attendence and repairs (labour)" is an excessive one, but the figures are, nevertheless, a statement of fact.

Attention is also called to the large gas consumption, which amounted to 36 cub. ft. per kilowatt-hour, a large figure, even on so low an annual load factor as 14 per cent. The plant load factor was 48 per cent.

In the case of the neighbouring independent steam-driven plant in a combined shipyard and engine works, the following figures were obtained :—

Duration of test, 1 year; ordinary working conditions.
Four triple expansion condensing steam engines, high speed, enclosed, each 250 h.p. Total, 1,000 h.p., 672 kw.
Cooling towers.
Boiler pressure, 160 lb. No superheat. Marine boilers, close to engines.
Maximum load observed, 504 kw.
Total units metered at switchboard, 891,655
Load-factor, 22 per cent.
Class of coal used, small at 11s. per ton.
Lb. of coal per unit generated, 7·3.

Cost of generation :—

	£	s.	d.
Labour	665	0	0
Coal, 2,924 tons at 11s.	1,608	11	11
Feed water	59	0	6
Circulating water and make-up	31	19	6
Lubricating oils	58	8	5
Repairs and general stores	141	2	10
Interest and depreciation at 10 per cent.	1,042	6	4
	£3,606	9	6

representing a total of 0·97d. per unit generated.

A shilling per ton rise or fall in the price of coal per ton would have raised or lowered the price per unit by 0·39d., or 4 per cent. The condensing appliances were somewhat faulty, and better figures would have been obtained with an improved vacuum, and with superheat.

In another case of an engine works driven by modern enclosed engines, representing a total of 1,000 h.p. with a load factor of 24 per cent., and where there were both superheat and a good vacuum, the author obtained the total figure of 0·71d. per unit metered at the switchboard.

In the above case 0·97 per unit generated, even with small coal, is admittedly a high figure, and could be reduced on test. The author's experience, however, leads him to think that whatever may be the results obtained on test—whether with gas or oil engines or steam—the consumers do not give that attention to the upkeep of their plant which might be expected, and the figures quoted are really reasonable average figures obtained in practice, and this is an argument in favour of generating plant being in expert hands in a centralised power station.

Paper Mills.—The following are particulars of a paper mill which came under the author's notice. He points out that the figures could undoubtedly have been improved upon, as some of the boilers were low pressure (80 lb.), and could have been replaced with advantage by high-pressure boilers. On the other hand, this paper mill is a successful one, and typical, the author believes, of very many throughout the country which offer a field to electrical enterprise :—

Duration of test, one year; ordinary working conditions.
Number of engines, 25. Total b.h.p., 1,820.
Total cost consumed for power driving, 17,680 tons.
Average horse-power, 1,760.
Running hours per annum, 7,000.
Total h.p.-hours, 12,320,000.
Annual load factor, 79 per cent.

The cost of power was as follows :—

	£
Coal	9,724
Oils and stores	156
Wages	1,524
Repairs	700
Interest and depreciation at 10 per cent.	2,730
	£14,834

representing 0·29d. per h.p.-hour, or an equivalent of 0·41d. per unit generated. In paper mills, boilers have to be installed in any case, and much coal used, for boiling the esparto grass, heating and drying the pulp, and heating the calenders. In this case, out of a total of 26,000 tons used per annum, no less than 8,320 tons were used for heating and drying purposes, the balance being required for power.

The works in question have in addition to the grass boilers, washers, and calendering machines, all of which require live steam, paper-making machinery, half-strip machines for straining, beaters, cutting and rolling machines. There are thus a number of machines which are usually at some distance from the main drive. These auxiliaries, which represent from 10 to 15 per cent. of the total power, and are usually from 10 to 30 h.p. each, could certainly be driven more economically by electrical means, either from generators driven from the main mill engines, or supplied independently from an outside source.

Works of this class have so high an annual load factor, and, in the author's opinion, are of such a size and nature that it becomes a difficult problem for a central power supply (unless of very large dimensions) to compete successfully with the manufacturer's own plant, more especially as the very nature of this day-and-night load does not permit of any improvement of the general diversity factor at the power station.

The author calculated that this consumer could have reduced the annual cost by 20 per cent. by installing high-pressure boilers, and by substituting motors for the wasteful steam engines situated at the outskirts of the mill. This would have reduced the cost of the manufacturer's own power from his own plant to an equivalent of 0·33d. per unit.

Jute Mills and Cotton Mills.—A jute mill is another difficult class of factory for the successful competition of electricity, and is very similar to cotton and other textile mills. The running hours are usually about 2,750 per annum, and the load is practically constant. This represents an annual load factor of 32 per cent., but a plant load factor of 92 per cent.—thus the cost of power is exceedingly low.

In an actual modern mill having a total horse-power of 990, the annual costs were as follows :—

	£
Coal	1,444
Water	124
Wages and repairs	720
Interest and depreciation at 10 per cent.	1,350
	£3,638

which is equivalent to 0·37d. per h.p.-hour. On an annual output of 2,284,500 h.p.-hours, this is equivalent to a price of 0·48d. per unit.

In this class of mill the main engines represent about 83 per cent. of the total power installed, the remaining 17 per cent. being made up of auxiliaries scattered about the place, which it would certainly repay to equip with motors, not only because of their isolation from the main drive, but also because the auxiliaries generally require to run for longer periods than the main engines in order to keep pace with the output from the spindles, spinning frames, and general machinery. It is interesting to know that in a mill of this description the shafting losses represent 25 per cent. of the total power. Regularity of

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speed is absolutely essential, and a 3-phase motor is the most beautiful application possible, not only giving regular speed, but also freedom from fire risk, which is important in this class of works.

Mr. Wilson,* in 1905, quoted some figures of a new mill engine, whose full-load diagram was 738 i.h.p., and the light-load friction diagram 300 i.h.p., showing an apparent efficiency of only 59 per cent. In such a case there must obviously be a good opportunity for electrical driving. He went on to say that the total cost per i.h.p.-year comes out to something of the order of £2 5s. to £2 10s. for large mills, *i.e.*, equivalent to £3 to £3 7s. per kilowatt-year, and in the case of small mills from £3 7s. to £4 7s. per kilowatt-year. Although he does not give the figure, this really means that, based upon the usual running hours of 2,700 per annum, the cost per unit ranges from 0·257d. to 0·287d. for large mills, and from 0·287d. to 0·375d. for smaller mills. These figures appear to the author to be too low. It is obvious, therefore, that only by the greater efficiency of electrical driving, *i.e.*, by competing with the cost per useful horse-power at the spindles, &c., can these mills be successfully dealt with by electrical power. If the 59 per cent. efficiency mentioned above is, however, a usual figure, there can be no question that the cost of providing motors could be successfully met.

In the investigations of jute mills the author has not been able to make the friction losses greater than 30 per cent., and information on this point from engineers who have to deal with mills will be of value.

Collieries.—Several figures have been quoted recently as to the cost of independent plants at collieries, but the author may be excused for quoting the following figures again in order to complete this list of possible large power users.

In a Paper† read before this Institution, Mr. C. P. Sparks quoted the following figures for the installation at the Powell Duffryn Collieries :—

Power house, 3,000 kw. installed.

Average horse-power of motors at work—

Haulage	2,900	h.p.
Winding	180	,,
Fans	380	,,
Pumps	340	,,
Screens	240	,,
Auxiliary motors	480	,,
	4,500	

Total cost—

Power house	£11·5
Distribution and sub-stations	2·6
	£14·1 per kw. installed.

Annual output in units, 4,800,000.
Average load factor, 36 per cent.
Coal consumption per unit, 3·7 lb.
Cost of coal, 5s. per ton.

The cost of power was as follows :—

Running cost	0·18d
Interest and depreciation, 10 per cent. on £34,000	0·17d.
Total cost	0·35d.

In such a case, Mr. Snell continued, it would appear to be impossible for an outside power supply to compete successfully with the colliery's own plant; for reference to the schedule of charges in Table XIII. will show that for an annual load factor of 36 per cent. a price of 0·47d. should be obtained for transformed alternating current as against 0·35d. obtained by the local plant. It is estimated that this local cost will be reduced to below 0·3d. as the installation becomes completed, and as the load factor rises to 46 per cent., which then will make competition from outside quite impossible. While this is true, however, of so large a local plant as 3,000 kw., it would not, of course, apply to smaller collieries involving an installation of, say, 1,000 kw., in which case the power station would no doubt successfully compete as the capital and standing charges would raise the cost materially.

Steel and Other Large Works.—The remarks that have been previously made upon the cost of supply to engine works apply generally to works of this description. Annual load factors of from 20 to 25 per cent. are obtained, and the prices are found to range between 0·7d. and 0·6d. per unit. Therefore, on referring to the schedule of charges, it will be seen that a large power company could compete successfully with works of this description. Of course, some deduction must be made in certain cases for the utilisation by steel works of their blast furnace gases, which are utilisable in gas engines. The load factor of such works can be improved by the adoption of some such system as the Ilgner and by kinetic storage, and thus prevent the abnormal fluctuations in the loads of the rolling mills. Although this system is costly to instal, it considerably reduces the amount of generating plant which would otherwise be required to meet the "peak" loads, and the additional cost of such a levelling-out system will be more than repaid.

Rope-Making Works.—In the case of a rope-making works which the author investigated it was found that the cost represented practically 0·5d. per h.p.-hour, equivalent to 0·67d. per unit, the running hours being 2,700 per annum, and the load being practically constant. The annual load factor being 30 per cent., and the equivalent price in the schedule quoted by the author being a little over 0·5d. per unit supplied, it would obviously be possible to supply such works from an outside source.

Breweries.—The author investigated the driving of a brewery equipped with modern plant. The prime movers were gas engines, developing in all 194 h.p.

The following were the annual costs :—

	£	s.	d.
Gas at 1s. 6d. per 1,000 cub. ft.	338	14	9
Wages and repairs	516	12	4
Oils and stores	111	4	0
	£966	11	1

Interest and depreciation not given.

The cost of driving the shafting amounted to no less than £270 per annum : thus the net cost of useful power amounted to £696 11s. 1d. The shafting was very lengthy, but owing to the positions of the various machines this was unavoidable, and explains the reason of so great an annual loss. The wages and repairs are certainly very high indeed, but, nevertheless, the figures are the real figures given to the author by the authorities of the brewery.

The electrical cost after conversion was as follows :—

	£
66,550 units at 1·5d.	416
Oils and stores	20
Wages and repairs	78
Interest and depreciation on new plant	112
	£626

or 2·25d. per unit.

In addition there was a great deal of saving of room by clearing out much of the shafting, and absence of vibration and noise and of dirt from the oil cups of the shafting.

Saw Mills.—The author was responsible for the electrification of a small saw mill which had been driven by steam engines at a cost of over 2d. per h.p.-hour, or, say, 2·6d. per unit. Seven motors were installed, ranging from 4 to 50 h.p. each, with a total horse-power of 179. After one year's run it was ascertained that the total consumption was 50,785 units. The suppliers found the static transformers and high-tension switchboard, but the low-tension switchgear and fireproof transformer chamber were found by the user. The cost to the consumer was as follows :—

	£	s.	d.
Electricity	264	10	2
Oils and stores	9	3	4
Interest on sub-station building	12	0	0
	£285	13	6

or 1·35d. per unit, exclusive of capital charges on motors and wiring.

Miscellaneous Works.—Turning now to the general smaller power users within towns, Mr. Snell continued, there is no question that it is possible to supply these successfully from a central source, as none of these works are likely to exceed the running hours of, or the load factor from, a saw mill and joinery works when the annual hours are 2,700 and the load fairly constant; and it has been demonstrated that the latter works can be supplied economically from a central source, and at a cheaper rate than it can be generated by local plant. In each case of small power supply the author has found it quite easy to compete successfully with local plant, whether steam or gas driven, when each case is carefully tested and dealt with. Moreover, in works of this nature, space is of the utmost importance, and the ability to switch the outside supply on or off at will constitutes a very great boon to the user.

* *Journal of the Institution of Electrical Engineers*, p. 757, vol. 34, 1905.
† *Ibid*., p. 477, vol. 36, 1906.

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In Sunderland, at the time of the last census for which the author was responsible, and omitting the large engine works and shipyards, there were 587 motors, representing a total horse-power of 1,634, or an equivalent to 1,220 kw. The maximum demand on the station plant was only about 500 kw. There was thus a diversity factor of 2·4, the total units for the year being 404.999, or 332 per kilowatt installed. This represented a consumption of 810 units per kilowatt demanded for this particular load, and was thus under an average load factor of 10 per cent.

Table III. will be of value as giving statistical information of the horse-power, which may be estimated for works of various kinds.

TABLE III.

Description of Works.	H.P. Installed.	Number of Persons Employed.	H.P. per Capita.	Annual Units.	Units per Capita per Annum.
Corn mill	378	43	8·79	—	—
Printing (daily papers) ...	118	32	3·70	15,770	493
Saw mills	190	84	2·26	50,780	604
Steel-rolling mills	712	448	1·59	87,117	194
Mineral waters	40	32	1·25	10,483	327
Engine and boiler works ...	485	412	1·18	—	—
Engine and boiler works ...	750	1,020	0·75	1,031,892	1,012
Glass merchants	10	11	0·90	—	—
Coppersmith and foundry ...	120	199	0·60	12,172	61
Printing (general)	37	69	0·53	21,249	308
Printing (general)	8	16	0·50	5,564	347
Laundries (average of several)	10·8	40	0·27	25,054	626
Shipyard	2,099	1,874	1·12	700,000	373
Shipyard	477	446	1·07	198,000	444
Shipyard (with compressors)	6,000	5,564	1·24	2,980,000	536
Paper mill	1,820	410	4·43	—	—

This will be found useful in prospecting any district, as, short of a complete census of the actual power installed, the only way is to compute the horse-power per capita of the several factories. It is interesting also to note the relation of the maximum demand in works to the motors installed, though such figures are difficult to obtain, as manufacturers are not generally inclined to give this information. The particulars in Table IV. are somewhat limited, but perhaps a discussion on this Paper will educe particulars of other classes of works which must be of general interest to the industry.

In the preparation of particulars for the recent London County Council Power Bills, the author and his colleagues ascertained that in the area of Greater London alone there are factories utilising altogether some 400,000 h.p., while in the evidence

TABLE IV.

Description of Works.	1. H.P. of Motors Installed.	2. H.P. of Transformers Installed	3. Maximum Demand H.P.	— Ratio $\frac{2}{1}$	— Ratio $\frac{3}{1}$
Shipyard	1,576	1,200	900	0·76	0·57
Engine works ...	5,538	3,200	2,400	0·57	0·43
Printing	37	—	37	—	1·00
Saw mills	179	200	140	1·12	0·78

brought forward in support of the Administrative Company's Bill, 1906, this figure was given as 535,742 h.p., of which only 29,053 h.p. was then supplied from electrical undertakings. That a very great impetus has been already given to the adoption of electrical power there is no question. In the town of which until recently the author was engineer, within four years the power load connected had grown from 2,000 to over 10,000 h.p.

A modern power station of important magnitude and favourably situated can be now equipped completely for £12 or £13 per kilowatt installed. One cannot imagine that this figure is likely to be reduced materially. A transmission system in which the cables are designed to allow for diversity of loads supplied over a large area could be laid down also for £12 per kilowatt supplied; thus the all-round cost of an electrical installation is some £25 per kilowatt, excluding transformers.

The author's experience obtained in providing and equipping a large number of sub-stations is given in Table V.

In new ground, of course, it is in the interest of every one concerned to use static transformers, not only because of their lower capital cost, but also because of the minimum space required by them, the absence of attendants, and the saving in running stores and repairs. Incidentally, the automatic arrangement of Mr. Berry should prove useful in factories, for, as a general rule, either offices in works require to be lit after the main power is shut down, or small repairing shifts are required at night, and lights required for watchmen in case of outbreaks of fire. The transformer losses in the larger sizes then become an important item if allowed to continue on circuit to supply these trivial loads.

TABLE V

Cost of Static Transformer Sub-stations.

Kilowatts Installed.	Kilowatt Demand.	Cost of Buildings, Plant, and Switchgear.	Cost per Kilowatt Installed.	Cost per Kilowatt Demand.
150	100	£ 501	£ 3·34	£ 5·01
900	600	1,557	1·74	2·59
		Average ...	£2·54	£3·80

Cost of Rotary Sub-stations.

Kilowatts Installed.	Kilowatt Demand.	Cost of Buildings, Plant, and Switchgear.	Cost per Kilowatt Installed.	Cost per Kilowatt Demand.
650	400	£ 3,238	£ 4·98	£ 8·09
1,000	750	5,553	5·55	7·40
1,400	1,150	5,968	4·26	5·19
		Average ...	£4·93	£6·89

There are, however, many large works which are already electrified and supplied from their own plant. If direct-current motors are already installed, then a rotary sub-station must be put in at a greater cost to both supplier and user. It then becomes a matter for calculation to the latter whether it will better pay him to replace his existing motors by 3-phase, or to pay a necessarily higher annual sum for transformed and converted current. Here, again, in power supply the difference between an all-round 85 per cent. efficiency for rotaries, and 95 per cent. for statics, cannot be overlooked.

The total capital cost per kilowatt installed at the power house, therefore, from the power station up to and including the user's sub-station, will be as in Table VI.

TABLE VI.

Cost of Stations, Transmission Systems, and Static Sub-stations.

Capacity of Sub-station.	Cost of Power House per Kilowatt	Cost of Transmission System per Kilowatt.	Cost of Static Sub-station per Kilowatt.	Total.	Equivalent Cost at 1·66 Diversity Factor.
100–250	£ 13	£ 12	£ 3·33	£ 28·33	£ 18·33
250–1,100	13	12	1·75	26·75	16·75
			Average	£27·54	£17·54

Cost of Stations, Transmission Systems, and Rotary Sub-stations.

Capacity of Sub-station.	Cost of Power House per Kilowatt.	Cost of Transmission System per Kilowatt.	Cost of Rotary Sub-Station per Kilowatt.	Total.	Equivalent Cost at 1·66 Diversity Factor
250–500	£ 13	£ 12	£ 5·20	£ 30·20	£ 20·20
500–1,500	13	12	4·26	29·26	19·26
			Average	£29·73	£19·73

These are, however, not the real figures to take when fixing a schedule of charges, because of the influence of diversity factor. This figure will be found to vary in different localities and among different industries. For instance, the ratio of the sum of maxima observed at the several sub-stations in Sunderland to the actual observed maximum demand on the plant supplying them was only 1·25, because the industries supplied were very much of the same nature; but it is more general to find a diversity factor of 1·66 in a more varied set of industries. The author is here speaking of the diversity of sub-station maximum loads compared with the observed maximum at the power station. Of course, the ratio of the sub-station load to the horse-power of motors installed in factories is really only about 50 per cent., representing a diversity factor of 2.

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The statistics in Table VIA. may be useful :—

TABLE VIA.

	Total Kilowatts Installed.	Maximum Load Observed.	Ratio.	Diversity Factor.
Engine works	1,574	750	0·50	2·00
Engine works	1,090	434	0·40	2·25
Shipyard	310	200	0·66	1·50
Shipyard	950	450	0·47	2·12
Shipyard	357	175	0·50	2·00
Dock cranes, etc. ...	223	56	0·25	4·00
Saw mills	135	88	0·65	1·50

Obviously the capital cost per available kilowatt at the power station depends very much on the diversity factor, for the figure which may be taken as the assessable value of a power house and transmission system in the one case is £25÷1·25, or £20; and in the other case, £25÷1·66, or £15. Thus the total capital cost of plant, including a static transformer sub-station, will be either £22·54 or £17·54, and the total cost of a rotary sub-station £24·73 or £19·73, according to size.

It is obvious that some differentiation must be made between a low-tension supply of direct current and one of alternating current when one is preparing a schedule of charges, for at any load factor, say 20 per cent., the capital charges as between the two systems represent an additional 5 per cent. for the rotary over the cost of static sub-stations, without counting the addition to standing charges from attendance or from stores, &c., required by the former type or the less efficiency of rotary sub-stations.

It is of little use straining to reduce the capital outlay per kilowatt on the power house and distribution system, if one is going to sink an additional £2 or £3 per kilowatt on rotary sub-stations, so that there can be no doubt as to the wisdom of applying static sub-stations to all industrial purposes, wherever possible; and it is useless designing a highly efficient power house and transmission system if one throws away 10 per cent. at least in a sub-station. Space is of great importance to the manufacturer, and so much less is required, of course, by the static sub-station (about 0·8 sq. ft. per kilowatt installed, as against 1·75 sq. ft. required in a rotary sub-station). Power suppliers will do well, therefore, so to arrange their transmission system that works requiring 100 kw. or more shall be supplied whenever possible from their own local static sub-stations. If the works can be grouped, a centralised sub-station can be put down with overhead low-tension mains to each of the works supplied from it, so as to minimise expenditure on this item.

In the published tables of 1907 of the London County Council Electric Supply Bill, a differential tariff was adopted by the advising engineers to the Council. Of course, the lighting charges will represent a curve higher at every point than the power curve. This is obvious from the fact that one does not get the same diversity factor with lighting consumers as with power consumers.

It is a comparatively easy matter to estimate closely the cost of a power station, and even of the transmission or distributing system and sub-stations; and the one factor which is really unknown, but upon which the scale of charges so much depends, is this diversity factor. 1·66 may be all right in one district, but if applied universally will certainly lead to trouble. Therefore, in fixing maximum scales it is wise always to base the *maximum* rates upon a diversity factor of unity, and the actual commercial scales which will thereafter be charged will, no doubt, depend upon the experience which is gained by the supplier after some years of working.

To some extent the load factor can be raised artificially and by arrangement. In one locality the author got manufacturers to modify their dinner hours, so that instead of all shutting down synchronously, approximately half shut down from 12 to 1 p.m., and half from 1 p.m. to 2 p.m. Some power companies are also arranging to supply chemical works, in some of which certain processes can be shut down during restricted hours.

The severest handicap to power supply from existing London and provincial stations—whether administered by companies or municipalities—is, in the majority of cases, their present high captal cost per kilowatt. It is true that with each extension this figure is reduced; still, it will be found very difficult, especially in the case of London undertakers, to reduce their total much below £60 per kilowatt, or, in the case of large provincial stations, to reduce their capital much below £40 per kilowatt, or smaller stations to £50, taking into account all existing capital outlay. This is where the modern power company comes in with the benefits of latest electrical practice, much cheaper buildings, larger and cheaper units of plant, and, generally, an altogether lower cost per kilowatt. Even with a power company, however, there is a danger that the capital, while minimised in the power house, may be unduly raised by the cost of transmission over too great a distance. The present capital expenditure per kilowatt on London municipal systems averages £93, and London company stations £103; while the present expenditure on provincial municipal stations is £70·8, and provincial companies, £90.

Table VII. shows the average prices charged by existing undertakings for power in 1906 within the area proposed to be covered by the various London Power Bills. Side by side are given the figures which ought to have been charged, assuming that the average load factor of power supply is 20 per cent. and the diversity factor 1·66. The average load factor will certainly not be more than 20 per cent.; and if it really has a lower value, then the author's criticisms tell so much the more against the present suppliers. It will be seen that in the case of the South Metropolitan Company the average price charged for power was 1·048d. per unit, whereas the real charge should have been 2·367d.; or take the Westminster Company: the charge was 1·83d., whereas it should have been 2·4d. Or take the municipal cases: Battersea, where the average charge is 1·5d., and the real charge should have been 1·975d.; Islington, where the charge was 1·37d. and the real charge 2·2d.; or St. Pancras, average charge of 1d., and the real charge should have been 1·83d. This means, obviously, that the power user is being supplied by these undertakers at the expense of their lighting consumers, who are paying an unduly high rate for their supply, or in the case of certain London municipalities at too high a cost of public lighting. This system may do very well where there is only a small amount of power to be given, and where the proportionate revenue is only a small fraction of the gross receipts; but let there be a big increase in the amount of power supplied at the same rates (and despite its effect in the general reduction of generating costs), it will be found then that the total receipts are not commensurate with the total costs, and the result will be an unsuccessful undertaking.

TABLE VII.

Comparison of Actual and Correct Charges for Power by Local Authorities.

Local Authority.	Actual Charge.	Correct Charge.	Probable Charge from Power Supply Company.
	d.	d.	d.
Barking	1·686	1·747	
Barnes	1·658	1·677	
Battersea	1·500	1·975	
Bermondsey	2·060	1·792	
Croydon	2·500	1·775	
Ealing	2·351	2·361	
East Ham	1·570	1·535	
Erith	1·581	1·595	
Fulham	1·000	2·024	
Gravesend	2·000	1·638	0·83 for direct current;
Hackney	1·240	1·384	
Hammersmith	1·240	1·201	
Hampstead	2·090	1·839	
Hornsey	1·270	2·225	
Ilford	1·324	1·440	0·68 for transformed alternating current
Islington	1·370	2·214	
Kingston-on-Thames ...	2·000	2·370	
Leyton	1·623	1·857	
Poplar	1·430	1·686	
St. Pancras	1·000	1·838	
Shoreditch	1·400	1·958	
Southwark	1·900	2·034	
Stepney	1·000	1·549	
Walthamstow	2·044	3·129	
West Ham	1·234	1·340	
Willesden	1·431	2·988	

Comparison of Actual and Correct Charges for Power by Metropolitan Companies.

Name of Company.	Actual Charge.	Correct Charge.	Probable Charge from Power Supply Company.
	d.	d.	d.
Brompton and Kensington	1·000	1·979	
Charing Cross (City) ...	1·940	2·198	
Ditto (West End)	1·940	2·511	
Chelsea	1·500	2·388	0·83 for direct current;
City of London ...	1·700	1·554	
County of London ...	1·800	2·267	
Kensington and Knightsbridge ...	2·140	2·082	
London Electric ...	1·860	1·862	0·68 for transformed alternating current
Metropolitan	2·460	2·093	
Notting Hill	3—½	3·328	
St. James' and Pall Mall	2·370	1·928	
South London	1·780	1·518	
South Metropolitan ...	1·048	2·367	
Westminster	1·830	2·404	

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That there is only one way in which to deal with the London problem must be obvious to all engineers—that is, through some means, a large power station must be erected at a minimum cost, which, without prejudicing the present capital involved in the existing undertakings, will enable electricity to be supplied for all purposes at considerably less rates than now obtain. The capital sunk in existing undertakings cannot, of course, be ignored; it constitutes a dead-weight upon electrical supply in London, which will remain until this original capital shall have been redeemed. That cannot be for several years yet, and, therefore, the only compromise is to provide this supplementary low-cost station to co-operate with and assist those already in operation.

The effect is apparent even now, for the more successful companies, whose able administration cannot be questioned, find that since they have had to reduce their scales of charges they are not able to declare the same dividends as they were able to do a few years back; and this effect is likely to get worse rather than better. Or take the case of some London municipalities who have so very foolishly contented themselves by merely putting aside a sinking fund on a 42-years' basis, well knowing that their plant could not possibly exist for so long a time. It will certainly be admitted that twenty-five years is the maximum period which engineers would be wise to allow as the equated life of their plant. These municipalities have, therefore, a good deal to make up for past years, and they simply cannot put themselves in a sound financial position and at the same time offer their power users such a low scale of charges as will promote a large revenue from the sale of electricity for power. They, again, can only carry out the duties imposed upon them by their orders by a wise co-operation with some central scheme.

Table VIII. shows the true cost of production in some of the larger provincial municipal stations. These figures are based upon the official published results for 1906 or 1907. In every case the capital charges have been taken as requiring interest at an average rate of 3½ per cent. and depreciation at 2¾ per cent; that is to say, 6¼ per cent. has been taken upon the total capital expenditure, and added to the costs.

TABLE VIII.

True Cost of Production in Larger Municipal Stations for the Year 1907.

Annual Load Factor.	Manchester.	Nottingham.	Leeds.	Glasgow	Average
Per Cent	d.	d.	d.	d	d.
5	5·03	4·93	5·24	4·70	4·97
10	2·71	2·72	2·82	2·59	2·71
15	1·93	1·98	2·02	1·88	1·95
20	1·55	1·61	1·62	1·54	1·58
25	1·32	1·39	1·37	1·32	1·35
30	1·16	1·21	1·21	1·19	1·19
35	1·06	1·14	1·10	1·08	1·09
40	0·98	1·06	1·01	1·01	1·01
50	0·84	0·94	0·89	0·90	0·89
60	0·77	0·86	0·81	0·83	0·82
70	0·73	0·82	0·75	0·78	0·77
80	0·69	0·79	0·70	0·74	0·73
No. of units sold	47,564,903	9,530,096	11,368,956	21,536,425	—
Plant installed ...	33,800 k.w.	10,043 k.w.	10,440 k.w.	18,493 k.w	—
K.W.D.	25,180	5,765	7,470	16,304	—

Table IX. shows the scale of charges which could be adopted for power after allowing the diversity factor. There it will be found that the average rate for, say, a 20 per cent. load factor consumer is 1·16d., whereas a power company ought to

TABLE IX.

True Charges for Power Supply, based on Cost of Production and 1·66 Diversity Factor.

Annual Load Factor	Manchester.	Nottingham.	Leeds.	Glasgow	Mean.
Per cent.	d.	d.	d.	d.	d.
5	3·19	3·16	3·32	3·02	3·17
10	1·79	1·83	1·86	1·75	1·81
15	1·32	1·39	1·38	1·33	1·35
20	1·09	1·17	1·09	1·11	1·16
25	0·95	1·04	0·99	0·99	0·99
30	0·86	0·95	0·89	0·90	0·90
35	0·79	0·89	0·82	0·84	0·83
40	0·74	0·85	0·77	0·80	0·79
50	0·67	0·81	0·70	0·73	0·73
60	0·62	0·73	0·65	0·69	0·67
70	0·59	0·70	0·62	0·66	0·64
80	0·56	0·68	0·59	0·64	0·62

be able to supply such a consumer successfully at not more than 0·8d., or a reduction of 30 per cent. This is the result of the larger stations. And if one turns to the smaller provincial stations, which are given in Tables X. and XI., the results are very much the same, as the larger districts will almost certainly have a higher diversity factor; therefore the author

TABLE X.

True Cost of Production from Smaller Municipal Stations for the Year 1907, at Different Load Factors.

Annual Load Factor	Aberdeen	Dundee.	Cheltenham	Coventry	Darlington	Oldham.	Average.
Per cent.	d	d..	d.	d.	d.	d.	d
5	5·66	4·43	6·20	4·90	4·25	6·07	5·25
10	3·04	2·40	3·42	2·67	2·79	3·32	2·94
15	2·17	1·72	2·50	1·93	1·71	2·40	2·07
20	1·74	1·39	2·03	1·57	1·39	1·94	1·67
25	1·46	1·18	1·75	1·34	1·19	1·67	1·43
30	1·30	1·05	1·58	1·19	1·06	1·49	1·28
35	1·17	0·95	1·43	1·08	0·98	1·36	1·16
40	1·08	0·88	1·34	1·01	0·91	1·25	1·07
50	0·94	0·78	1·19	0·90	0·81	1·12	0·95
60	0·86	0·71	1·11	0·82	0·74	1·04	0·88
70	0·80	0·66	1·04	0·77	0·70	0·97	0·82
80	0·75	0·63	0·99	0·73	0·67	0·90	0·77
No. of units sold	4,280,248	3,439,231	1,701,370	2,522,110	1,095,287	4,133,615	—
Plant installed ...	3,810 k.w.	3,010 k.w.	1,980 k.w.	2,400 k.w.	748 k.w.	5,232 k.w.	—
K.W.D.	2,633 k.w.	2,367 k.w.	1,316 k.w.	1,533 k.w.	740 k.w.	2,400 k.w.	—

TABLE XI.

True Charges for Power Supply based on Cost of Production and 1·66 Diversity Factor.

Annual Load Factor.	Aberdeen.	Dundee.	Cheltenham.	Coventry.	Darlington.	Oldham.	Mean.
Per cent.	d.	d.	d.	d.	d.	d.	d.
5	3·58	2·82	3·99	2·53	2·73	3·87	3·25
10	2·00	1·59	2·32	1·49	1·58	2·22	1·86
15	1·47	1·19	1·76	1·14	1·16	1·67	1·56
20	1·21	0·98	1·48	0·97	1·00	1·39	1·17
25	1·05	0·86	1·31	0·86	0·89	1·23	1·03
30	0·95	0·78	1·20	0·80	0·81	1·12	0·94
35	0·87	0·72	1·12	0·75	0·74	1·04	0·87
40	0·82	0·68	1·06	0·71	0·70	0·98	0·82
50	0·74	0·61	0·98	0·65	0·66	0·90	0·76
60	0·69	0·57	0·92	0·63	0·62	0·85	0·71
70	0·65	0·55	0·88	0·60	0·58	0·81	0·68
80	0·62	0·52	0·85	0·58	0·56	0·77	0·65

suggests that he may be quite wrong to assume the same co-efficient in both tables. These figures, of course, will improve as years go on—or at least it is hoped so—because with extensions of the stations, as has been said before, the capital cost per kilowatt should be reduced. This will apply with more force to the larger systems. But a warning should be noted by station engineers that the future will bring, in all probability, a very large proportionate increase of low-price power units, and with improvements in lamps and their reduced energy consumption, the proportionate lighting units may even fall below their present figure.

The author has purposely taken only 6¼ per cent. in the case of the large undertakings for capital charges and depreciation, and 10 per cent. in Tables I. and II. for the smaller local works plant, because in the supply stations the plant has been built to careful specifications, is under expert supervision, and there is a reasonable proportion of stand-by plant with consequent relief in the running hours per unit of plant. The 10 per cent. allows depreciation of 5 per cent., and interest is at 5 per cent. (which manufacturers generally assume). Table XII. gives

TABLE XII.

Load Factor.	Newcastle Power Company.	
	Average Cost of Production, 1907.	Real Cost for Power Supply, 1·66 D.F.
Per cent.	d.	d.
10	2·31	1·49
15	1·62	1·07
20	1·28	0·86
25	1·07	0·74
30	0·98	0·65
35	0·83	0·60
40	0·76	0·55
50	0·65	0·49
60	0·58	0·44
70	0·53	0·42
80	0·50	0·39

the real cost of production of the Newcastle-upon-Tyne Electric Supply Co., based on the 1907 figures. Side by side is the power scale of charges based on 1·66 diversity factor. This company has an expenditure of £59.6 per kilowatt installed, of which the cost of the stations has been about £33 per kilowatt: mains and sub-stations, &c., £26. It is interesting to note that the plant installed in sub-stations amounts to about 35,000 kw., supplied by generating plant installed at the station with a

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total capacity of 20,000 kw. Now it cannot be said that even this company having so large a capital expenditure involved, and operating on such a big scale, is entirely satisfactory in its finances with a depreciation and reserve account amounting to only 1·07 per cent. for the year. The question arises on such an undertaking whether undue expenditure has not been made upon the transmission system.

The author read a Paper in 1904 which dealt with the question of transmission distances in this country, and then showed that at a pressure of 10,000 volts the economical distance for transmitting a load of 1,500 kw. was only 11 miles, where the displaced local station cost £20 per kilowatt. A new diagram (Fig. 1) is now given which shows the effective radii of distribution for

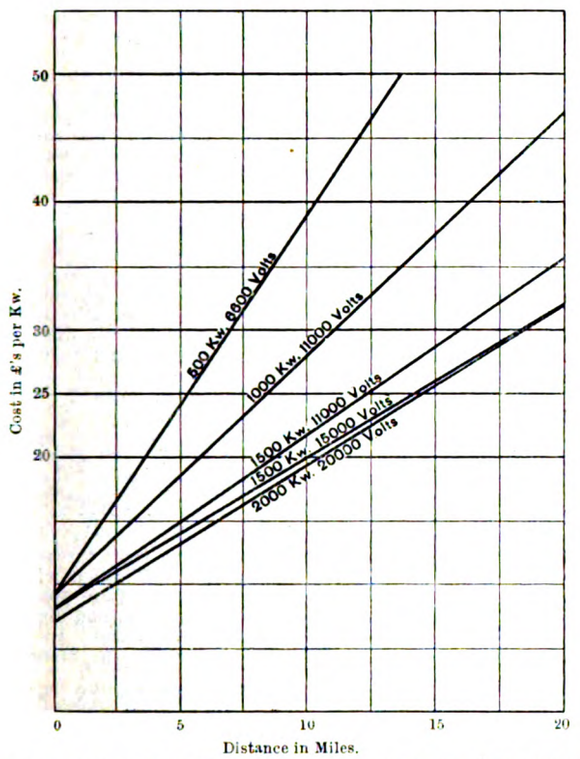


FIG. 1.—COMPARATIVE COSTS OF LOCAL GENERATING STATIONS AND POWER HOUSE, TRANSMISSION SYSTEM WITH SUB-STATIONS.

different loads, and different costs per kilowatt. It has been assumed that every 100 kw. installed at the power station will supply 166 kw. outside; and the cost of the power station is taken at £12 per kilowatt, or £7·2 per effective kilowatt supplied. Each curve represents a consumer, or group of consumers situated at the respective distances and supplied through high-tension cables laid in duplicate and static transformer sub-stations. The horizontal lines show the costs of alternative local stations per kilowatt. The point at which the two curves cross is that at which both systems are equal in cost. It shows, therefore, that so far as capital is concerned the effective radii of transmission in miles are as in Table XIII. These distances, of course, only refer to a comparison between a supply from a central source and local plants installed within factories which usually cost from £20 to £25 per kilowatt. Transmission by

TABLE XIII.

Kilowatt.	Voltage.	Local Station Costing per Kilowatt.				
		£20.	£25.	£30.	£40.	£50.
		Miles.	Miles.	Miles.	Miles.	Miles.
500	6,600	3·7	5·3	7·0	10·3	13·8
1,000	11,000	5·8	8·5	11·2	16·5	22·0
1,500	11,000	7·8	11·5	15·0	22·0	—
1,500	15,000	8·5	12·4	16·2	—	—
2,000	20,000	9·7	14·2	18·5	—	—

overhead lines would still further increase these radii, of course, but there is still much difficulty and great expense in obtaining the necessary easements for high-tension lines in this country.

Table XIV. sets out the estimated charges of various power companies. In the first column are given the estimated charges which were proposed in the London County Council (1907) Bill, for supply to authorised distributors, column I*a*. being for extra-high-tension untransformed energy at the consumer's terminals, column I*b*. for transformed alternating current at any pressure, and column I*c*. for transformed and converted direct current at any pressure. In the next column are set forth the maximum prices chargeable to individual power users under this Bill; in column III. the maximum price proposed by the Administrative Company of 1906; and in column IV. the real tariff which could be charged by the Newcastle Power Company, based on their 1907 results and with an estimated diversity factor of 1·66, is set out again for convenience.

TABLE XIV.

Estimated Charges from Bulk Supply Undertakings.

Annual Load Factor.	I. London County Council, 1907. Estimated Charges to Authorised Distributors.			II. London County Council, 1907. Maximum Prices to Individual Power Users.		III. Administrative Co., 1906. Maximum Prices.	IV. Newcastle Real Cost based on 1907 Figures and 1·66 D.F.
	(a) E.H.T.	(b) T.Alt.	(c) D.C.	(a) T.Alt.	(b) D.C.		
Per cent.	d.	d.	d.	d.	d.	d.	d.
10	1·002	1·159	1·453	1·738	2·179	1·50	1·49
15	0·728	0·839	1·042	1·258	1·562	1·16	1·07
20	0·591	0·679	0·836	1·019	1·254	1·02	0·86
25	0·508	0·583	0·713	0·875	1·069	0·94	0·74
30	0·454	0·519	0·631	0·779	0·946	—	0·65
35	0·414	0·474	0·572	0·710	0·858	0·81	0·60
40	0·385	0·439	0·528	0·659	0·792	0·75	0·55
50	0·344	0·391	0·466	0·587	0·699	0·72	0·49
60	0·317	0·359	0·425	0·539	0·638	—	0·44
70	0·297	0·337	0·396	0·505	0·594	—	0·42
80	0·282	0·319	0·374	0·479	0·561	0·64	0·39

If Table XIV. is compared with Tables I. and II. it will be seen that a power company can compete successfully with any of these other prime-movers if the power company supply transformed alternating current, but if the power company is constrained to supply direct current, then it is only with smaller plants—*i.e.*, 100 h.p. or less—with which it can hold its own. It is not suggested that the figures in this table are the ultimate minimum charges for power which power companies can afford to make, but they cannot be reduced materially.

The influence of additional capital cost per kilowatt is shown in Fig. 2, in which successive curves are shown adding to each

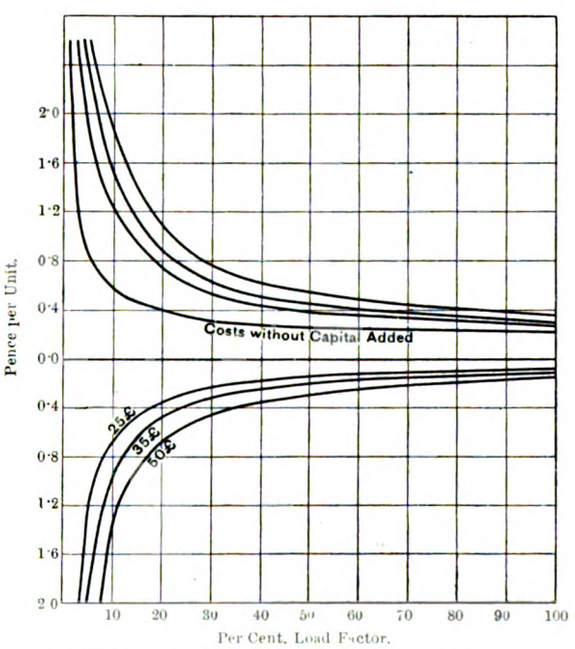


FIG. 2.—EFFECT OF CAPITAL UPON TOTAL COSTS OF PRODUCTION.

	20 %	25 %	30 % L. F.
£50 per Kw.	1·06d.	0·88d.	0·76d.
£35 ,, ...	0·86d.	0·72d.	0·63d.
£25 ,, ...	0·72d.	0·60d.	0·54d.

the capital charges due to the increased expenditure. It will be seen that the difference in cost of production, at 20 and 25 per cent. load factors, between a system costing £25 per kilowatt and one costing £50 per kilowatt, is 32 per cent.—and

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at 30 per cent. load factor, 29 per cent. This demonstrates very clearly how important it is to minimise the capital involved.

The author believes he has made out a case for showing that in all the larger power stations where the capital expenditure is reduced to a minimum and the supply is produced on a sufficiently large scale but within a reasonable distributing radius, a sound scale of charges for power can be made which can hold its own with any independent local power plant, whether supplied from steam, oil, or gas. The London companies and municipalities, having been the pioneers of supply, are unfortunately crippled by a large expenditure, and, except in a few isolated cases, cannot in the author's opinion so reduce their cost per kilowatt nor increase their production as to meet economically this demand for low-priced power. This problem in London can only be dealt with by centralisation, and all further expenditure on existing individual systems is prolonging an evil which must ultimately be reflected upon the undertakers, and is, in fact, already so doing.

In the provinces many of the smaller boroughs cannot hope to attain such dimensions, and many of them are already saddled with a high capital expenditure per kilowatt, such as to prevent them from offering the low scale needed. This remark does not apply to those smaller boroughs in which power supply cannot become a dominating part of the output, for in such cases among smaller users a larger diversity factor exists, and it may be expedient to sacrifice the principle of a uniform tariff to all classes by offering a special rate to such sparse power consumers. But if this principle—or rather want of principle—be applied in a small industrial town where the power supply may become quite the dominating output, then such a policy can only produce disaster. In such a case there appears to the author to be only one alternative, viz., that all extensions of the local generating plant should be stopped, and that supply should be taken from a power company, if there be one reliably constituted in the neighbourhood, as has been arranged by the Middlesbrough and Tynemouth municipalities, for instance; or a joint Board of local towns could co-operate at a very considerable saving to the respective partners if sufficiently proximate to one another. If this be too Utopian, then possibly the County Council of the district could take the matter up, or by the aid of legislation the principal borough of the group could undertake this responsibility. It would have been much wiser if the controlling authorities— viz., the Local Government Board and the Board of Trade—had prevented some of the smaller local boroughs from adopting their separate electricity stations.

DISCUSSION IN LONDON.

Mr. J. H. RIDER (Chief Electrical Engineer, London County Council), in opening the discussion, said that the importance of the Paper could be judged to some extent by the large number of station engineers who were present thirsting for Mr. Snell's blood. He himself was rising to support what Mr. Snell had said. He was afraid it was rather a common habit for lighting stations with a poor load-factor to try and encourage the power-load by offering a very low price. The attempt was then made to make up whatever loss might accrue from the cheap power supply by charging a higher price than should be charged under the circumstances for private lighting, and more commonly for street lighting, particularly when the station belonged to the municipality which was its own street lighting authority, and could charge practically what it liked for street lighting. They had all heard the story of the fair proprietor who, to induce people to come into the showyard, charged a very low price for the swings, but made up what he lost on them by the profit on the roundabouts. But if the demand for swings was going to become preponderatingly great, then the roundabouts would not make up the loss. Some interesting figures were given in Table VIA. with regard to diversity factor, which Mr. Snell had found in certain classes of works. Mr. Snell also gave it from his experience at Sunderland that he had there a diversity factor of 1·25. He presumed the author was in this case speaking of sub-stations which were supplying lighting and power. It might be of interest to the meeting to know that even with such a constant character load as the London County Council tramways they had a diversity factor of 1·25 among the various sub-stations. He personally was very much surprised at that, considering the fact that the tramway load increased fairly generally over all parts of the system at the same time. Consequently, if they could get a lighting load *plus* a street lighting load *plus* a power load, he thought the figure which Mr. Snell gave of 1·66 might even be too low, which would be all the better for giving a cheap supply. The author had quite properly emphasised the greater expense of using rotary sub-stations as against static transformers. He had been through these figures (Table V.) and checked them, and could corroborate the relative prices of static transformers and rotaries. All those who were trying to sell power cheaply should go in, as far as possible, for alternating current motors, the only disadvantage of which, in certain cases, might be the difficulty of getting variable speed. It was very interesting in Table XIV. to compare Columns I.c. and IV., which gave in the first case the estimated average charges for low-tension direct-current in the L.C.C. Bill, and in the last column, the actual cost according to Mr. Snell, of the Newcastle Company's working. It would be found that all through, from 10 per cent. to 80 per cent. load-factor, the prices were remarkably close to one another. This showed, at any rate, that the character of the curve adopted by the London County Council engineers was a true one. He thoroughly agreed with Mr. Snell's statement that the true way of getting at a scale of charges was to fix the maximum prices on a unity diversity factor. They would then be safe whatever the character of the load. They could then charge an actual price according to the diversity of the various classes of consumers. He also agreed with the author's remark near the end of the Paper that the problem in London can only be dealt with by centralisation, and that further capital expenditure on individual systems or local power houses was wrong.

Mr. A. M. TAYLOR (Birmingham Electric Supply Department) said it appeared to him that the Paper dealt only with the large consumer, and all questions of supplying smaller consumers had been totally ignored. It would not help those who had to deal with the supply to both large and small consumers as was the case in many provincial towns where there were many consumers under 100 h.p. who had to be supplied off the lighting mains. Table VII. was a little misleading, because he took it that Mr. Snell had first calculated the average charges for power for both small and large users and set them against the probable charge by the power company, which apparently only related to the large consumer; consequently, all the costs of distribution from the sub-centres, which were very serious, were eliminated. Probably £20 per kw. would be a minimum figure for distribution to the small users all over a fair-size area, and that was omitted altogether. In Fig. 1, the author appeared to get £7·2 per kw. at the main station as the ordinate for zero distance by dividing £12, shown earlier in the Paper, by 1·66. This, of course, was very low, and according to the figures Mr. Snell published before the Institution of Civil Engineers four years ago, it was only applicable to stations of the size contemplated by the London County Council. Presumably, he had divided the sum for cables by the diversity factor as well. He had also divided the costs per unit by the diversity factor, and this was why Mr. Snell's tables were wrong right through.

THE PRESIDENT (Col. CROMPTON) said that the author wished him to point out that Mr. Taylor was going on a false premiss.

Mr. SNELL said he took the total standing charges, and divided them by the kilowatts of the true maximum demand. He did not divide the cost per unit to the consumer by the diversity factor.

Mr. TAYLOR asked if the same applied to Table IX., which gave the correct costs for certain towns.

Mr. SNELL: I take them in precisely the same way.

Mr. TAYLOR, continuing, said that Mr. Snell passed over the question of storage and sub-stations rather briefly, but four years ago he had recommended it rather strongly. He believed there was really a future for storage at sub-stations, especially in connection with long distance lines. He believed it would be possible by this means to double, if not treble, the length of line to which Mr. Snell said it was possible to extend supply.

Mr. A. H. SEABROOK (Chief Electrical Engineer, West Ham Corporation) said there were one or two things he could not reconcile in the Paper. In Tables I. and II., the average costs in the last column appeared to him too low. Even allowing for the difference of cost of fuel in the North of England and in the South, the result given was entirely contrary to his experience. But even supposing they were correct, he did not see what any power company was going to do in the way of taking them over, because if they took Table II. for a load factor of 25 per cent., the average costs were 0·615d., and there was not much margin between that and the figure of 0·679d given in Table XIV., sub-column *b*. He thought there was something wrong there. If a big station with 12,000 kw. or 15,000 kw. units could not get a bigger margin than 0·02d. per unit, there was surely some explanation for it. The details of individual tests also did not support the figures in Tables I. and II., and were contrary to his experience, correcting, of course, for the cost of fuel. Further on in the Paper he found that old friend the £12 per kw. station. He would really like to know whether it was possible to build a station at that figure, or even double that figure. The Newcastle Company had been credited with cutting these things about as fine as possible; but, as the author assumed himself, the cost of their station was £33 per kw. Further, they did not appear to be extending their main Carville station, but were building on another site on the Tyne, so that it was to be assumed that they had found the limit of economical power stations. The cost of sub-stations mentioned by Mr. Snell appeared to him to be rather high. His figure, compared with the cost of a great many recently constructed in West Ham, was quite double, and the same thing applied to rotary sub-stations up to 200 or 300 kw. capacity. With regard to the space taken up by static chambers, 0·8 square feet per kw. seemed very high indeed, because the best place for them was outside the premises altogether, say on the roof, where they could get plenty of ventilation. He

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had no doubt that other London engineers with greater experience would give their views upon the author's idea as to the solution of the difficulty in London. Personally, he did not believe the large power station was the solution of the problem at all. The problem was quite a different one to that in the provinces, where they sent out half a million to a million units per annum. In London 12 to 20 millions were sent out over a very small area, such as the City of London Company, for instance, with one square mile. Comparing Table VIII., giving the true costs of production from various power stations in the provinces, with Table II., apparently Manchester, Nottingham, Leeds, and Glasgow had a cost of production of double that of a private installation of from one to 500 kw. Newcastle also, in Table XII., showed a considerably higher cost per unit than the same small private installations. The author's warning that the future would bring a very large proportionate increase of low-price power units, while, with improvements in lamps, the proportionate lighting units might fall below their present figure, was unnecessary, for if the charges had been calculated correctly, there would be no reason that a lower average receipt per unit would imply a lower net profit. It was quite obvious that if the power units were incorrectly calculated it would be disastrous, and it would be specially so in his (the speaker's) station, where four-fifths to five-sixths of the main output consisted of the low-price units. But he was convinced that the cost at which they had put these power units was correct. He admitted that his present balance sheet was not very brilliant, but this was due to other causes—not to the reduction to power consumers, but mainly due to reductions to lighting consumers. In Table XIV., main column 1, there appeared to be a bigger difference between the sub-columns than there ought to be. He could not reconcile, for instance, at a 25 per cent. load factor, that the untransformed extra high-tension price of 0·508d. was changed to 0·583d. transformed. The very high efficiency of modern transforming plant and the small capital cost surely could not mean such a difference as that. Again, the author stated that "If Table XIV. is compared with Tables I. and II., it will be seen that a power company can compete successfully with any of these other prime movers if the power company supply transformed alternating current; but if the power company is constrained to supply direct current, then it is only the smaller plants, *i.e.*, 100 h.p. or less, with which it can hold its own." Considering that the bulk of the small boroughs and installations consisted of direct current, it did not seem to him that if the power company could only take up to 100 h.p., the small boroughs were going to receive much benefit. He was quite certain the author could explain all these points, but he thought it only right to mention them.

Mr. J. A. JECKELL (Chief Electrical Engineer, Coventry Corporation) said he was very much afraid that if Mr. Snell's figures were correct there was not much chance for many station engineers to induce consumers to take a supply of energy at all. Table IX. showed that with a load factor of 25 per cent., Manchester was bound to charge 0·95d. per unit; Nottingham 1d. (there were perhaps reasons for this), Leeds 0·99d., Glasgow 0·99d., whilst the average came out at 0·99d. He ventured to think that although the consumer who had only about 100 h.p. would be willing to pay these prices, the consumer who wanted 500 h.p. to 5,000 h.p. would certainly not pay that price. He felt sure, therefore, that somehow Mr. Snell had prepared his tables from a wrong basis. He would take an extreme case—namely, Coventry, with which he was connected. Going back to the time when Coventry had only a lighting supply, the cost of production, according to Mr. Snell, came out at about 6d. per unit; what chance was there of anybody inducing any consumer to turn out a steam engine or a gas engine with a charge like that? Fortunately, possibly, he did not prepare his calculations in the same way that Mr. Snell had. The position which he personally took up was that having already a lighting station, he did not propose to charge the power consumer the capital charges which were incurred on the lighting plant at all. Supposing a manufacturer took over premises and he found that £100,000 had been spent in, say, making cycles. Assume these works did not make a profit, and the manufacturer decided to put down by the side of them some buildings, using the same offices, &c., to manufacture motor cars. Against the price that he was going to charge for his motor cars, he would naturally not debit the capital charges on the cycle works, but would only debit against the new undertaking the capital charges incurred on that new undertaking. Then if he made money on the new undertaking, he could, if he liked, depreciate, at any rate he pleased, the plant which perhaps had become to a certain extent obsolete with regard to the cycles. To apply this to the Coventry Electricity Works he said they had, as a matter of fact, spent £75,000 on a lighting station, the cost of production at which was over 6d. per unit. They spent another £75,000 on a new station, and the cost of production there came out at 0·89d. For this supply they obtained about 1½d. per unit, and the result was a balance sheet which showed that the true cost of production came out at 1·63d., which happened to be less than the price obtained for the current. But had they started with the supposition that the power consumer had to be debited with capital charges on the old lighting plant, they then could never have offered to supply power at a price at which the ordinary consumer would take it. However desirable it might be to reduce the capital charges on a station, it was equally necessary to reduce the manufacturing or station charges. He thought it would be found that if they expended £10 per kilowatt more on a station and had a load factor of 22½ per cent. (this was a convenient one simply because they sold 2,000 units per kilowatt demanded) at 7 per cent. capital charges, the extra cost per unit owing to the 10 per cent. extra capital meant 0·1d. If they would take the Board of Trade returns, it would be found that between stations of somewhat similar size they had in the station costs a difference of 0·3d. or 0·35., which meant that one station could have spent £35 per kilowatt more than the other, and yet the total station charges *plus* capital charges would have come out the same. They had also to remember that they could not reduce capital charges on an existing station unless they could put down another station by the side of it, but they did know that they could start and reduce station costs possibly without a single penny expended. He thought Mr. Snell must really have made a mistake with regard to the cost of static sub-stations. In Table VI. he had put down the cost of sub-stations with a capacity of 100 to 250 kilowatts at £3 3s. per kilowatt. He was sure that they did not spend so much money as that in the North of England; £2 per kilowatt would well cover it. In the outside area which the Coventry Corporation was now authorised to supply, they were proposing to give the supply by means of kiosks with transformers in them. Two 25-kilowatt transformers in a kiosk cost £100, or £2 per kilowatt. There must be some special reason for Mr. Snell's £3 3s.

Mr. W. H. PATCHELL cordially agreed with that part of the Paper in which co-operation was recommended rather than the extension of small stations. That was the creed started in 1905 by the chairman of his old company (the Charing Cross, West End, and City Electricity Supply Co.), Mr. Fladgate, and he thought if that had been loyally worked to by the companies and authorities in London they would probably have settled this power question once and for all in London long ago. On the question of costs, it was evident that in some cases the capital expenditure had been greatly increased by the necessity of giving a supply within the Board of Trade limits of variation of pressure. He lately heard this question put in all seriousness: What lamps had I best use when my pressure varies from 90 to 115 volts? That was not put by a London engineer, although it might be a case of *proxime accessit*. There the metallic filament lamps scored. A good many of the power company mains which now give an indifferent supply for carbon filament lamps would give a very good supply for metallic filament lamps, and the regulations of the Board of Trade might be modified, with advantage to the power companies, to suit metallic filaments. With regard to the small stations which Mr. Snell had tabulated, he did not quite see how they could fairly look at the cost of a station on the same basis, whether it was for 1 h.p. to 100 h.p., or from 100 h.p. up to 500 h.p., because the cost of labour affected the question so very largely. Mr. Snell, after spending all this time on the arithmetic, afterwards stated, "There is no proportionate charge for supervision or general establishment charges, or for rating." Really, that discounted the value of those figures very materially. Neither did he see the use of averaging the cost of steam, oil, and gas in the Tables I. and II. Nobody ran a three-line engine, one steam, one oil, and one gas. If that last column of Tables I. and II. had been filled by a statement on a power company basis for comparison, such as £6 per kw. and a farthing per unit, it would have been seen how the power company load factor affected the cost. It was very unfair, he thought, to speak in the same breath of the cost of a private plant which only ran economically 54 hours a week, with the cost of supply from a station which worked 24 hours a day. There had been a good deal of fallacy on that ground, and the poor man who was offered a gas engine plant never dreamed that the cheap supply would only be for eight or nine hours a day, and that there were considerable extra charges if they had to run overtime. So that really the equivalent hours were misleading unless they knew the basis—whether it was long hours and average load, or shorter hours and high load. Referring to Mr. Snell's reference to paper mills, Mr. Patchell said that it was sometimes misleading to take the figures given by paper-mill people, who used a very large quantity of their steam for boiling and a very small proportion for power. If they wished to tempt a hotel manager to shut down his private plant, they had to remember that his kitchen cost nothing whatever to run, as his engines supplied exhaust steam for heating; if he shut down his electrical plant and got his supply from the company he began to realise what his kitchen really cost him. A good deal of the disappointment the power companies had experienced had been due to the ridiculously small amount of energy which was taken to run some works. When the power Bills were first thought of in London, the horse-power of boilers was converted into horse-power in machines, and that was gravely used as the basis of the horse-power available for electrical driving in London. But some works took ridiculously small figures. He had some figures of a wagon shop, which was turning out 500 wagons a year. There were seven motors in that shop, of an aggregate of 150 h.p., and the units used per month per horse-power installed were only 17. In a brewery with 16 motors, the aggregate power

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of the motors was 167 h.p., and the units used per month per horse-power were 28. In a colliery he had nine motors aggregating 1,060 h.p.—60 h.p. of which was in two 30-h.p. pumps—and even allowing for that the units used per month per horse-power were only 36. Another case which would make the mouths of London engineers water was an 85-h.p. motor driving a fan which took 580 units per horse-power per month; but in the manufacturing trade the units used for driving the works were surprisingly small. In this connection it might be useful to members who wished to follow the question further to refer to a Paper by E. W. Lloyd, which was really a report to the National Electric Light Association on the purchase of electrical power in factories. It was published by the National Electric Light Associations Convention in June, 1905.

The discussion was then adjourned, and will be continued this evening, not at the usual place, but at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.

DISCUSSION IN DUBLIN.

The Paper was discussed simultaneously in Dublin last Thursday.

The CHAIRMAN (Mr. T. TOMLINSON), in opening the discussion, complimented the author on the fairness of the statements in the Paper; he had pointed out clearly both the possibilities and limitations of centralised power production and distribution. Mr. Tomlinson then showed curves that he had plotted for Tables VIII., X., and XII. He regretted that the author had not given information as a basis upon which these tables had been prepared, and hoped that the author, in his reply, would give that information, and also define his definition of load factor as he had used it. The speaker then gave a series of figures he had himself worked out in connection with the Dublin and Central Ireland Power Company, of which he was engineer. He assumed a generating station of 5,000-kw. capacity, consisting of five 1,000-kw. units, one of which would be a spare. He then took two cases of supply—one close by the power station, the other 27 miles away. The earning capacity of such a plant was 4,000 kw. The capital cost for a gas plant was £17·5 per kilowatt installed. Therefore the capital cost per kilowatt of earning capacity, £22; to this must be added £4 for transformers and switch gear, and £5 for Parliamentary and establishment charges, a total of £31 per earning kilowatt. The cost of a duplicate overhead line was £6·5 per kilowatt, assuming the pressure to be 30,000 volts. The cost of operation, excluding fuel and distribution, would be £6,600, or £1·65 per kilowatt, and distribution £0·26 per kilowatt. Assuming it was required to earn 10 per cent. on the capital outlay, the earning power per kilowatt must be :—

Interest on capital = 10 per cent. on £31 ...	744d.
Operating expenses = £1·65	396d.
	1,140d.,
Or, allowing 10 per cent. loss	1,266d.

At a load factor of 100 per cent., the cost per unit would be :—

$\frac{1266\,d}{8760} = 0{\cdot}145d.$, to which cost of fuel must be added.

Assuming the diversity factor to be unity, then the cost per unit would be 1,266 = hours' demand × price per unit.

Similarly, in the case of a long transmission, the earning power would be :—

Interest on capital = 10 per cent. on £37·5	= 900d.
Operating expenses	£1·65 = 396d.
Distribution charges	£0·16 = 62d.
	1,358d.,
or, allowing 2 per cent. loss in distribution,	1,698d.

The cost per unit at 100 per cent. load factor would again be :—

$\frac{1698}{8760} = 0{\cdot}194$ pence *plus* cost of fuel. For any other load factor the cost per unit (less cost of fuel) is then given in the following table :—

Annual Load Factor per cent.	Distribution near Generating Station.	Distribution 27 miles from Generating Station.
	d.	d.
10 ...	1·444 ...	1·940
20 ...	0.731 ...	0·970
30 ...	0·486 ...	0.646
40 ...	0·364 ...	0·484
50 ...	0.291 ...	0·390
60 ...	0·243 ...	0.323
70 ...	0·208 ...	0·226
80 ...	0·182 ...	0.242
90 ...	0·162 ...	0·215
100 ...	0.144 ...	0·194

In the scheme for which these figures were prepared, the speaker added, no addition need be made for fuel costs, as the plant was intended to be driven from producer gas obtained from peat fuel, and it was estimated that the recovery of the sulphate of ammonia would at least cover the cost of peat used. The "diversity factor," where operative at the lower load factors, would reduce the cost per unit.

Mr. MARK RUDDLE (Engineer-in-Chief, Dublin Corporation Electricity Works) said it was all very well for Mr. Snell to criticise the heavy capital outlay per kilowatt in some of the older stations, but it was there, and the difficulty had to be faced. Mr. Snell appeared to consider that only in a big power company could there be salvation. Mr. Ruddle, however, thought it was easy to work out a very rosy result for a hypothetical power company, but in practice the business had to be got, and the best plans frequently had to be departed from. For instance, primarily one might schedule a certain street or district as good for power requirements, but later, when the undertaking came into operation it was often found that the demand was in quite another quarter, which necessitated deviation from the original plans, or perhaps a duplicate expenditure. The speaker did not share Mr. Snell's pessimistic attitude towards those companies and corporations who were supplying power at low rates. In many cases the power load had resulted in a great reduction in costs, and he considered that there was every hope for the existing systems. In any case it was altogether too early to condemn them. The whole Paper was apparently considered from the view of the necessities of London, but personally he was not at all sure that it was not a sounder policy to divide the risks among a number of stations rather than concentrate the whole. Mr. Ruddle considered that a 5,000-kw. station could be just as economically worked as a 25-kw. one. Finally, he asked the author how he had determined what he had termed the "correct charges" which the London companies and authorities should make as given in Table VII.

Mr. L. J. KETTLE expressed the opinion that if Mr. Snell's figures were correct nobody would buy electrical energy, whereas the Dublin Corporation were doing a considerable and growing business in supply for motive power. He was very interested to notice that according to Mr. Snell's figures suction gas plants cost more to run than steam; he had always understood that the reverse was the case, at any rate so far as small plants were concerned.

Mr. P. S. SHEARDOWN (Electrical Engineer, Dublin United Tramways) said that the capital cost per kilowatt of the largest power company, that at Newcastle, was £59·6, and in the light of that the figure of £12 given by the author seemed absurd.

Proposed New West Indian Cable.—At a meeting of the executive committee of the West India Committee on Thursday, Sir Nevile Lubbock presiding, a resolution was passed favouring the establishment of an all-British cable to the West Indian colonies via Canada.

Heavy Electric Cars at the Berlin Automobile Exhibition.—Electrically-propelled vans and other heavy vehicles formed quite a prominent feature of the recent Automobile Exhibition at Berlin, and showed clearly that much more attention is being paid on the Continent, as is also being done in America to this class of vehicle. One of the most interesting of the exhibits of this nature, a *résumé* of which is given in *Motor Traction*, was the series of cars ranging in size up to brewers' drays for two tons, shown by the Bergmann Co., and equipped with the much-talked-of but rarely seen Edison battery in the 175 ampere-hour size. Another prominent exhibit was a large fire escape, shown by the Deutsche-Mercédès-Verkaufs-Ges, mounted on an electrically-propelled chassis, driven by hub motors similar to those familiar in this country on the Mercédès electric carriages (see ELECTRICAL ENGINEERING, Vol. II., pp. 797). The Norddeutsche Automobil und Motoren A.G., of Bremen, exhibited a number of vehicles on the well-known Kriéger system, including a 30 h.p. petrol-electric chassis. A representative collection of vehicles illustrated the Scheele system, which was fully described in ELECTRICAL ENGINEERING, Vol. I., p. 689. The well-known accumulator firm of Hagen showed a number of electric vehicles ranging from a large combined fire engine and escape for Düsseldorf and a large street-washing machine. The Siemens-Schuckert Co., who, we believe, have only recently taken up this class of work, showed nine vehicles. Like a number of the German firms, this company believe in the hub motor for some purposes, but exhibit other types as well. Perhaps the most notable feature of these cars is the arrangement of the switchgear. Great care has been taken to obtain very graduated variations from one "speed" to another, and a field rheostat with an exceptionally large number of contacts is employed. The gearing between the controller handle and the switch appears unnecessarily complicated. The application of either brake cuts off the current, but to start again it is necessary to bring back the controller to zero. The majority of the exhibits except two or three notable examples appear to be somewhat in the experimental stage, and a tendency to employ somewhat undersized batteries is apparent.

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A NEW PETROL-ELECTRIC OMNIBUS FOR PUBLIC SERVICE

ON more than one occasion we have remarked upon the shortcomings of the usual mechanical gearing and clutch mechanism of the ordinary petrol motor omnibus, as we know it in the streets of London, under the exceptionally severe conditions which it is called upon to fulfil, and have drawn attention to attempts that have been made to introduce an electrical form of transmission gear, with the object of obtaining greater smoothness of action, freedom from noise, and diminished cost of upkeep. (ELECTRICAL ENGINEERING, Vol. I., pages 456, 461, and 463.) Quite a considerable number of such systems, varying a good deal among themselves, have been brought forward, companies have been floated, and more or less extensive trials have been made with the object of detecting the weak points in designs which had appeared feasible on paper. It is of some interest, therefore, to learn that after all this preliminary work an actual petrol electric omnibus is now being put to the test of regular work in London by Messrs. Thomas Tilling & Co., Ltd., and started running on the Sidcup and Oxford Street route on Saturday.



FIG. 1.—"HALLFORD" PETROL-ELECTRIC OMNIBUS.

The chassis of the omnibus in question, which is fitted with one of Messrs. Tilling's standard 34-seated bodies, was supplied by Messrs. J. & E. Hall, Ltd., of Dartford, by whom the engine, frame, and all mechanical parts were constructed, and is fitted with an electrical equipment manufactured by Messrs. W. A. Stevens, Ltd., of Maidstone. In numerous details, the design has benefited by the experience of the actual conditions of motor omnibus work of Mr. P. H. Frost Smith, chief engineer to Messrs. Tilling's motor department. The complete omnibus is known as the "Hallford," and the petrol-electric system is covered by the "S. B. & S." syndicate and Stevens' patents. A view of the vehicle is given in Fig. 1, and full details of the arrangement of the chassis can be seen in Fig. 2.

The engine is similar to that employed in the Hallford heavy vans, which received one of the gold medals in the recent commercial vehicle reliability trials of the Royal Automobile Club, and is of the four-cylinder vertical type, with an R.A.C. rating of 30 b.h.p. The cylinders, which are each of 110 mm. bore × 140 mm. stroke, are cast in pairs, and a symmetrical arrangement of the inlet and exhaust valves on opposite sides of the engine, and actuated by separate cam shafts within the crank chamber, is adopted. High-tension magneto ignition is employed, with duplicate plugs for each cylinder, and forced lubrication is used throughout. A throttle governor is provided, which can be set for speeds up to 1,050 r.p.m. This is the maximum speed at which the engine can be run under any circumstances. Ball bearings are employed for the main crankshaft, but not for the connecting rod big ends. The engine is supported on two steel cross frames at three points only, thus allowing a considerable degree of flexibility.

Before proceeding to describe the electrical equipment and method of driving the road wheels, attention may be drawn to the design of the steering-gear and front axle. A straight solid forged steel axle is employed, the central part of which is of girder section with a tapering portion at each end, and the steering gear, which is remarkably simple, is arranged so that all its working parts are well protected by being above and behind the axle.

The electrical equipment, like that in the earlier forms of Messrs. Stevens' system as applied to smaller vehicles, is of the type where the transmission is at all times electrical, without any mechanical connection between the engine and the road wheels, and works with continuous current without employing accumulators. It simply takes the place of the clutch and gear-box of the ordinary mechanical system. As will be seen, however, the arrangement of control is somewhat different from that of the petrol-electric equip-

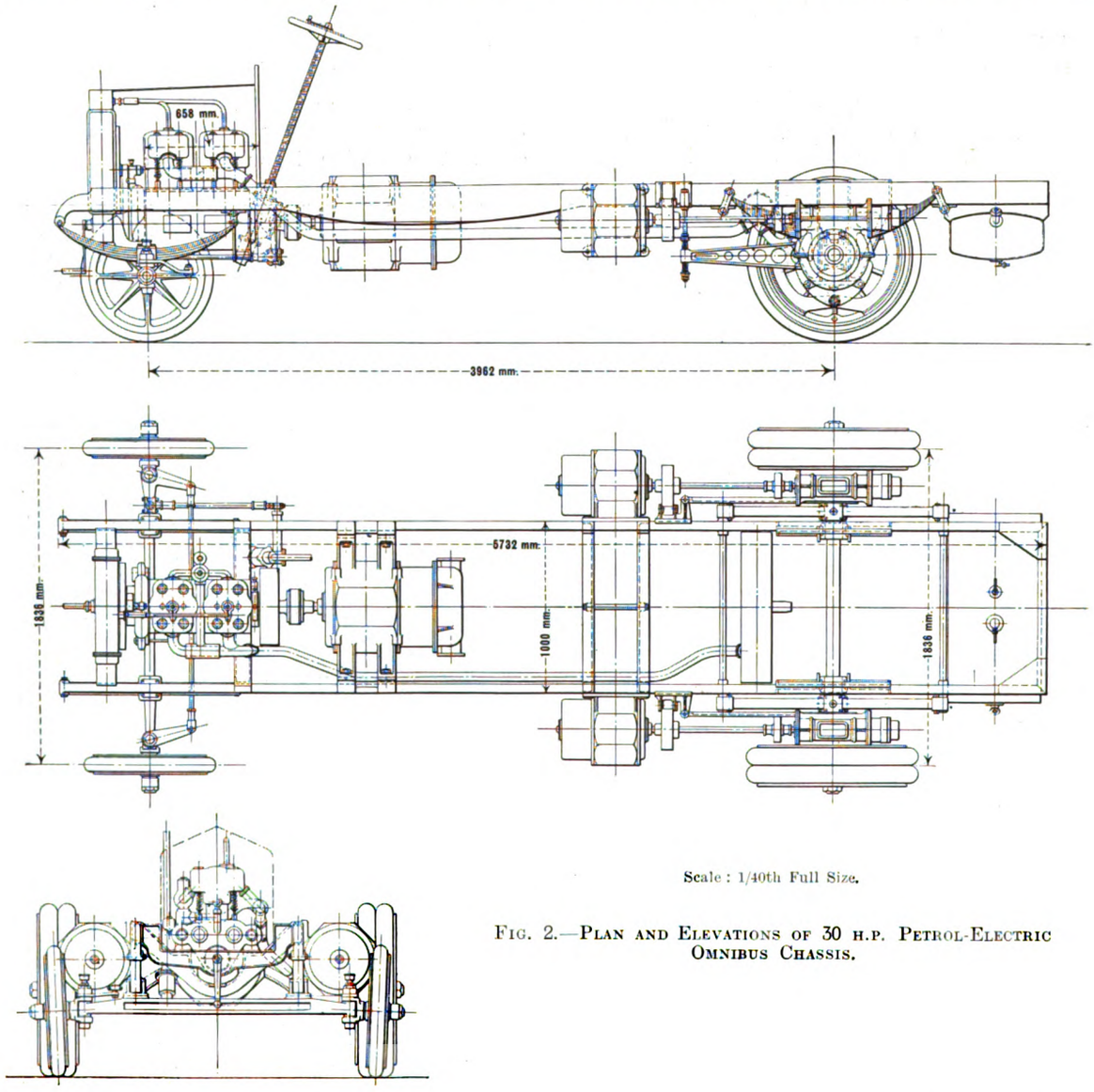
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ment which Messrs. Stevens showed at the Commercial Vehicle Exhibition at Olympia last March (see ELECTRICAL ENGINEERING, Vol. I., p. 462), in that two motors are employed, and the generator has not a double-wound armature. The solenoid control of the engine throttle has also been abandoned. The general feature aimed at has evidently been simplicity, which is all important in this class of work.

The dynamo, which can be seen in position in Figs. 3 and 4, is connected to the flywheel of the engine by means of a flexible coupling. It is of the enclosed type, with cast steel frame and aluminium end plates, and weighs complete about 8 cwt. It will be noticed in Fig. 4 that it is supported from lugs attached to the frame by brackets cast on to the case. The suspension is so arranged that by withdrawing a few bolts and sliding the dynamo a few inches longitudinally, it can be lowered and removed from below without disturbing any other part of the mechaism.

Although enclosed, the dynamo is most efficiently ventilated by a Sirocco fan, mounted on the back end of the armature shaft inside the casing, which draws air right through the machine from an intake aperture at the top, covered with wire gauze. The generator is of the four-pole, shunt-wound type, provided with interpoles, and is designed for an output of 200 amperes at a normal voltage of 180 volts. It can, however, work up to about 200 volts. The utmost care has been taken in the proportions of the winding of the interpoles, with the result that not only does the machine run sparklessly under the trying conditions of varying load and voltage to which it is subjected, but, as has been shown by repeated experiment, the armature can be absolutely short circuited practically without sparking. "Morganite" brushes are used on both dynamo and motors.

The position of the motors is shown clearly in Figs. 1 to 4. They are mounted rigidly in a longitudinal position outside the frame, and each drives one of the rear road wheels through a telescopic universal joint, a short cardan shaft, and thence through universal joints of the ordinary star pattern, and a specially designed worm gear with a 12 to 1 ratio. There is thus an entire absence of spur or bevel wheels and chains, and as each motor drives its own wheel, the differential gear is entirely eliminated. The design of the back axle is particularly worthy of note. A "dead" axle of solid steel is employed, provided with horn blocks, the bearings of which are spherical and therefore capable of movement in every direction. The arrangement of the worm gear by which the wheels are driven is shown in Fig. 5. The worm casing is bolted to a flange forged solid on the axle itself, on to which flange is secured the torque rod, which is steadied at its outer end by two heavy springs. The worm wheel is carried on a housing supported on ball bearings of ample size, provided with separate ball races for taking the thrust. The connection between the worm wheel and the road



Scale: 1/40th Full Size.

FIG. 2.—PLAN AND ELEVATIONS OF 30 H.P. PETROL-ELECTRIC OMNIBUS CHASSIS.

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wheel is by means of a dog clutch, so that the wheel can be readily taken off for the renewal of tyres, &c., at any time, without in any way disturbing the worm gearing. This arrangement also obviates any side strain to which the worm wheels might be subjected. The worm itself forms simply a prolongation of the cardan shaft, and is also provided with ball bearings and thrusts. The worm wheel is constructed of phosphor bronze, but the worm is of hardened steel, and the whole runs in a special graphite grease. A water-cooled brake drum is mounted on each motor shaft, close up to the motor, in a most accessible position for inspection and adjustment, and powerful side brakes of the expanding type act upon the inside of the rim of each road wheel. It may be suggested that there is a possible course of danger in the rapidly revolving motor shafts being exposed, but a light removable cover could easily be arranged.

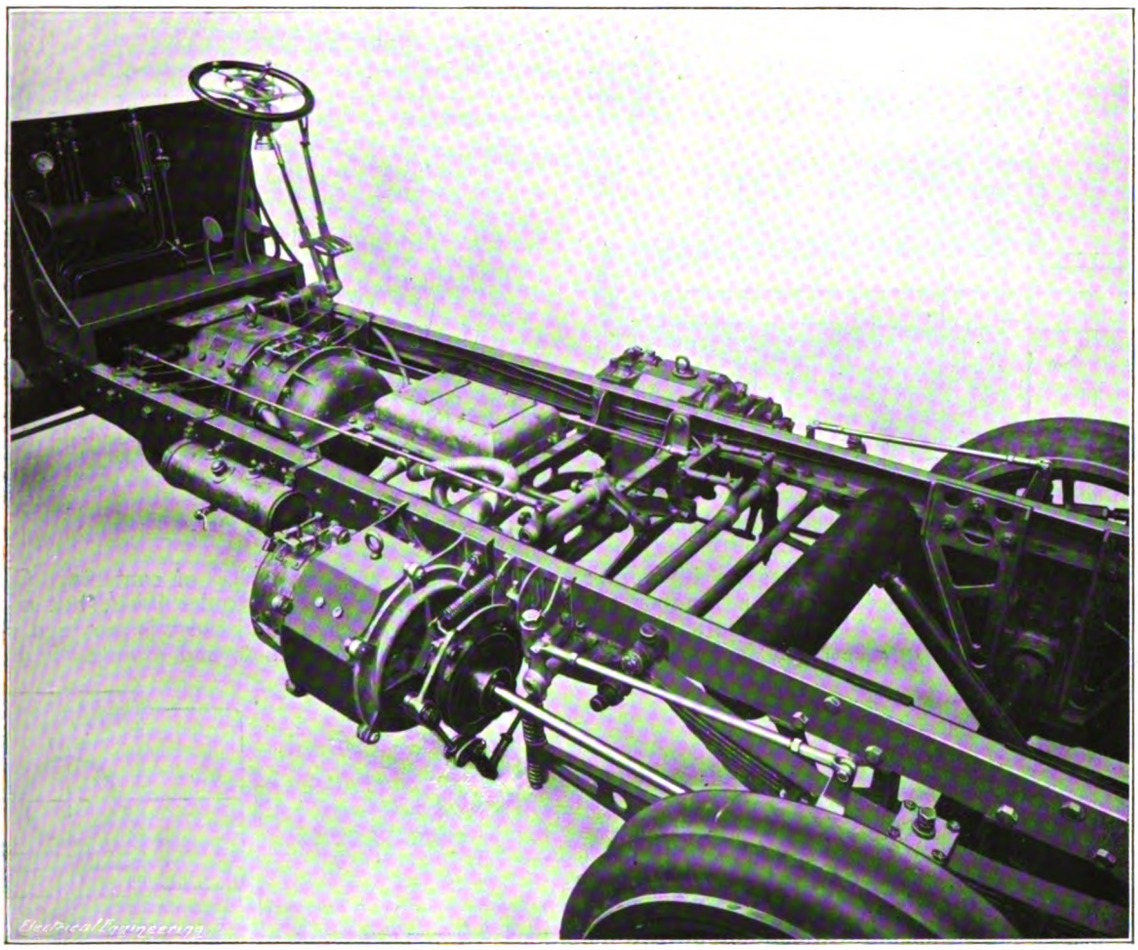


Fig. 3.—View of Chassis, showing Electrical Equipment, &c.

The motors themselves are of the four-pole, series-wound, enclosed type, closely resembling the ordinary tramway motor in the main points of their design. They are of ample size to deal with the whole output of which the generating set is capable, and weigh about 400 lb. each. Control of the vehicle is effected partly electrically and partly by means of the engine throttle. A full diagram of connections is given in Fig. 6. The main items of the control equipment are the main controller, worked by a side lever, which is used to place the motors in series or parallel and for reversing, and the field regulating rheostat of the generator, which is worked by a small lever moving over a quadrant on the steering wheel. There is also a main switch actuated by a pedal. The engine control is effected by a throttle lever on the steering wheel, which works in connection with the engine governor, and can be set to cut the engine down to a low speed, and an accelerator pedal, by which the throttle can be opened irrespectively of the position of the throttle lever, but which if released allows the engine to take up the reduced speed determined by position of the throttle lever.

The main controller corresponds exactly to the ordinary "change speed" lever, giving two forward speeds (series and parallel), and one (series) reverse. No series resistances are used. It might be thought

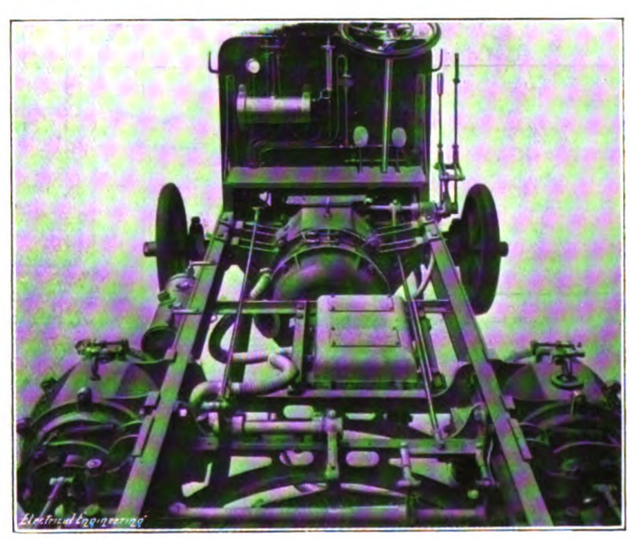


Fig. 4.—View of Chassis looking Forwards, showing Method of Supporting Generator.

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that only two "speeds" would not be sufficient, and with mechanical gearing this would certainly be so, but the extreme flexibility of the electrical transmission, owing to the voltage control of the dynamo, and the perfect smoothness with which it takes up its work, goes far to eliminate the necessity for a number of steps to the main controller. Although the speed on hills might be improved, in practice it is found that except on very steep hills the controller can be left permanently in the parallel position, upon which all starting and manœuvring in traffic can be done. The main controller itself is contained in a case under the driver's seat, and consists of an inner and an outer ring of metallic contacts on a slate base, arranged as shown in Fig. 6. Over these contacts moves a four-arm switch piece carrying brushes for suitably connecting the inner and outer ring of contacts. Current is never broken on this controller itself, but a separate main switch, referred to already, is provided, which is fitted with carbon contacts and a magnetic blow out. This switch is worked by a pedal, and is interlocked with the controller lever in the manner shown in Fig. 7, so that the lever can only be moved when the main circuit is broken. There is, however, no arrangement

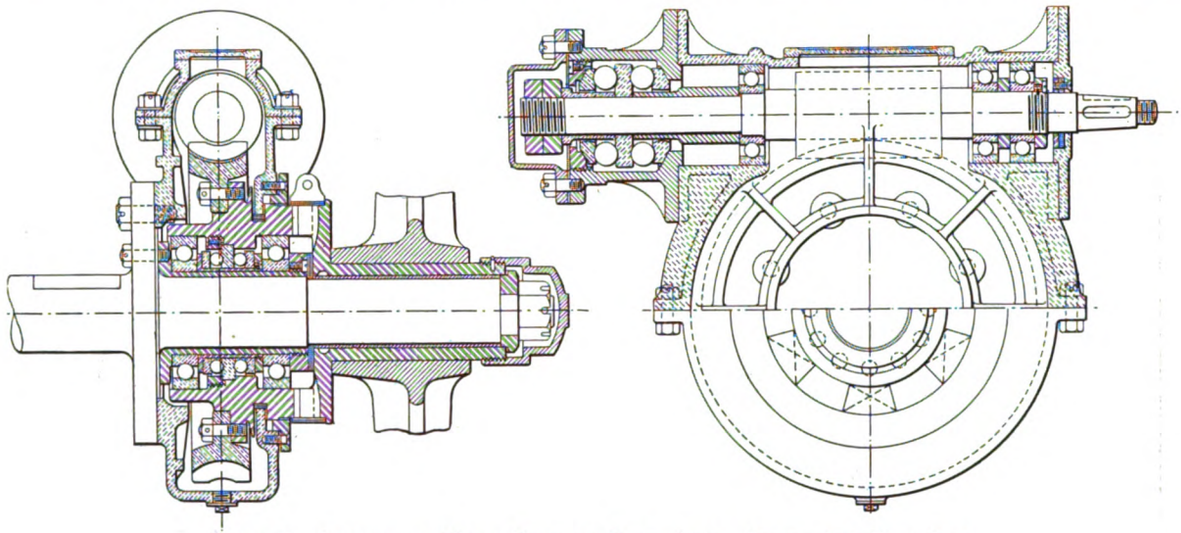


FIG. 5.—SECTION OF WORM GEAR ON BACK AXLE. SCALE: $\frac{1}{8}$TH FULL SIZE.

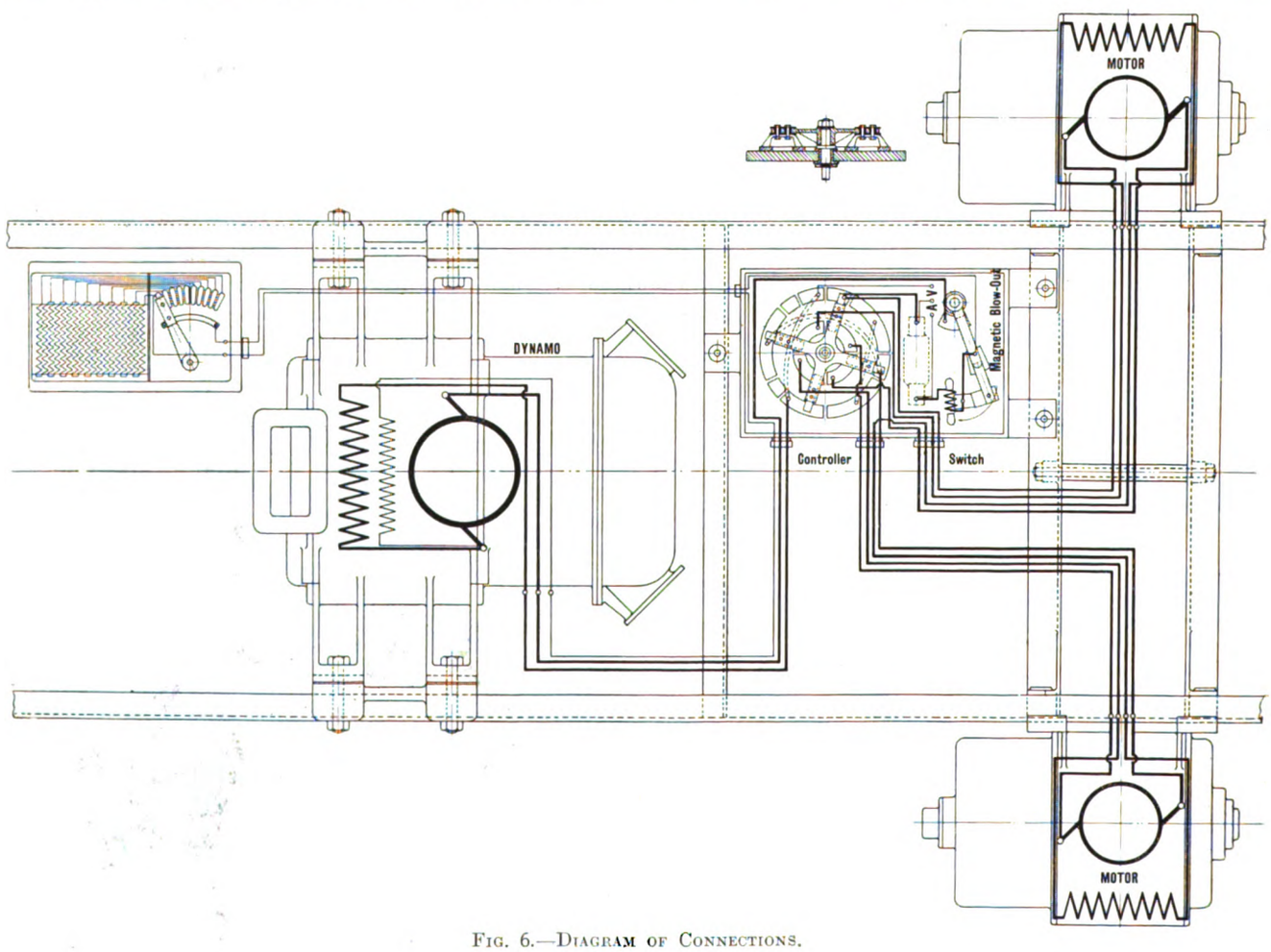


FIG. 6.—DIAGRAM OF CONNECTIONS.

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for ensuring that the lever is in the neutral position when the engine is started, so that there is a possibility of the vehicle starting off if the lever has been inadvertently left in the forward position with the brakes off. No provision is made for electric braking. The field-regulating resistance for the generator is contained with its switch in a watertight case inside the engine bonnet on the right-hand side of the engine, near the magneto. The wiring from the controller to the generator and motors is enclosed in flexible metallic tubing with watertight screwed joints.

The control of the speed of the vehicle is effected almost entirely on the accelerator pedal and the field switch, and under ordinary conditions the main circuit is never broken, even at stopping. Before starting, unless the gradient is very steep, the controller lever is put into the parallel notch with the engine running slowly, and the generator field reduced. In order to start, the brakes are released, and the engine is accelerated by opening the throttle with the pedal so that the voltage of the dynamo rises, the field switch is gradually moved over to raise the voltages as the vehicle gains speed. The running speed is then controlled by the throttle pedal, and to stop the throttle pedal is released. the dynamo field weakened, and the brake applied.

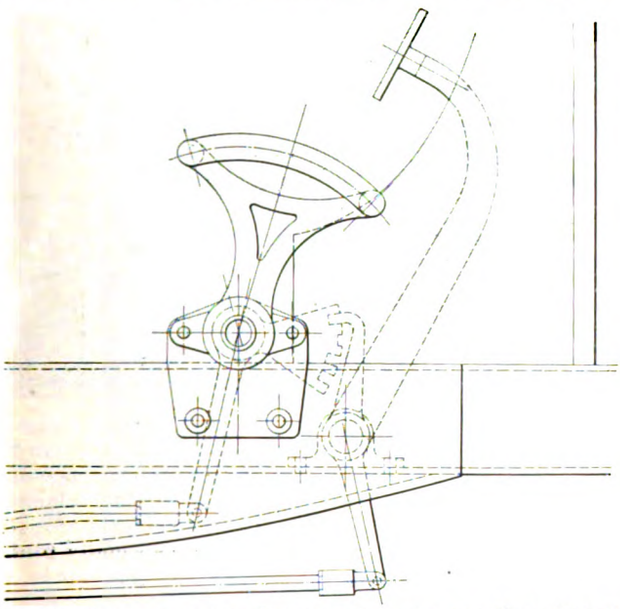


FIG. 7.—ARRANGEMENT OF INTERLOCKING BETWEEN MAIN SWITCH PEDAL AND CONTROLLER LEVER. SCALE: ⅛TH FULL SIZE.

without, however, breaking the main circuit. It should be observed that the accelerator and main switch pedals are both worked by the driver's right foot, and cannot be depressed at once. It is thus impossible for the main circuit to be broken when the engine is running fast. In order to start, the brake has only to be released when the vehicle will gently commence to move. It will be seen that although the principal control is by means of the throttle pedal, attention has also to be paid by the driver to the handling of the field switch. If, for example, the field is too strong during acceleration, when the motors are taking a heavy current, the voltage for a particular engine speed will be too high, and the engine will be overloaded, and will be heard to knock, and in like manner when climbing a steep hill at reduced speed, a reduction of the field is necessary in order to allow the engine to get away with the load. A very small amount of practice will enable the driver to know the best position of the field switch for different circumstances. The manner in which it is handled is not unlike that of the ignition of a petrol engine, which should be retarded when the engine is running slowly heavily loaded to obtain the best results, and advanced for high engine speeds. A short ride on the omnibus soon demonstrates the simplicity of the control and the extreme quietness and smoothness of starting and running. It is intended that the omnibus be driven by a driver who is not allowed to make any mechanical or electrical adjustments, and to prevent interference by unskilled hands the commutator covers of the motors and generator are provided with locks.

The most interesting consideration is, of course, wherein lie the advantages over the ordinary gear-driven omnibus. The increased silence and smoothness of running are obvious, but against them must be put slightly extra weight and possibly a slightly worse average overall efficiency of transmission to the road wheels, which would be unfavourable in hilly districts. On the other hand, it is likely that, owing to the better conditions at starting, a somewhat smaller engine may be used for the same class of service, so that the petrol consumption is not by any means excessive. The main point, however, where economy is to be expected, is in the reduction of garage expenses, and the avoidance of the heavy maintenance and depreciation due to the short life of gears and clutches. Mr. Frost Smith estimates that whereas at present 1·5 men per car are required at the garage in the night shift, 0·75 men per car would be sufficient with petrol-electric vehicles. The following table compares the items of expenditure as ascertained for gear-driven omnibuses with those estimated for the petrol-electric system, taking account only of those headings under which a change is expected.

	Pence per Car-Mile. Gear-Driven.	Petrol-Electric.
Depreciation	1·375	1·000
Running	0·666	0·333
Maintenance	2·500	0·666
Grease, oil, &c.	0·350	0·175
	4·891	2·174

The remaining items would be unaffected. This shows an expected saving of 2·717d. per car-mile.

Before the chassis was taken over by Messrs. Tilling's some extensive road trials were made, in one of which a trip was made from London to Hastings, over an exceedingly trying road, with a load representing an omnibus body and half a dozen passengers, when the petrol consumption is reported to have been about eight miles to the gallon.

A demonstration run of the omnibus was held on Thursday last, when, by the invitation of Messrs. J. & E. Hall & Co., a party, which included some representatives of the technical Press, were enabled to form their opinions of the working of the system. A start was made from the Motor Club in Coventry Street at 11.20 a.m.; the route was by way of Westminster Bridge to Peckham, where the first stop was made at Messrs. Tilling's omnibus offices to allow more passengers to be taken up. The run proceeded very satisfactorily to Eltham, where a slight mishap to the circulating pump delayed the run for a few minutes. The journey was soon continued, everything ran smoothly, and the 'bus arrived at Messrs. Hall & Co.'s works at Dartford soon after 2 p.m. The run was accomplished without any electrical troubles, the engine, dynamos, and motors working very smoothly. There was a noteworthy absence of vibration or noise. The 'bus attains a good speed on the level and slight gradients, on which kind of road it was entirely run on with the controller in the parallel position, and only once, when ascending a steep hill just before reaching Crayford, were the motors put in series. On arriving at the works a complete inspection of the vehicle was made, and the commutators of both dynamo and motors were examined. The surfaces of these were found to be in excellent condition, showing a total absence of sparking, and all the armatures were quite cool. The company then partook of lunch at the North Pole Hotel. After lunch the party was conducted round the works and shown many interesting details in the manufactures

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of the firm. The return journey was commenced soon after 5 p.m., and everything ran perfectly. The route on the homeward journey was through the Blackheath district, and over Shooter's Hill. When about halfway up this hill the motors were put in series. The 'bus was stopped on the steepest part of the hill, in order to see if it would start on that gradient when the motors were in parallel, but after several unsuccessful attempts they were again put into series, and the journey was continued, finally concluding a few minutes after 7 p.m. at the Motor Club.

The 'bus behaved splendidly, and one of the most pleasing features from the passengers' point of view is the easy and smooth manner of starting, absolutely without jerk, but just an easy gliding away. The absence of clutch and gearing entirely does away with the noise and sudden jumps forward which are unfortunately too familiar in the case of the ordinary petrol 'bus. The brakes are exceedingly powerful, but when put into operation the vehicle pulls up with an easy and quiet motion. The system appears well adapted for London and suburban street traffic. The speed on the level is evenly maintained, but on steep gradients the rate of progress is rather slow, although sure.

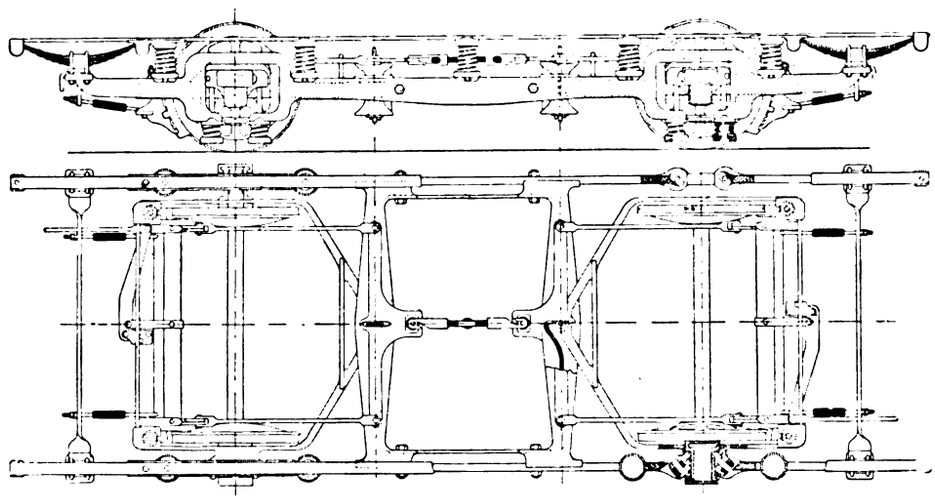
Starting Large Motor-Generators.—A somewhat unusual method of starting large motor-generators used by the Edison Illuminating Co. at Detroit, is described in *The Engineer*. A pneumatic jack is employed which consists of an air cylinder with a piston connected to an arm, this arm having a pawl engaging a ratchet on the armature shaft. The idea is for this jack to give the armature a single impulse to overcome the standing bearing friction, which is considerably higher than the running friction of any plain bearing, and also to overcome some of the inertia of the rotating parts. It is stated that by the use of this device the machine can be started with a maximum current of 500 or 600 amperes, as against 1,500 amperes when it is started in the usual manner from rest.

Electrical Engineers' Ball.—This annual event is to be held at the Hotel Cecil on Friday, January 31st. Tickets, price one guinea, may be obtained from any of the following members of the Committee:—Messrs. H. Alabaster, A. K. Baylor, J. Horace Bowden, H. W. Bowden, Guy Burney, J. Carlton, T. O. Callender, E. A. Carolan, A. Clift, E. C. De Segundo, R. S. Erskine, A. L. C. Fell, G. Flett, E. J. Fox, T. E. Gatehouse, Sir J. Gavey W. Geipel, Dr. R. T. Glazebrook, James Gray, R. Kaye Gray, A. E. Hadley, Robert Hammond, H. E. Harrison, H. Hirst, J. S. Highfield, H. R. Kempe, J. E. Kingsbury, E. M. Lacey, W. E. Lane, H. M. Leaf, G. C. Lloyd, W. L. Madgen, W. Lee Matthews, W. H. Massey, W. M. Mordey, H. T. S. McKay, P. V. McMahon, F. H. Nalder, W. A. Major O'Meara, G. W. Partridge, J. Petersen, J. S. Raworth, J. H. Rider, Martin F. Roberts, W. Rutherford, J. H. Rosenthal, Alex. Siemens, A. M. Sillar, F. A. Smith, J. Spagnoletti, T. E. P. Stretche, G. Sutton, E. M. Sawtelle, C. P. Sparks, C. D. Taite, J. Taylor, and R. J. Wallis-Jones. The Executive Committee consist of Messrs. J. E. Kingsbury, P. V. McMahon, G. C. Lloyd, Martin F. Roberts, and R. J. Wallis-Jones. Mr. R. Hammond is Hon. Treasurer, and the Hon. Secretaries are Messrs. A. M. Sillar and H. Alabaster.

THE WARNER TRAMCAR STEERING CONTROL

A Flexible Four-wheeled Truck

A LARGE party of engineers, including some representatives of the technical Press, were present on Friday last, at the invitation of Mr. J. Sutherland Warner and the Warner Engineering Co., at a demonstration of the Warner patent "steering control," as applied to tramcars, held, by the courtesy of the chairman, and Mr. H. E. Blain, general manager of the West Ham Corporation tramways. A car fitted with the truck which had been in service on the West Ham tramways for about two years was inspected. Briefly, the idea sought after is the construction of a four-wheeled truck, in which certain degrees of freedom are allowed, which enable the two axles to conform readily to variations in the "straightness" of the track independently of each other, and without causing the body of the car to deviate appreciably from a smooth course. Mr. Warner designates the ideal course of the centre of gravity of the car by the picturesque expression, "The conformity line." A further advantage claimed for his truck against the ordinary parallel axle truck is the diminution of flange and rail wear, especially round curves and on irregular tracks by the avoidance of sudden jerks from side to side.



ELEVATION AND PLAN OF WARNER NON-PARALLEL AXLE TRUCK.

A plan and elevation of the truck is given in the accompanying figure, from which it will be seen that each axle is carried on bearings, which are mounted on a frame pivotted on a king pin between the axle and the centre of the car, while the main frame carrying the body springs is hung by means of short swinging rods from the axle boxes, giving the necessary freedom for angular motion of each axle. The object is in some ways similar to that of the radial axle-box, but is attained in a different way.

The first part of the demonstration consisted in taking a car fitted with the truck a short distance along the road, and tracing a line along the ground by means of a thin stream of whitewash, running from the car body, with the object of showing how little the course of the car deviated from the "conformity line." This test, although sufficient to show what was required, would, of course, have been more striking if carried out on a more irregular track than can be found on the West Ham system. After this the floor boards were taken up in order for the movement of the axles to be watched, and a more extended trip was taken. The so-called steering action was clearly seen, and it was generally agreed that the running of the car was particularly smooth. Finally, a car fitted with an ordinary parallel axle truck was subjected to similar tests for the sake of contrast.

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INSTITUTION OF ELECTRICAL ENGINEERS

Election of New President



Photo. by Elliott & Fry.

COL. R. E. B. CROMPTON, C.B.

President of the Institution of Electrical Engineers.

AT the meeting of the Institution of Electrical Engineers on Thursday, Mr. C. P. Sparks, the senior Vice-President, announced that at the meeting that afternoon, the Council had unanimously elected their Past President, Col. Crompton, as President for the remainder of the session.

COL. CROMPTON, R.E., who thereupon took the Chair, said it was with very mixed feelings that he came before the meeting. An hour previously nothing was further from his thoughts than that he would have to asume that position. He could not say how deeply he felt the honour of being called upon to succeed the greatest man in the world—at any rate in the electrical world—and how sad it made him feel that his being in the Chair was caused by such a world's loss. Lord Kelvin had been so long the central figure of the electrical world that they did not realise how much was due to his gigantic labours in electrical science, and how much the whole of the English electrical community had borrowed from him. Ever since he had himself begun to work at electrical matters, he had known Lord Kelvin personally. He had been associated with him in the work of the Corps of Electrical Engineers, and in the international work of which Lord Kelvin was the world's president, and he knew that it would not be easy to replace him. It was difficult at short notice and in a few words to convey to them how great was the loss the Institution had sustained; but in any event it would have been very hard to express what he really felt and what they all really felt at the death of their President.

He thanked the Council for asking him to fill the gap for the remainder of the session. He would do his best to serve. He was an old man, and not so vigorous as he had been, but he would do his best to make the session a success.

Col. R. E. B. Crompton, C.B., who was previously President of the Institution in 1895, was born in 1845, and is thus nearly sixty-three years of age. The firm of Crompton & Co. was established at Chelmsford in 1878, so that Col. Crompton has been associated with the electrical industry from its very earliest stages. Col. Crompton has always been the moving spirit of the Electrical Engineers Corps of Volunteers, of which he has been commanding officer since the death of Dr. John Hopkinson, F.R.S. His work with the detachment of the corps which served during the last South African War brought him to the notice of the military authorities in connection with steam haulage for transport work, and he has since been acting as technical adviser to the Mechanical Transport Committee of the War Office. In December, 1907, the honorary rank of Colonel was conferred upon him.

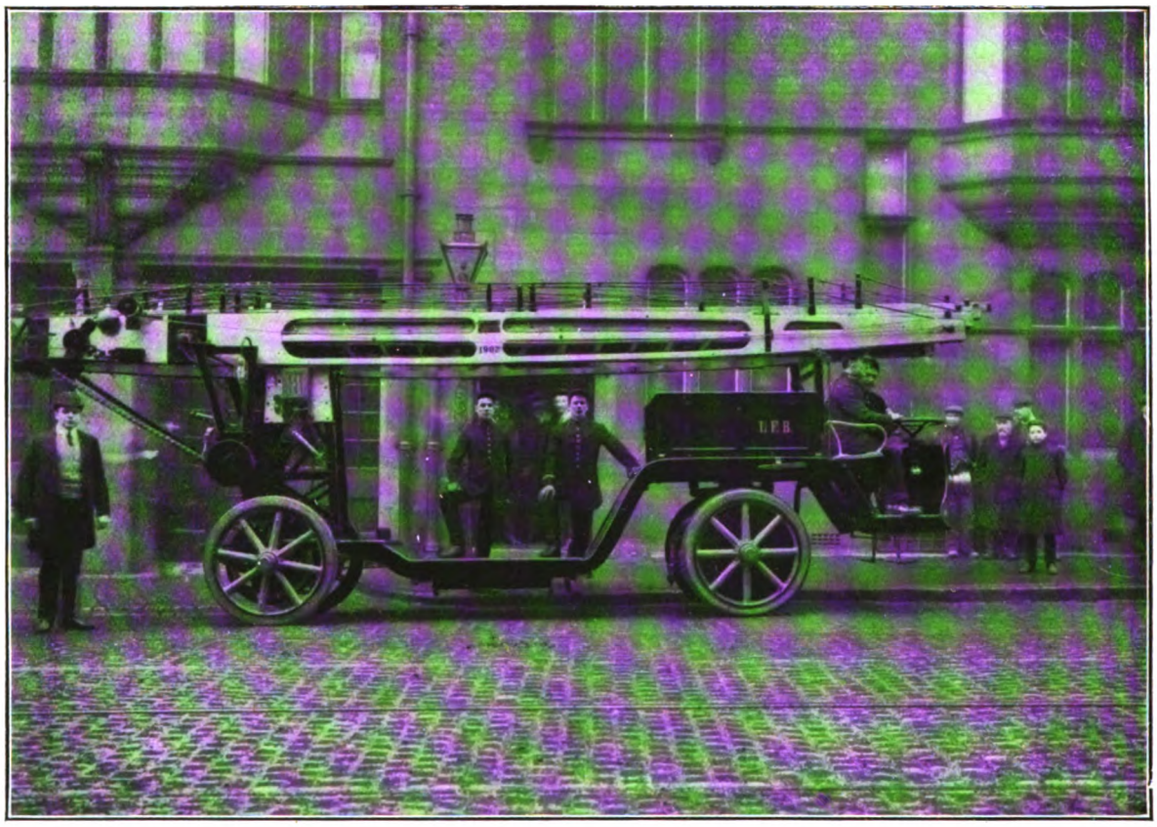
AN ELECTRICALLY PROPELLED FIRE ESCAPE

SEVERAL fire brigades in this country have now adopted mechanical traction to some extent, but comparatively little attention has been paid to electrical methods, although a good deal has been done in this direction on the Continent. The principal argument in favour of electric traction for fire appliance is simplicity, and the fact that less skilled attendance is required on the road as compared with petrol-driven vehicles. Electric accumulator traction is particularly suitable for fire brigade service, where the runs of the machine average about three miles per turn-out, and there is no reason why the electrically-equipped car should not be a great success. The electrical equipment, as now adopted, is only used on the non-pumping appliances, that is, the escapes, water towers, and auxiliary brakes for the conveyance of extra men. The electric drive has the advantage of being immediately ready for service. The car can be started at a moment's notice, as the batteries can be kept fully charged, and all that is necessary is to put in the starting switch and move off. These are undoubted advantages compared with the explosion engine method, with its starting handle to turn. In the motor-driven fire appliances recently placed on the market by Messrs. Simonis, of Norfolk House, London, some details of which were given in a Paper read by Mr. Otto Simonis, at the annual meeting of the Association of Professional Fire Brigade Officers at Liverpool last summer, the drive takes place on the two front wheels, by separate motors, through a single reduction internal gear. The motors are so arranged that while one is fixed to the front part of one wheel, the other is fixed to the hind part of the other. The battery consists of 80 cells, which are divided into groups of 10 cells each. These cells are interchangeable, and if any one cell requires attention it can be taken out and replaced at will. From the batteries, cables are led to the switchboard and controller, which latter is actuated by a lever, mounted on the steering wheel. This lever moves on a half-circle, and has nine different positions, five in one direction and four in the other. The first five are for the different speeds ahead, while the latter four are divided, the first two being the two electric brakes, and the other two the reversing speeds, so that in the one lever the driver can perform absolutely all the manipulations that are required for the handling of the machine. The front wheel drive has been adopted, as the most natural method of driving, and many advantages are claimed for it. In the first place, power is said to be saved by driving on the front wheels, and in the second place a fuller steering lock can be secured, as the front axle can even be placed directly sideways to the body of the machine, so that extreme turning capacity is obtained, which is vastly important in such appliances as fire escapes. There is one more point in favour of the front-wheel drive, and that, under most circumstances, is, it reduces liability to side slip. It stands to reason that if in going round corners the front and driving wheels draw the machine, the hind wheels will readily follow in their track, but if the drive is on the hind wheels the tendency of the power is to push the machine in a different direction to the front wheels, being steered sideways, and consequently the hind part of the machine swings round. The front wheel drive is also better adapted for get-

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ting out of the gutter of a sloping road, as the wheels can be put straight, and pull directly out, whereas with the back drive the back wheels tend to push the machine in the straight direction, and the front wheels fail to grip, and cannot pull the machine out.

There are two points to which attention may be drawn: one is that the battery can be carried in a space which otherwise would be of no service, such as between the axles and below the frame, so that the whole of the upper part is available for the accommodation of extra hose pipes, stores, &c. The second point is the comparative immunity against serious damage by collision. The car might get a knock which would place one of the driving motors out of action, but might still proceed at a slower speed by means of the other motor. If the car received a blow which bent the frame, it would not much matter so long as the wheels remained intact. The battery box might even get damaged without seriously affecting the running of the machine, and one or two sets of cells might even be put out of action. The accumulators are capable of allowing 200 to 250 full discharges without attention to the plates, which represents some 6,000 miles' running of the machine, a considerable distance for fire brigade apparatus. A complete set of plates cost about £90, and it is estimated that they would depreciate about 7 per cent.



ELECTRICALLY PROPELLED FIRE ESCAPE AT LIVERPOOL.

of their initial cost per annum, so that about six years may be taken as the serviceable life of the accumulators. The annual cost of the upkeep of an electrically-propelled machine may be roughly taken as follows:—Depreciation of the battery, £15; current for 1,000 miles, at 2d. per mile, £8 6s. 8d.; for acid, oil, washers, and so forth, say £5; in all a total of £28 6s. 8d., which will compare very favourably with the maintenance and cost of upkeep of the petrol-driven car, and very much more favourable than the steam-driven car, where it is always necessary to keep steam up. Among the important cities on the Continent where electric traction for fire brigade purposes has been adopted are:—Hanover, Munich, Charlottenburg, Schoneburg (Berlin), Offenbach, Duisburg, Leipsig, Paris, Basle, and, last of all, Vienna, which was the pioneer of motor-driven fire appliances, and has 21 self-propelled fire vehicles, of which 19 are driven by electricity. Glasgow was the first city in the British Isles to employ an electrically-propelled fire escape, but this is on petrol-electric principle, in which accumulators are not used.

The accompanying illustration represents a large electrically-propelled fire escape, supplied by Messrs. Simonis to the Liverpool Fire Brigade. The escape is carried on the machine telescoped in four sections, and lying with its trunnions on a steel frame affixed to a turn-table. An automatic device releases the ladders, and in doing so takes the weight off the springs of the carriage. By two men hanging on at the foot of the ladder it will now swing up into the vertical position, when the current from the batteries is switched over to the electric motor, built in at the foot of the main ladder, and which, acting on the winches, fully extends the ladder is about 20 seconds, so that the whole manipulation of the machine from its travelling position to its full extent is executed in less than half a minute. But while this is being done, the machine can be turned in any desired direction by means of the turn-table. Standing upright, extended to its full height of 87 ft., the machine will carry one man on top of each section of the ladder giving water with two lengths of hose against the burning building, without any support whatever except its own base, and this can be used most effectively as a water-tower, enabling the Brigade to get on top of the fire when it is quite impossible to lean against the building owing to it being involved in a mass of flame. For rescue work the escape is fitted with devices so that it can be placed at any angle, right down to the horizontal, or even made to form a bridge. It can be quickly shortened and extended again both by the electrical power and by manual labour. The trussing forms a hand-rail all the way up, and quite a number of minor safety devices are attached to the machine. When it is to be lowered again the automatic rung catches, which always fall in position when the ladder is extended, are released, and an oil brake will let the ladders slide down gradually, and allow them to be stopped at any moment.

The New Telephone Charges.—As the result of persistent representations by the various Chambers of Commerce throughout the country, the Postmaster-General has consented to receive a deputation on the subject of the new telephone charges on February 11th. The deputation will probably be received in the House of Commons at about 4.30 p.m., and is expected to include representatives of at least seventy Chambers of Commerce, about thirty Town and County Councils, and several of the leading trade associations of the country. The deputation will be introduced by Lord Joicey, President of the Newcastle Chamber of Commerce.

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ELECTRICAL POWER IN RAILWAY GOODS WAREHOUSES

MR. H. HENDERSON, in his Paper read last Monday before the Newcastle Section of the Institution of Electrical Engineers, summed up the chief advantages to be gained by the introduction of electrical power in dealing with goods traffic in warehouses as follows:—(1) More floor space available by making use of overhead travelling cranes. (2) Less aggregate power to perform the same work as hydraulic. (3) Less cost of power. (4) After the machinery is in running order, less maintenance is required.

Nos. 1 and 2 are very clearly seen by comparing the equipment of the North-Eastern Railway Co.'s Forth Goods Warehouse, Newcastle, as originally designed for hydraulic power, with that of the company's New Bridge Street warehouse. The

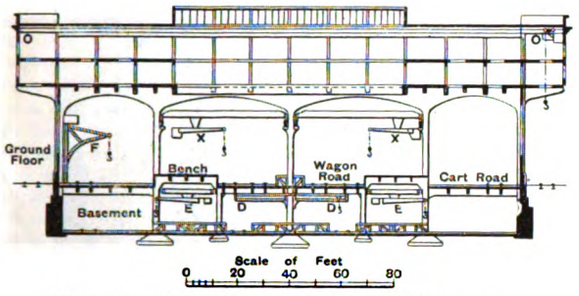


FIG. 1.—NEW BRIDGE STREET WAREHOUSE.

total number of hydraulic cranes at Forth Banks per row of benches was 18, in three rows, making a total of 54. These cranes served benches with an approximate length of 1,500 ft. and an area of about 48,000 sq. ft., which gives 30·3 h.p. per 1,000 sq. ft. of bench area and a lifting capacity of 1·4 tons for the same area.

In the company's new warehouse (Fig. 1) at New Bridge Street, Newcastle, which is designed for electrical working, four electric overhead travelling cranes, described later, serve two benches of a total length of 580 ft. and an area of about 15,000 sq. ft. These cranes give 6·13 h.p. per 1,000 sq. ft. of bench area, and a lifting capacity of 0·27 ton for the same area. These figures show what a great saving can be made by adopting such cranes, and that nine similar electric cranes could have

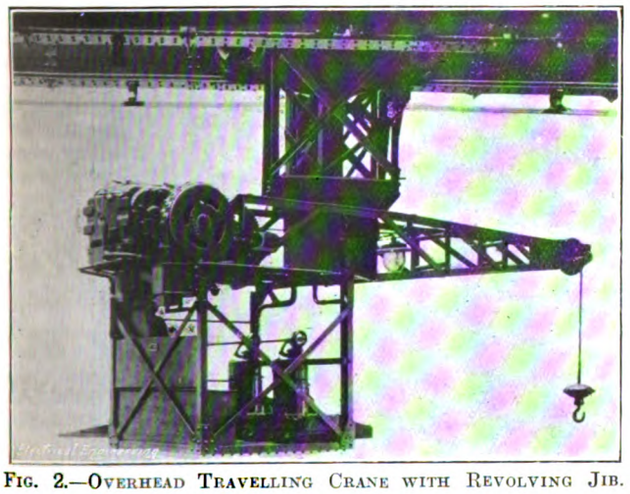


FIG. 2.—OVERHEAD TRAVELLING CRANE WITH REVOLVING JIB.

replaced the 54 hydraulic cranes at the Forth Goods Warehouse, where head room is ample for the use of overhead travellers. The figures cover all motions in each case.

The types of machinery used in a goods warehouse are:—(1) Machinery for dealing with goods, namely: cranes, hoists, &c. (2) Machinery for dealing with traffic, namely: capstans, hoists, and traversers

In describing the different types, the new goods warehouse of the North-Eastern Railway at New Bridge Street will be taken as an example, because it has been designed for electrical working, and the whole of the machinery is electrically driven. Under heading No. 1, a type of crane has been adopted which seems to be most suitable for this class of work. It consists of an ordinary overhead travelling crane, but instead of being fitted with the usual crab, the hoisting gear is attached to a revolving jib carried on a lattice framework fixed to the crab. The crane has thus four motions controlled by two universal controllers fixed to a platform on the revolving jib. The jib, controllers, and hoisting gear are clearly shown in Fig. 2, which also shows the method of suspension from the crab. The lifting capacity is 1 ton, and the sizes of the four motors are:—Lifting motor, 15 B.H.P. at 150 ft. per minute. Revolving motor, 1½ B.H.P. at 250 ft. per minute. Cross traversing motor, 1½ B.H.P. at 150 ft. per minute. Travelling motor, 5 B.H.P. at 350 ft. per minute.

The span is 48 ft. 6 in., and the jib radius 11 ft. From the

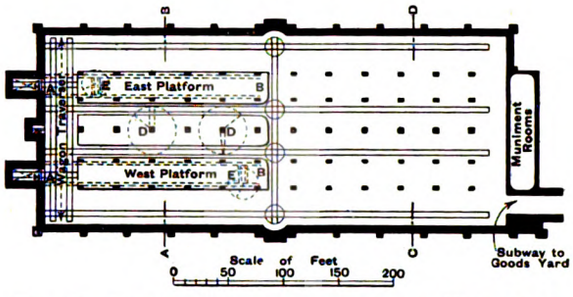


FIG. 3.—BASEMENT, NEW BRIDGE STREET WAREHOUSE.

cross-section of the building shown on Fig. 1, upon which these cranes are marked X, it will be seen that a jib can reach material outside the span of the main girders and do lifting work in three spans of the main building. This is a great advantage, as material can be taken from any wagon and deposited on a cart irrespective of the position of either vehicle. Such work cannot be accomplished by any other type of crane, and at the same time the full command of the whole of the bench is obtained without in any way taking up valuable storage space.

Other cranes on the same floor include two wall cranes shown at F on Fig. 1. These are ordinary revolving jib cranes with stationary machinery and a fixed driving platform. The machinery, consisting of lifting and revolving gear with a separate motor for each motion, is fixed on brackets above the top support of the crane, and the jib is revolved by a vertical shaft carrying a pinion, driving a spur wheel fixed to the top of the crane post. These cranes are capable of lifting 1 ton at

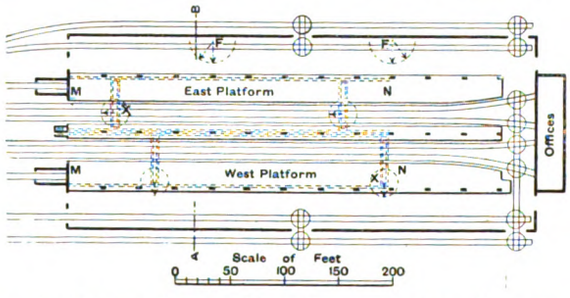


FIG. 4.—GROUND FLOOR, NEW BRIDGE STREET WAREHOUSE.

a speed of 60 ft. per minute with 6 B.H.P., and of slewing at a speed of 150 ft. per minute with 1½ B.H.P. The motors are driven by a double controller with a single handle, as in use on the travelling cranes.

In the basement four cranes have been erected, and, owing to the smallness of the head room, special types have been used. Two of the cranes are travelling jib cranes, similar to the ground floor. These are shown at E on Fig. 4 and in further detail on Fig. 5. In these cranes the revolving jibs are 12 ft. radius, and the span is 20 ft. They can thus cover a width of nearly 40 ft. and have a track 200 ft. long. The capacity is 1 ton and the sizes of the motors are:—Lifting motor, 6 B.H.P. at 60 ft. per minute. Revolving motor, 1½ B.H.P. at 150 ft. per minute. Cross traversing motor, 1½ B.H.P. at 100 ft. per minute Travelling motor, 2¼ B.H.P. at 100 ft. per minute.

It will be seen that the hoisting gear is forward on the jib in this case, and a heavy balance weight attached at the back. This is done to keep the controlling platform up, on account of

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the small amount of head room available. The remaining two cranes in the basement are of a special type, and are named revolving pillar cranes. They are shown at *D* in Fig. 3, and a full view of the crane and circular track is shown on Fig. 6. Each crane consists of a revolving framework, one end of which is constructed to encircle one of the main pillars of the building, whilst the other is fitted with wheels which run on a circular track attached to the roof. The cage and hoisting gear are fixed

the warehouse. These machines are shown at *O* in Fig. 1. The hoisting gear is contained in a travelling crab, which also carries the cage. The track is formed of heavy channel irons bolted to the roof girders and to the concrete roof, the running rails being bolted to the bottom flange. The lifting is done with a 15-B.H.P. motor, at 150 ft. per minute, and the travelling with 1½-B.H.P., at 350 ft. per minute, both motors being driven from one controller. The lifting capacity is 1 ton. These hoists can

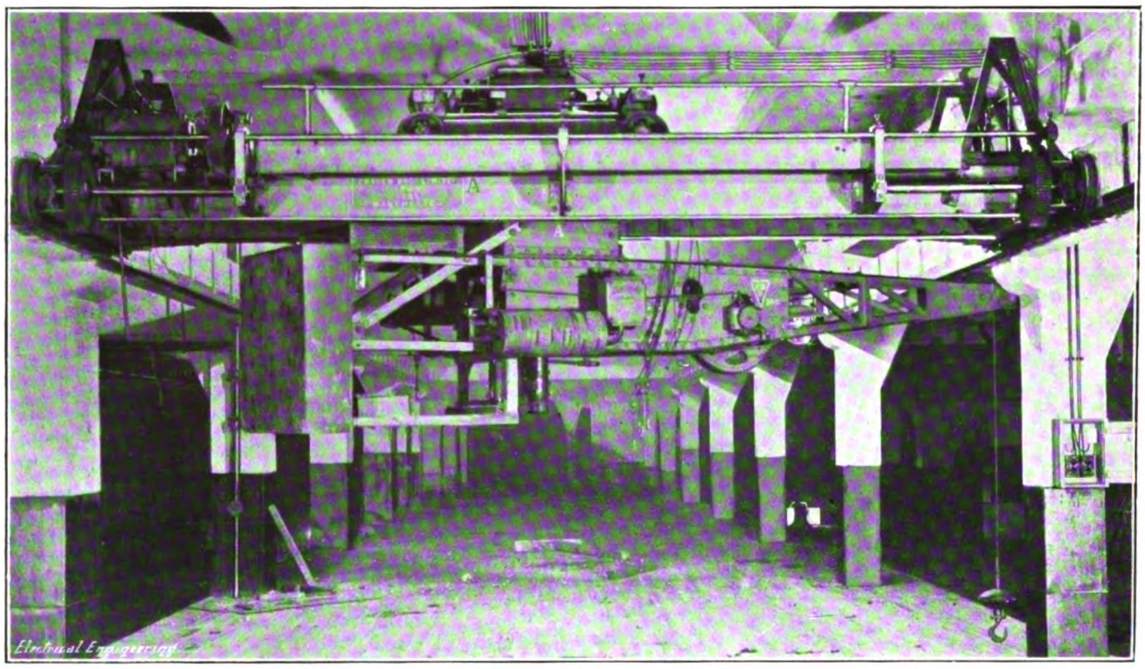


FIG. 5.—OVERHEAD TRAVELLING JIB CRANE.

near the pillar to the revolving frame, and the travelling motor is at the outer end near the wheels, the two motions being driven from one controller. The pillar end of the frame runs on a heavy casting which, when bolted up, forms a vertical circular support carrying a square horizontal flange on the bottom. The end of the frame surrounds this support and carries two rollers which bear on the vertical surface, thus keeping the motion circular. These cranes are capable of lifting

pick up material from any part of the ground floor directly beneath them, and can deposit it on either of the upper floors, the wire passing through a slot in the floor when travelling from the well to the first floor. In the jiggers the machinery is fixed. A heavy H-iron is bolted to the roof, and along this travels a small framework for bringing in the load from outside either to the first or to the second floor, and in two cases to a third floor also. These hoists are shown in Fig. 7. The hoisting rope is

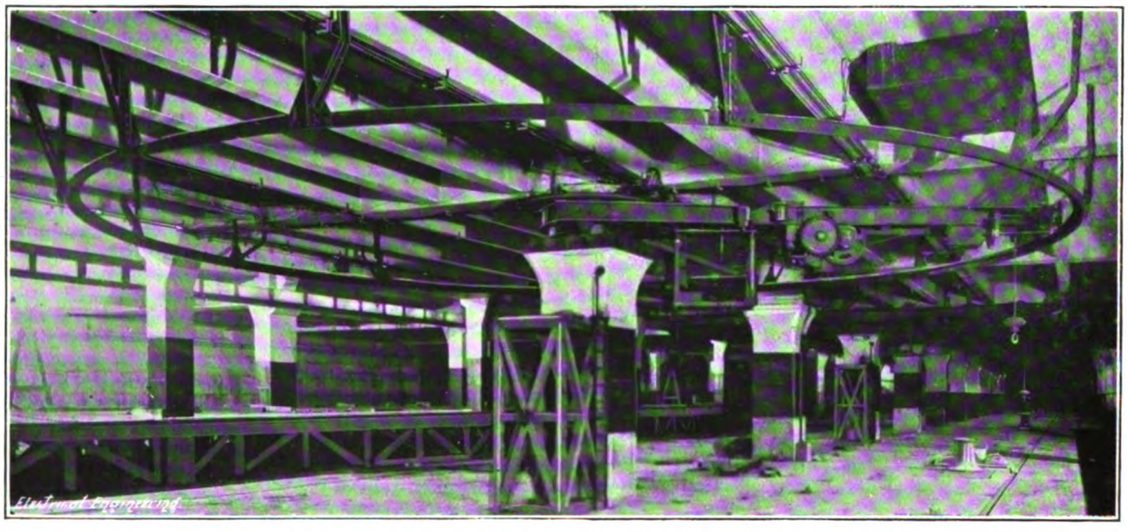


FIG. 6.—REVOLVING PILLAR CRANE.

1 ton at 60 ft. per minute with 6 B.H.P. and revolving at 150 ft. per minute with 1½ B.H.P.

For hoisting material to the top floors, which are used for storage of grain, flour, and similar materials, there are in use two transporters and six jiggers. The transporters travel the full width of the building at about 70 ft. from the ground-floor rail level, the track being extended 16 ft. on each side of the building to permit the hoisting of material from wagons outside

permanently fixed at one end to the outer end of the girder, and passes through the travelling frame over two pulleys to the fall block, and thence to the winding drum. The travelling motor drives an endless rope attached to the frame, running it in or out as required. A large pulley is fixed at the outer end of the girder to take this rope. The capacity is 15 cwt., and the lifting is done with 10 B.H.P., at 100 ft. per minute, and the travelling with 1½ B.H.P., at 120 ft. per minute. These jiggers

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are made to be controlled from each floor, and also from two places on each floor, namely, one inside and one on a platform outside. The various points of working are interlocked in such a manner that the controllers can only be worked from one point at once. This is done mechanically by gear-wheels and clutches, the various points being coupled by wire ropes driving small shafts with bevel wheels, and finally driving two controllers. All these machines, with the exception of the jiggers, are driven by universal controllers.

Machinery for Dealing with Traffic.—The capstans, which number 42, are designed for a pull of 1 ton, or six loaded wagons averaging a total weight of about 90 tons, at a speed of 250 ft. per minute. The motors are 26 B.H.P., and are compound wound, the series winding being on two poles and the shunt on the remaining two. The starting switches are operated directly by the treadle, a strong dashpot preventing too rapid movement of the switch. The switch also contains an overload release, which brings the switch to starting position and necessitates the treadle being released before the motor can be started again. This works very promptly, and prevents rough usage of the capstan. Whether this type of starting switch is the most desirable one for electric capstans is a debatable point. Electric capstans cannot be roughly treated as hydraulic capstans can. In the latter, if the capstan is overloaded (a very frequent occurrence), no harm is done to the capstan, and the load must be reduced until the power of the capstan is sufficient for the load before any movement will take place. Such methods of working cannot occur with an electric capstan, and unless a protective device is provided damage will occur to the apparatus. Provided the overload release is kept in order, the operator, however careless, will soon learn that the capstan must be treated with respect if any work is to be got out of it. Another serious objection to the direct operation of the starting switch by the treadle is that the necessity of gradually depressing the treadle tends to take the man's mind off his work, which is by no means without danger; also, owing to his having to work against the dashpot and balance weight attached to the treadle, he may not cut out all the resistance, which will burn out after a few such operations. The preferable method is for the treadle to operate a main switch only, the starting switch being automatically worked either by a magnetic coil or by gearing from the motor spindle. The movement of the treadle then becomes a single one, as in hydraulic capstans. Another point which seems to be overlooked in capstans is the space allowed in the cast-iron tank. Capstans are often designed so small that it is impossible to get into them, and any work on repairs or alterations necessitates working in most awkward positions, where sight of what is being done is almost impossible. This is a great mistake. If the capstan is inside there is no reason why it should not be covered in by light plates, which can be easily removed and the whole of the mechanism exposed. With outside capstans this would not apply, but the difficulty can be got over in a different manner. The author recently had the privilege of seeing several capstans in a goods yard in Lancashire which were excellently arranged. The tank was of a double pattern, fixed end to end, these ends being cut out to form a communication between the two. The tanks were very deep, and one of them was covered with a heavy lid in one piece, which carried the motor and the capstan head. The switch-gear was also fixed in the same tank, and consisted of a double-pole switch worked from the treadle, a starting switch from the motor spindle, and a switch which short-circuited the armature when the treadle was off, thus acting as a brake. The second tank was covered with light plates, and simply contained the outlet to the drain, and a ladder for descent. Thus access was easily gained to the capstan proper, and it was possible to pass in underneath the motor and capstan head and do any work required in comfort. All the apparatus was thus under a cover, which did not require to be removed, was easily got at, and there was room to deposit any parts which required to be taken down. Objection may be taken to the expense of having to dig a deeper hole for the tanks, but the advantages gained easily outweigh such objection. If all electric capstans were designed upon this principle it would do much to remove a number of the troubles which occur with electric capstans in practical working. In the 42 capstans at New Bridge Street the head is driven by bevel gearing, and the shaft of the armature is fitted with an electro-magnetic strap brake in series with the motor operated for braking by a heavy balance weight when the current is cut off.

Wagon Hoists.—As will be seen from Fig. 3, the only access to the basement for railway wagons is by way of the wagon hoists. These are worked electrically, and are capable of lowering 30 tons and lifting 20 tons. They are controlled on the push-button principle, and are probably the largest hoists of that type ever made. The hoisting arrangement is very simple, being, in reality, two sets of huge pulley blocks. The usual method of operation is, however, reversed, and that block which is generally fixed is in this case the movable set, and the load is raised by means of the tail end rope. Its use in connection with a hoist, especially of such a size, is indeed very novel. The machinery, which is at the top of the hoist, is composed of two exactly similar parts, each driven by a 50-h.p. 240-volt compound motor, the motors being connected in series. Each motor is coupled to its gearing by means of a shaft carrying a magnetic strap brake and also a high-speed centrifugal brake, to check too rapid motion. The gearing finally drives a large-toothed wheel, which has teeth over about $\frac{3}{8}$ of its rim, the remaining part being simply flat. The two parts of the machinery are coupled together by means of a heavy crank-pin, forming a complete engine, and leaving a space of about 3 ft. 7 in. between the large-toothed wheels, in which the ropes are operated. To this crank-pin are attached the ends of the four ropes which hoist the cage, and also the ends of the ropes connected with the balance weights which balance the load. Starting with the ends, the two ropes are attached to the crank-pin. From thence they pass over a fixed pulley at the side (both ropes running in one groove). From this pulley they pass over the pulley on the crank-pin and back to a second fixed pulley, after which they pass over "dumping" pulleys to the

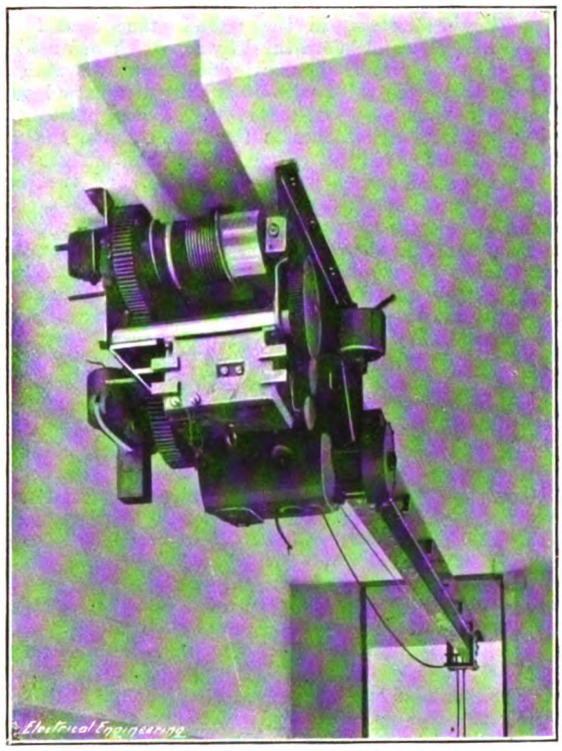


FIG. 7.—TRAVELLING CRAB.

top of the cage, the double rope opening out so that they may be attached to each side of the top beam. The ropes then return from the pulleys attached to the cage to the second set of blocks, finally being made off at the opposite end of the crank-pin to which they started. The switch-gear is of Messrs. Smith & Stevens pattern, operated from push-buttons on the ground floor and from a set of push-buttons in the cage. The speed of the hoists is 60 ft. per minute and the lift 18 ft.

After the wagons are lowered to the basement floor they are received by a large traverser. This machine runs in a special pit 30 ft. wide and the full width of the building, as shown on Fig. 3. The traverser consists of a large platform 27 ft. long and 18 ft. wide, running on eight large grooved wheels on four sets of rails. There are also two sets of roller wheels running on the same rails to take the centre weight and that of the driving platform. Upon one side, which is extended and fitted with a hand-rail, is fixed the motor which drives the traverser, and also a capstan head for drawing wagons on to the traverser from the hoists. The motor is 26 B.H.P., driven by a simple reversing controller. The motor drives a shaft fitted with a double-clutch gear. One clutch drives the nearest shaft which carries the running wheels, and the other clutch drives the capstan head. The clutches are operated by one hand-wheel, so that both motions cannot be used together. The clutch connecting the capstan head is arranged to drive the head in one

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direction, the reversal of the motor driving the shaft only, the arrangement being similar to that of a free-wheel. Current is carried to the motor through collectors fixed underneath the floor of the traverser and running in a conduit carrying the bare wires. The speed of the traverser is 300 ft. per minute, and the capstan speed 200 ft. per minute.

The power is taken from the Newcastle Electric Supply Company's Pandon Dene sub-station at a pressure of 480 volts between the outers. All the power is supplied at this pressure and the lighting at 240 volts. The whole building is controlled from two switchboards, one for power and the other for lighting, a separate account being kept of the energy used for each.

With regard to the cost of electrical working, the New Bridge Street Warehouse has not yet been in use to any large extent, so that no figures can be given. Some interesting figures are, however, given below with respect to a goods warehouse in the South-West of England. This warehouse originally contained 50 hydraulic cranes and six hydraulic capstans. Before deciding to electrify the cranes, &c., experiments were made to ascertain which cranes and capstans used most of the water. It was found that three of the cranes, and the six capstans, used 90 per cent. of the water. It was then decided to electrify these and drive the remaining cranes with electrically-driven pumps. The cranes were electrified by fixing a lifting and slewing gear on a fixed framework underneath the bench, utilising the old crane posts and jibs. In one case the old hydraulic controllers were used to work liquid starters, in the second crane special liquid starters were fixed, and in the third crane, which was used most frequently, ordinary controllers with wire resistances were used. The two pumps were fitted with 15-B.H.P. motors and worked automatically from float switches on the accumulators. By means of change-over switches in the float circuits, the pumps and accumulators could be grouped as desired. These alterations were carried out at a cost of £1,157, and the cost of working fell from £600 to £150 per annum. The saving of labour in such cases is very great, especially if the power is taken from a public supply, as is done in the case mentioned, the rate being 1d. per unit. This shows what a great saving can be made by means of electric driving even by converting steam or gas-driven hydraulic pumps to electrically-driven pumps, and working these by automatic switches.

Under the heading of conversion of plant may be added a change which was made at the Forth Goods Warehouse, Newcastle. Upon the benches are a number of hatchways for the cellars, and the hydraulic cranes are arranged so that most of them can lower material into the cellars. It was decided to experiment on one row of benches with electric cranes. A crane of the transporter type was designed, and the track laid out in such a manner as to pass over the roadway, benches, and railroad, and at the same time to pass vertically above the principal hatchways. This necessitated a specially curved track. The track is made of channel iron and carried on a series of lattice girders attached to the roof columns. Current is conveyed to the motors on the transporter through the track rails, which necessitates the insulating of each support. Some difficulty was experienced with this at the commencement, due to the vibration breaking down the insulated bolts. This trouble was easily got over by using hard red fibre plates, and bushing the holes with two fibre tubes and washers, one tube sliding within the other. This made an excellent joint, and no trouble was experienced afterwards. The transporter consists of a small bogie running on four wheels and driven by a vertical motor fixed on top of the framework. To the underside of this framework are attached the cage and lifting gear. As there is a difference of 480 volts between the rails, the wheels have to be insulated from the axles. Brushes press on each wheel and carry the current to the motors and the controller, which is of the universal type previously described. The lifting capacity is 1 ton, and the lifting is done with a 15-B.H.P. motor, the travelling motor being 3 B.H.P. There are two transporters on the track, and these displaced eleven hydraulic cranes. They work very well and can easily perform the duties which were previously done by the hydraulic cranes. The number of units registered against these cranes averages 350 per month, which is very small, and if the wages of the boys who drive the cranes are added, the total cost taken at the power rate of most supply companies would be insignificant compared with that of the number of hydraulic cranes displaced.

Mr. Henderson, in referring to the costs of electrical working at the New Bridge Street warehouse, said :—Since this Paper was written I have taken a few tests with the following results. Taking the transporter lifting cage on the top floor (15 b.h.p. motor running 350 r.p.m. with 1 ton lifting capacity), 4 tons 10 cwt. of bran were lifted 40 feet with an expenditure of 1·27 units. Four bags, equivalent to 4 cwt., took energy working out at 0·327 unit per ton. Six bags or 6 cwt. took 0·244 unit per ton. Tests on the jigger showed, in lifting 10 tons of flour in 20 lifts through 50 feet, 0·164 unit per ton. The time of each hoist was 26 seconds.

He also showed a special capstan starting switch as fulfilling conditions better than the usual dash-pot and arm-swinging over-contacts. This starter is shown diagrammatically in Fig. 8; the principal parts consist of a solenoid, a plunger with retarding dash-pot, and a number of levers hinged to the lower pole-piece of the solenoid. The upper ends of the levers carry the carbon contacts. The levers are controlled by their lower ends passing through a frame which is attached to the bottom of the plunger. The solenoid, becoming energised by the closing of the small controlling switch, begins to lift its plunger, the motion of which is retarded by an air dash-pot. As soon as the frame, which is attached to the base of the plunger, begins to move, one of the levers is released, and this lever being attracted by the magnetic flux of the solenoid makes the field and contact. As the frame travels still higher another lever is released, which, in its turn, is attracted and cuts out a step of resistance, and so on, one lever after another being attracted until the entire amount of resistance in series with the armature circuit is short-circuited or cut out. When the circuit to the solenoid is opened, the plunger with its attached frame drops. As the frame goes down the lower ends of the levers are pulled inward, breaking the contacts in the reverse order in which they were made. As the contacts are broken the resistance is inserted in the armature circuit, so that the resistance is all inserted when the last lever breaks the main-line contact.

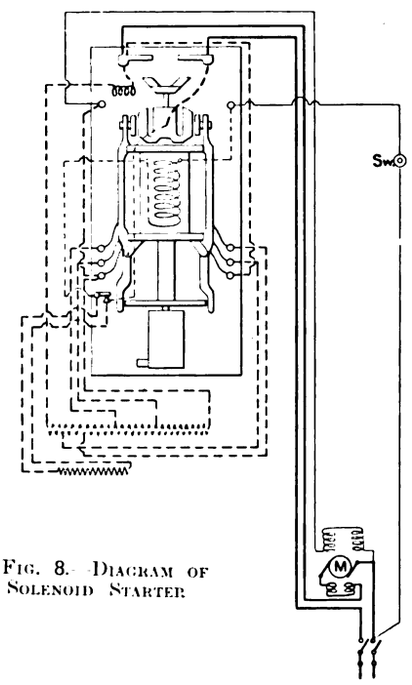


FIG. 8.—DIAGRAM OF SOLENOID STARTER

DISCUSSION.

MR. F. O. HUNT referred to the control of the jiggers, pointing out that this was accomplished by means of wire rope. It would seem as if the more direct way would be by a system of electrical multiple control in the same way that push-button lifts are operated. Relays with electrical transmission might be employed. With reference to the electric capstans employed, especially in out-door situations, the wide changes of temperature to which they are subjected must produce much condensed moisture within, and he suggested that the question of supervision of the switchgear would be important with the arrangement shown. No one but a trained acrobat could make a good contact in some underground chambers below capstans. This point was of influence in producing an opinion as to the reliability of electric capstans, as, although they are not really frail, they are sometimes put down as faulty owing to lack of proper supervision. In the case now discussed, as the capstans are not out of doors, it would be better to put nearly the whole of the control gear above ground on a wall or pillar, which would probably be near at hand, making maintenance easier. He also wished to know why the makers of the waggon hoists had inverted the usual block and fall system. The good point of this inversion—that one cannot lift the cage above a certain point—had not been utilised by the makers. The

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drawback to the arrangement was that the large steel ropes passed round small pulleys with a reverse bend. Under these conditions ropes wear out four times as fast as if they were bent in one direction.

Mr. J. ANDERSON asked for information as to the units consumed, the kilowatts demanded, and the financial results. He gathered that the author had had trouble with his capstans, and wanted to know if this was at the commutator or confined to the starter. He would like to know if circuit-breakers were freely used in the installation. He regarded the switchgear for the waggon hoists as rather complicated, and asked if liquid starters had been considered. He also wished to know if three-phase working had been considered. All motors but the hoisting motors on the overhead travellers could have been squirrel cage, and no complicated starting-gear would have been needed. The motors would, of course, be larger with three-phase work to give sufficient starting torque. The capstans would undoubtedly have been better if driven by three-phase motors. They would have stood rougher usage, as the only limiting factor would have been the load at which the motors would burn out. With regard to the capstans, were they started up on load or with a slack rope? The waggon hoist could have been run by small transformers and relays. Three-phase motors would have been cheaper and more easily maintained.

Mr. C. FARADAY PROCTOR, referring to the unique arrangement effected in the conversion of the Forth Goods Warehouse, wished to know what special precaution had been taken against damp in using fibre insulation.

Mr. HOLLIS asked the speed of the capstans; were they direct-driven from the motors? He also referred to the field winding on the compound-wound machines, and wished to know why the shunt and series windings were placed on different poles. What was the load factor on the installation? Were cut-outs or fuses used on the motors? If the latter, were the fuses of the cartridge type?

Mr. CLOTHIER congratulated the N.E.R. on the saving effected in power by adopting electric drive, and wished to know the further saving through economy in space. He thought a chamber eight feet deep involved rather a tremendous amount of excavating for a capstan, and suggested as an alternative that the motor and gear should be fixed to the underside of the chamber cover, which could be raised by screws some three or four feet for inspection purposes.

Mr. W. CROSS also referred to the difficulty of getting at the electric capstans, and asked why the arrangement adopted in hydraulic capstans was not followed. In these the whole of the gear is fixed to the lid of the tank, and the lid suspended on pivots, enabling the whole gear to be slewed round for inspection. The switchgear shown seemed a little complicated. Capstan resistances should be designed so that they could be left in circuit, if necesary, for half an hour.

Mr. LONGMAN, referring to the compound wound capstan motor, asked if any sparking between brushes occurred through having the shunt and series windings on separate poles. He also requested information as to the cost of upkeep of the special switch shown, and asked whether the 240-volt motors of the hoists which were connected two in series had any mechanical connection between their shafts. He would like to know the reasons for adopting direct current in preference to three-phase supply.

THE CHAIRMAN (Mr. PIGG) interposed to say that the design of the warehouse was settled six or seven years ago, and contracts placed; other things had intervened. When the actual building was commenced the designs were again considered, but for commercial reasons, in spite of the advance in three-phase work, it was decided to adhere to direct current.

Mr. CLAGUE detailed some experiments he had made on red fibre, and asked what special means were taken to make its use possible.

Mr. PIGG explained that the fibre was heavily shellaced.

Mr. HENDERSON, in reply, said that, owing to special conditions, such as the amount of work involved in removing goods from box waggons, the mechanical control of the jiggers was considered better. He agreed that, wherever possible, the switchgear should be fixed outside capstan tanks. The chief trouble in capstans was moisture, and where the electrical gear was hard to get at, the cost of maintenance was doubled. The cost of the tanks described was not heavy, and was merely a capital charge, while excessive maintenance due to shallow tanks went on as long as the plant was used. The power factor could not yet be determined, as the place was not yet in full use. There were automatic circuit-breakers on each capstan, and breakers controlling the main power circuits, branches of which were protected by fuses. Trouble was sometimes experienced by a small fuse, flashing over to terminals, pulling out the big main cut-outs. The capstans were never started with the rope tight on, as the man would then have a chance of being pulled into the capstan through dividing his attention between his foot treadle and the load. He recommended a form of switch, such as that on the table, the treadle of which could be at once pressed home, and relieve the man's mind as to the gradual starting up of the motor. With regard to the traverser at the Forth Goods Station, he admitted the design was unusual, but by bushing the wheels with dished mica bushes secured by insulated bolts, and paying attention to the insulation of the rails, no trouble had been experienced throughout a run of four or five years. The capstan motors were connected direct to the head. The reason for placing the shunt and series windings on separate poles of the four-pole motor described was that the depth of the poles was limited by the space at disposal. There was no trouble due to flashing over between brushes. The wiring of the building was open, on porcelain cleats, except where there was danger of crushing or abrasion, when metal tubing was employed. The principle of mounting the capstan electrical gear on the tank lid, this being placed on trunnions, was good, provided the motors had grease lubrication. The 240-volt motors on the hoist were mechanically connected through the crank-pin. The object of putting them in series was to simplify the electrical connections.

It was announced that the Paper should have been previously read in London, but, owing to the death of Lord Kelvin, its discussion had been postponed till February 20th.

MAGNETIC OSCILLATIONS IN ALTERNATORS

THE paper read by Mr. G. W. Worrall at the meeting of the Manchester Local Section of the Institution of Electrical Engineers last Tuesday contained the results of the continuation of some experiments detailed in a previous paper (see ELECTRICAL ENGINEERING, Vol. I., p. 263) on the magnetic oscillations occurring in alternators due to the shape and proportions of the machine parts. Such oscillations may be broadly divided into two classes:—(1) The oscillations taking place in the main magnetic circuit; (2) the oscillations taking place locally in the pole-face and air-gap. The first have been shown to be practically independent of the shape of the armature slots and the armature current, while the second were greatly influenced thereby, both in their magnitude and nature.

Although the existence of oscillations of the main magnetic flux has been fully recognised, diverse views have been expressed regarding the conditions determining its nature and magnitude.

There does not appear to be any record of experimental observations of the phenomenon except Fischer-Hinnen's experiments on the humming of dynamos and motors. The experiments of this author show that the pitch of the note emitted corresponds to the frequency with which the teeth pass the pole-shoe, and he concludes that humming is due to the oscillations in the main magnetic circuit. As a result of his experimental observations he gives the formula:—

$$\frac{b - 0{\cdot}7\,r}{(D + 2\,\delta)\,\pi} N = (\text{whole number}) + 0{\cdot}5\,;$$

where b = breadth of pole-face, r = radius of pole-tip, D = diameter of armature, N = number of teeth in armature. This author considers that theoretically the expression should be equal to a whole number, because in that case the reluctance of the magnetic circuit is constant, and he explains his experimental results by assuming that on account of fringing of the flux at the pole-tips the effective is greater than the actual pole width.

The machine employed in the present investigation was the same as that described in the author's previous paper already referred to, *i.e.*, three-phase, lap-wound tapped armature, 4 poles, 44 teeth, speed 1,200 r.p.m., P.D. on open circuit 173 volts. To this machine and for the purpose of the present investigation new pole-pieces were fitted having an arc approximately equal to six times the tooth-pitch. The pole-shoe and limb were laminated and in one stamping. The armature slots were open, $\frac{9}{32}$ in. wide and $\frac{15}{16}$ in. deep; the width of the tooth at the armature surface was the same as the width of slot; the air-gap was 0·118 in.

The magnetic oscillations were observed by means of the E.M.F.'s induced in search coils linking the magnetic circuit. One search coil of 10 turns, wound on a wood frame, enclosed the pole-shoe another of 60 turns was wound round the limb, midway between the pole-shoe and the yoke, and a third of 60 turns round the yoke. The position of the search coil on the pole-shoe is shown in Fig. 1.

As in the author's previous investigation, the E.M.F.'s were photographically recorded by means of a high-frequency Duddell oscillograph and revolving film camera. Since the armature current had been shown to have practically no influence on the

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magnitude of the oscillations, the machine was run only on open circuit. The polar arc was varied by planing down the tips of the pole-shoes. The planing was done in a direction parallel to the laminations, and with a very sharp tool and fine feed, so as to prevent as far as possible a burr forming over the edges of the laminations. The exciting current was adjusted so as to produce the same magnetic flux in the magnetic limb in the case of each experiment. The flux in the other parts of the circuit also remained nearly constant throughout. Fig. 1 shows the pole-shoe in its various sizes.

The area of the E.M.F. wave induced in a coil represents the periodic increase and decrease of the flux occurring at that

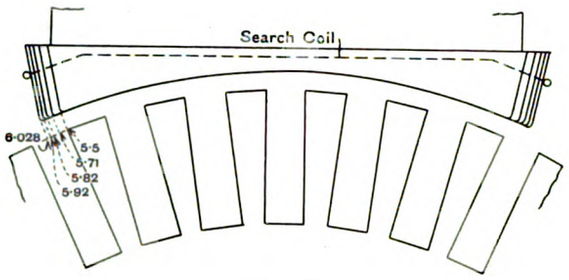


FIG. 1.

point of the magnetic circuit. Fig. 2 represents graphically the value of this change of flux for the different sizes of pole-shoe. It will be noted that the magnitudes of the oscillations occurring in the yoke are approximately one-half those occurring in the limb of the pole; this is, of course, due to the yoke flux being one-half the limb flux. The percentage oscillations are the same in both parts of the magnetic circuit. From these results it will be seen that the magnitude of the oscillations varies through a great range, and that it is a maximum when the polar arc is six times the tooth-pitch and a minimum when the polar arc is five and one-half times the tooth-pitch.

The P.D. wave was oscillographed for each size of pole-shoe, and Fig. 3 shows the half-waves recorded. It will be noted

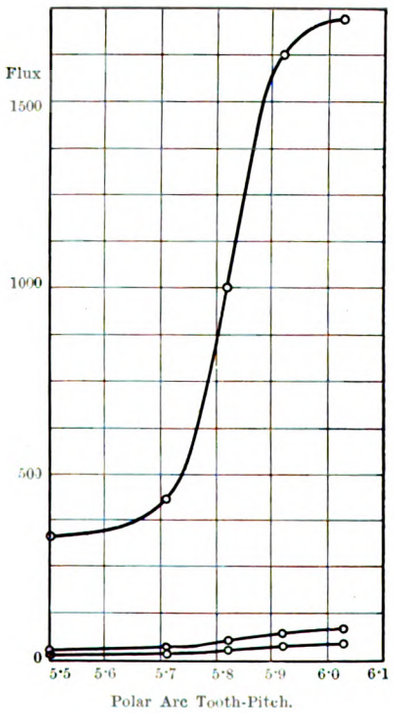


FIG. 2.

that the ripples increase very considerably in magnitude as the polar arc is reduced, and are a minimum when the polar arc is such that the magnetic oscillations recorded are a maximum and *vice versâ*. The P.D. was found to rise as the ripples increased, and the values corresponding to the various waves are indicated thereon.

The general distribution of the field in the case of the smallest size of pole-shoe was determined by means of the E.M.F. wave induced in a coil attached to the armature surface, and of a width equal to the pole-pitch. Each side of the coil was laid over the centre of a slot, and the E.M.F. wave obtained is shown in Fig. 4. It will be seen that the field immediately beyond the pole-tip is very small compared with that under the pole, and hence the stray flux increases the effective polar arc by but a very small amount. The variations to which the main field is subject may be examined by means of the diagrams in Figs. 5 and 6. In Fig. 5 the polar arc equals six times the tooth-pitch, and in Fig. 6 five and one-half times. In the case shown in Fig. 5 the two extreme positions of the armature relative to the pole-arc when (*a*) two slots and (*b*) two teeth are under the pole-tips; the former position is shown at A and the latter position at B.

In position A, since there is very little fringing, the major portion of the flux will only enter the teeth actually under the pole, and hence the boundary lines of the flux will be approximately as shown. In position B the flux will spread out towards the outer edges of the teeth, and the boundary of the flux will be somewhat as shown. Thus the surface through which the flux enters the armature increases from *l m* to *p q* as the latter moves from position A into position B. Hence the arc of the armature under the influence of a pole is subject to a periodic variation in magnitude, and the reluctance of the magnetic circuit, and hence the magnitude of the magnetic flux is subject to a periodic variation also. This magnetic oscillation may therefore be termed "flux pulsation." In the case shown in Fig. 6, when the polar arc equals five and one-half

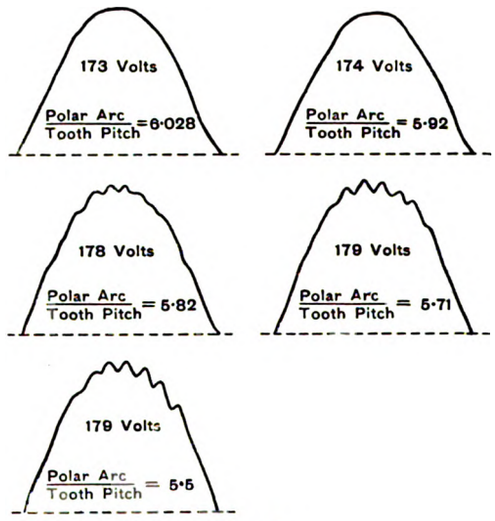


FIG. 3.

times the tooth-pitch, the two extreme positions of the armature relative to the pole are when (*a*) a slot is under the trailing tip and a tooth under the leading tip, and (*b*) a tooth under the trailing tip and a slot under the leading tip; the former position is shown at A and the latter at B. The boundary lines of the flux in the two cases will be approximately as shown. From these latter diagrams it is clear that the surface through which the flux enters the armature remains constant in magnitude, but is subject to a periodic variation in position relative to the pole-piece, giving rise to a to-and-fro swinging of the main flux, which therefore may be termed the "flux swing." Notwithstanding that the principal variation to which the main flux is subject in the two cases is as described, yet it is evident that it is also subject to a slight "swing" in the case shown in Fig. 5 and to a slight "pulsation" in the case shown in Fig. 6. When the proportion of polar arc to tooth-pitch lies between the values given above, the oscillations which occur will include both of the types described, but their magnitudes will not be so great. The "flux pulsation" would affect the whole of the magnetic circuit, but the "flux swing" would affect the air-gap only. Thus it is that the E.M.F.'s generated in the experimental search coils linking the magnetic circuit were a maximum for the case shown in Fig. 5, and a minimum for that shown in Fig. 6. The two kinds of magnetic oscillation of the main flux have now been dealt with, and their effect in generating E.M.F. ripples in the armature coils may next be considered. The frequency of the ripples is the same as that of the magnetic oscillations, *i.e.*, equal to the number of teeth passing a pole per second; in the case of these experiments the frequency was 880. When the flux is subject to a "pulsation," the E.M.F. ripple generated in an armature coil will be in proportion to the flux linked by the coil. The flux linked is a minimum when the centre of the coil coincides with the neutral line, and is a maximum when it

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coincides with the centre of the pole-face. Hence the E.M.F. ripples will be a minimum in the former position and a maximum in the latter. On the other hand, the main E.M.F. generated in the coil due to the rotation of the armature will be a maximum in the former position and a minimum in the latter. Hence, in the case shown in Fig. 5, the ripples in the E.M.F. wave will be a maximum as the wave crosses the zero line, and a minimum in the crest of the wave.

When the flux is subject to a "swing," the E.M.F. ripple will be generated in an armature coil only as the sides of the latter are actually cutting the flux, that is, when they are under the pole-face. Hence, in the case shown in Fig. 6, the ripples in the E.M.F. wave will be a maximum in the crest and a

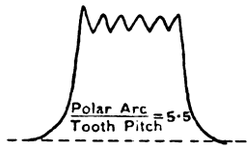


FIG. 4.

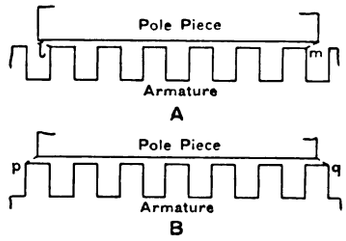


FIG. 5.

minimum as the wave crosses the zero line. This case is very clearly illustrated in the E.M.F. wave shown in Fig. 4, already referred to.

In considering the summing-up effect of the armature coils, distinction must be made between the two principal types of winding, *i.e.*, the open circuit and the tapped continuous-current winding. In the former the E.M.F. ripples in successive coils will add up in the same way as the main E.M.F.'s, and therefore in this case the remarks made on a single coil apply to the whole armature. In the latter the main E.M.F. is a maximum when the tapping points are in the neutral plane, and a minimum when they are opposite the middle of the pole-face. In the former position of the tapping points the "pulsation" of the main flux will induce E.M.F. ripples in the conductors of any armature circuit which will cancel each other and so give no resultant P.D. between the tapping points, while the "swing" of the main flux in the air-gap will induce E.M.F. ripples which will add up and give a resultant P.D. between the tapping points. In the latter position of the tapping points, and when the main E.M.F. is zero, the "pulsation" of the main flux will induce E.M.F. ripples in the conductors of any armature circuit which will add up and give a resultant P.D. between the tapping points, while the "swing" of the flux

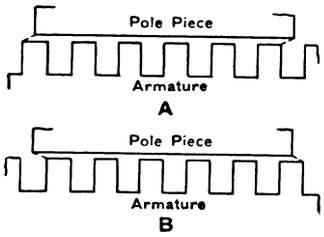


FIG. 6.

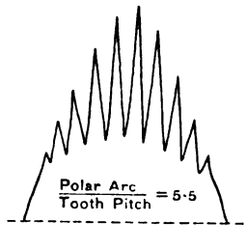


FIG. 7.

will induce E.M.F. ripples, which will cancel each other and so give us resultant P.D. between the tapping points. Thus it appears that in all types of armature winding the ripples in the crest of the wave are due to the "flux swing," and those in the zero portion of the wave are due to the "flux pulsation."

This effect may be made more apparent by intensifying the ripples in the P.D. wave by means of resonance. Fig. 7 shows the resonance P.D. obtained in the case of the smallest polar arc, from which it will be seen that the zero portion of the wave is practically smooth. In order to ascertain if this effect occurred in the case of other machines, several generators were oscillographed. Fig. 8 shows two of the half-waves recorded. A is the P.D. wave of a single-phase generator with rotating field; the ratio of polar arc to tooth-pitch was six, the air-gap was slightly greater at the tips than at the centre of the pole-face. It will be seen that the crest of the wave is practically smooth, due to the absence of "flux swing." B is the P.D. wave between neutral and line of a three-phase generator with rotating field; ratio of polar arc to tooth-pitch was very slightly greater than five and one-half, the air-gap was constant over the whole pole-face, but the tips of the pole-shoes were very thin. It will be noted that the ripples are very strong in the crest of the wave, due to the "flux swing" effect, but diminish towards the zero portion. The ripples cover a somewhat larger arc of the wave than in the case of the author's experimental machine, on account of the special nature of the winding. Thus similar results have been obtained from three machines widely differing in construction, and it may therefore be concluded that the experimental results given in this paper are of general application.

Local Oscillations of the Magnetic Flux in the Pole-face and Air-gap.—In the experiments described in the author's previous paper, already referred to, the phenomenon of "phase displacement" was observed. This phenomenon has now been more fully investigated and the displacements measured, and it may be well to introduce this part of the subject in hand by repeating briefly here the description of the phenomenon given in that paper. When the conductors in a slot under the pole-face carry current, the local magnetic flux generated by the current has two paths open to it: the one lies across the slot and the other across the air-gap from one tooth-top to the pole-face and back to the next tooth-top. In the case of an open slot armature the reluctance of the latter path, in proportion to that of the former, is usually such that the major portion of the flux proceeds that way. The local flux in that case strengthens the main flux, entering one tip of a tooth, and weakens that entering the other tip. Thus the line of symmetry of the flux is slightly displaced. This effect was called by the author "flux displacement." In the investigation forming the subject of the previous paper search coils were attached to the pole-face for the purpose of observing the local magnetic oscillations due to the passing of the armature teeth; one side of each coil was attached to a N-pole and the other in a corresponding position to an adjacent S-pole; the sides of the coils were parallel to the axis of the armature. When "flux displacement" occurred the phase of the E.M.F. wave generated in a search coil was slightly changed in its relation to the armature teeth. This effect was referred to as "phase displacement."

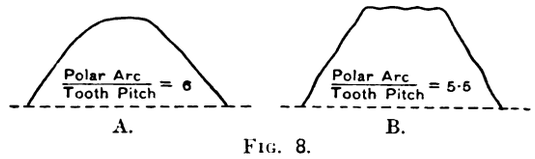


FIG. 8.

In the present further investigation of this phenomenon the machine employed was that already described in the opening remarks of the present paper. Three search coils were attached to the faces of adjacent poles, *i.e.*, one of a single turn in the centre and one of three turns each of the pole-tips. The E.M.F.'s generated were photographically recorded by means of the oscillograph, and a definite position of the armature was instantaneously marked on the record by means of a contact-maker of special design. The construction of this is shown at Fig. 9. It consists essentially of three parts, the steel spring S, the copper gauze C, and the moving steel contactor K. This last is attached to an arm on the machine shaft (not shown) and rotates with it, while the spring S and the gauze C are stationary. The three parts are so adjusted that the contactor K at the same instant flicks the tip of the spring S and rubs the gauze C. Fig 10 shows the diagram of connections. R is the contact-maker, P is a pair of strips of the oscillograph, T is a search coil, and L is a small accumulator. It will be seen that at the instant of contact the accumulator L is connected in parallel with the search coil T, and hence the current flowing through the oscillograph strips will be momentarily altered, producing a sharp break in the continuity of the E.M.F. wave being recorded. Fig. 11 shows a record obtained; the break in continuity occurs at P, and this point corresponds to a definite position of the armature relative to the search coil,

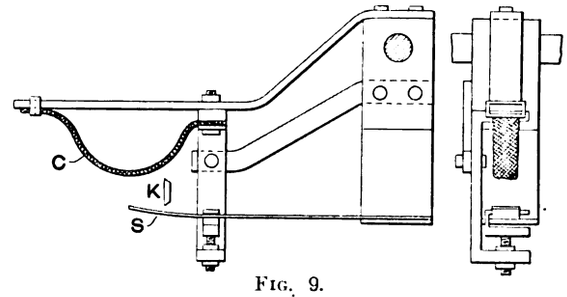


FIG. 9.

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Only one contact was made in each revolution, and each oscillograph record represented a complete revolution of the machine. The accuracy of the contact-maker was tested from time to time, and proved by the exact repetition of previous records.

When the machine was on load and the armature conductors passing the sides of the search coil carried current, the E.M.F. wave generated was found to be slightly displaced from its position on open circuit relative to the contact mark on the record. This change of position, as measured on the oscillograph record, gives the displacement of the line of symmetry of the flux, or "flux displacement."

Table I. gives the displacements observed expressed as a percentage of the tooth-pitch. In this table the positive sign indicates a forward displacement of the E.M.F. wave on the oscillograph record and hence a backward displacement of the flux relative to the armature. It will be noted that in the case of non-inductive load the displacements are all positive,

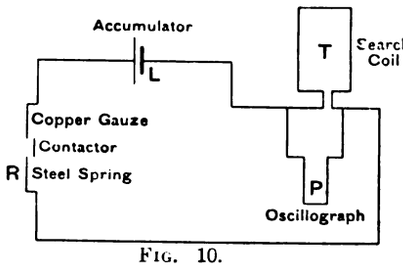


FIG. 10.

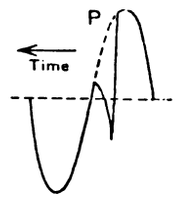


FIG. 11.

while in the case of inductive load the displacements change from positive through zero to negative in passing from the trailing tip to the leading tip of the pole. This is due to the distribution of current under the pole-face. When the load is non-inductive the current is in the same direction as the main E.M.F. generated, and hence strengthens the flux in the rear tip of a tooth and weakens that in the forward tip. When, however, the load is inductive the current under the centre of the pole-face is zero, and that under the leading tip is in the opposite direction to the main E.M.F.

It will be further noted that in the case of non-inductive load the displacements are greatest under the leading tip and diminish towards the trailing tip. This is probably due to the main armature reaction flux weakening the leading and strengthening the trailing tip of the pole. As successive slots pass a given point in the pole-face the armature current opposite that point would not be quite constant, but the flux displacement was not found to vary within the possibilities of measurement. In a single-phase generator, however, the variation of current and hence the variation of "flux displacement" would be very great. "Flux displacement" would cause the distribution of eddy currents over the pole-face to vary between no load and full load and with various power factors, and hence the eddy current loss would be also subject to a variation. The periodic variation of the "flux displacement" as successive

TABLE I.

Load.	Leading pole-tip.	Centre of pole-face.	Trailing pole-tip.
Open circuit	0	0	0
Non-inductive half-load	+8·0	+6·5	+3·0
Non-inductive full load	+15·0	+10·7	+4·1
Inductive half-load	−2·3	0	+2·8
Inductive full load	−4·5	0	+4·1

slots pass a given point in the pole-face would cause the eddy current distribution and hence the eddy current loss to vary periodically also. The magnitude and frequency of this latter would depend upon the type of winding and the number of phases possessed by the machine.

The results of the investigations described in this paper may be briefly summarised as follows :—

1. There are two kinds of magnetic oscillation in the main magnetic circuit :—(*a*) A variation in magnitude or "flux pulsation"; (*b*) a to-and-fro movement of the flux or "flux swing."

2. "Flux pulsation" is a maximum when the ratio of polar arc to tooth-pitch equals a whole number, and is a minimum when the ratio equals a whole number plus one-half.

3. "Flux swing" is a maximum when the ratio of polar arc to tooth-pitch equals a whole number plus one-half, and is a minimum when the ratio equals a whole number.

4. The ripples in the crest of the P.D. wave are due to the "flux swing" and those in the zero portion of the wave to the "flux pulsation."

5. When the armature carries current, the flux entering the teeth is displaced (*a*) backwards, when the current is in the same direction as the main E.M.F. generated: (*b*) forwards, when the current is in the opposite direction to the main E.M.F. generated.

The author expresses his thanks to Messrs. Thomas Parker, Ltd., for the loan of the machine and special pole-pieces, and to Professor Marchant for his interest in the work and valuable advice.

THE LONDON POWER SCHEMES

UP to the present the views of the majority of the London Local Authorities towards the Companies' proposal embodied in their Parliamentary Bill are not known. In the case of St. Pancras, however, a report has been submitted to the Council by Mr. Sydney W. Baynes, their electrical engineer, in which he points out that St. Pancras would be included in the area scheduled, but it was not clear whether the Companies would compete for the Council's consumers. It appeared to be their intention, however, to supply private consumers for power purposes. At a later date the Company would be likely to obtain further powers to enable them to compete with the local authority. In any case, it was undesirable that the Company should possess powers over the St. Pancras area. Further, there was not sufficient provision in the Bill for the protection of the local authority as regards the breaking up of roads.

In the Preamble of the London and District Electricity Supply Bill there is a statement that the generation of energy is expensive because it is in the hands of a number of authorities and companies, and that it is expedient that electricity should be generated on a large scale in order that it may be used to a greater degree for industrial and other purposes. The results obtained at large stations recently, Mr. Baynes says, do not bear out these assertions. In the case of the Lots Road generating station (London Underground Electric Railways), he understood that the works costs were extraordinarily high for a station supplying so much power and with such an excellent load factor; and this new station might be taken as being well up-to-date. Section 52, sub-section 3, of the Bill provides that in the event of a local authority being authorised to supply in the area, the Company shall not supply power without the consent of the authorised distributor, provided the authorised distributor is willing to give a sufficient supply of energy at a price which the Company are supplying it, or are willing to supply it. Under this clause, Mr. Baynes protests, the Company would be in direct competition for all the Council's power consumers. They might easily bring the price down to an impossible figure and obtain the Council's power load. They might also acquire the lighting of power consumers' premises, as they propose that they should be permitted to supply lighting in any premises, together with the power supply, if the former load did not exceed 20 per cent. of the latter. It had been proved, however, that this 20 per cent. was sufficient to provide full lighting for most power consumers. The engineer further pointed out that under the Bill, whilst the Company supplying an authorised distributor were only liable to a penalty of £10 per day in default of supply, the authorised distributor would be liable to each individual consumer in the event of the Company failing to supply. There were other provisions which protected the Company in every way, and placed them in a much better position than that of the present authorised distributors. The engineer expressed the opinion that the Bills referred to should be opposed. This is to be done, and petitions will be presented against each of the schemes.

CATALOGUES AND PAMPHLETS RECEIVED

MOTORS WITH BALL BEARINGS.—A brochure from the Electric Construction Co. describes a new type of continuous-current motor fitted with ball bearings which the firm have introduced. It is claimed that, with this type of bearing, friction losses are almost eliminated. The bearings are liberally designed and fitted for heavy, continuous work, and their compactness facilitates efficient ventilation. In addition to this, constant replenishment of air (as in journal bearings) is not necessary, and the grease only needs replacement at intervals of four to six months.

SWITCHGEAR.—Messrs. Veritys have sent us a copy of a new abridged switchgear list in a convenient form, uniform with other small-sized lists previously issued. The publication is as condensed as possible, in order to cover extensive ground in a small space, and a useful feature is an index of catalogue numbers. Amongst novelties listed for the first time are a new pattern of heavy open protected fuse, a special street lighting switch, some new voltmeter switches and plugs, and some ornamental switchboard pediments in wrought iron.

NEW PUBLICATIONS

"Transactions of the Mining Institute of Scotland." Vol. XXX. Part I. Proceedings of General Meetings at Dunfermline and Edinburgh, 1907. (Newcastle-upon-Tyne : The Institution.)

"Electric Wiring and Fitting for Plumbers and Gasfitters." By Sidney F. Walker. (London : Scott, Greenwood & Son.) 5s.

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ELECTRICAL MEASURING INSTRUMENTS AND SOME OF THEIR WEAKNESSES

IN a Paper read on Wednesday, January 8th, before the Association of Engineers-in-Charge, Mr. K. Edgcumbe said :—No apology is, I think, needed for admitting that electrical measuring instruments do possess some weaknesses.

I feel that if the ways of measuring instruments were rather better understood, and their little weak points more fully recognised, engineers would be spared many a *mauvais quart d'heure* with their meters, and the long-suffering instrument manufacturer would spend fewer sleepless nights.

A mistake is often made from the very outset in selecting the most suitable range when ordering the instrument; frequently the maximum possible emergency load which is likely to occur is selected, it being quite overlooked that for possibly nine-tenths of the time the load will not exceed a third of this value. The normal deflection is consequently so small that the accuracy is very much impaired. This is particularly unfortunate with moving iron instruments, since, owing to the fact that the permeability of iron is small at low inductions, the first tenth of the scale of such an iron instrument is always cramped. For this reason the top reading should be chosen as small as possible, so that the upper part of the scale may be mostly used.

In the case of moving coil instruments the scale is perfectly even throughout its range; but even then it is a great mistake to order a higher range than is absolutely necessary. For the same reason, if an instrument with several ranges is required for general testing work, each should be not more than five times that of the next lower in the case of a moving iron instrument, or more than ten times with a moving coil. In this connection it may be pointed out that it is always better, as far as possible, to make all the ranges round multiples of one another, so that one set of divisions can be used throughout, a constant of 2, 5, 10, &c., being applied according to the range.

This question of range becomes of supreme importance in ampere-hour or watt-hour meters, since with very light loads it is not simply a case of the indications being inaccurate, but the meters will not start at all below a certain minimum, owing to the initial friction which has to be overcome. An ampere-hour meter should start with from 1 per cent. to 1½ per cent. of its full load, and a watt-hour meter with from ¾ to 1 per cent.; but, unfortunately, after being installed for some time, it will often be found that these figures have to be doubled; consequently, it is better to so select the range of a meter that its maximum reading is, say, fifty times the smallest load, which it is wished to register, even if this entails overloading it to the extent of perhaps 20 per cent. or 30 per cent. for short periods.

In the case of alternating-current watt-meters, the power divided by the voltage does not necessarily give the amperes flowing. The current may be much greater than the value so obtained, according to the "power factor" of the circuit. Whenever possible, therefore, in ordering a watt-meter, not only the maximum reading in watts, kilowatts, or horse-power should be given, but also the corresponding current, or, failing this, the approximate power factor to be expected.

With voltmeters the requirements are different, the aim being, as a rule, to provide as open a scale as possible on either side of the normal working voltage; the rest of the range is unimportant, and may be closed up, or even suppressed altogether. This is easily done in one or two ways; in the case of moving iron voltmeters, the iron can be so shaped as to give the required scale, but with moving coil instruments it is only necessary to set up the control spring. By "set up" is meant, turning the outer end of the spring (that is, the end not attached to the pointer) back through a certain angle, so that when no current is flowing, the pointer is pressed hard against the left-hand end of the scale. Let it be assumed that the scale corresponds to a deflection of 90 degrees, and that the resistance is so proportioned that a full deflection from zero is given with 100 volts at the terminals. Then, if the free end of the spring is turned back through 90 degrees, it will require exactly 100 volts at the terminals of the instrument before the pointer begins to deflect, and 200 volts will take it to the end of the scale. Thus the length of each 1-volt division is now twice what it was before; if the spring had been set back through 180 degrees, it would have required 200 volts before it started reading, and 300 volts to take it to the top of the scale, and so on. It is, in fact, as though the instrument was provided with a very much longer scale, of which only the last 90 degrees were visible.

In practice several considerations prevent this setting up being pushed too far. In the first place, since the resistance remains unchanged in all three of the cases just considered, the watts lost with the 200-300 range are nine times as great as they were with the 0-100 scale, consequently, in order to reduce the power consumption to a reasonable value, a correspondingly weaker spring must be employed, which means an increased friction error. Again, with every spring there is a limiting angle through which it can safely be turned without strain; if deflected beyond this, an uncertainty of reading will be found. Neglect of this point is the cause of most of the wandering "zeros" in moving coil instruments.

All things considered, then, it may be said that a set-up corresponding to a scale of say 450-500 volts is about the greatest which can be regarded as satisfactory. In such an instrument the lower reading is 80 per cent. of the upper. A moving iron voltmeter scale reading up to 250 volts might contain 100-250 volts in the upper half, that is, roughly, 25 per cent. of the top reading. With an evenly divided moving coil scale, this would correspond to a total range of 125-250 volts. The smaller the percentage, the more open the scale; expressed in this way, it may be said that for a moving iron voltmeter, as ordinarily constructed, 25 per cent. is about the most open scale which it is advisable to provide, and for a moving coil instrument the corresponding figure would be 10 per cent.

For alternating-current central station work a voltmeter with an extraordinarily open scale has recently been introduced by one firm of instrument manufacturers, and with these instruments a scale such as 200-220 is quite satisfactorily obtained. It is, moreover, perfectly evenly divided throughout, and the power consumption is quite moderate. Such a scale would correspond to 5 per cent. of the top reading contained in the upper half.

A point requiring careful consideration when specifying an instrument is the accuracy to be aimed at.

One must remember that the accuracy of a test really depends on that of the least exact instrument used. For example, in testing the efficiency of a glow-lamp, it is sheer waste of time to measure the power consumption to 1 per cent., when the candle-power cannot be relied upon to within more than 5 per cent. In the case of a cell-testing voltmeter, on the other hand, an inaccuracy of more than 1 per cent. would be inadmissible.

A voltmeter, comprising, as it does, a copper coil, will have a resistance which varies with changes of temperature, yet it can only act correctly as a voltmeter so long as its resistance remains constant. In order to ensure this, as far as possible, an idle resistance is connected in series with the copper coil. The greater the proportion this "swamp" bears to the copper resistance, the less will be the variation of the reading with temperature. In order, however, to get the same working forces, the power consumption must be raised in proportion as the idle resistance is increased, since the watts lost in the latter are valueless as far as the working coil is concerned. The difference in reading when first put in circuit and after warming up, is quite negligible with moving coil meters, and may amount to 1 per cent. in the case of a moving iron instrument.

Of course, there are circumstances in which it is essential that the cold and hot readings should agree extremely closely, and in that case a slight increase in power consumption should be allowed. This seems to me to be just one of those cases in which nothing would be lost by consulting the instrument manufacturer as to the necessary conditions and the best means of meeting them.

The mistake often lies in the type of instrument selected for a particular purpose; for direct-current circuit the moving coil pattern is undoubtedly the one to choose. At the present time, owing to standardisation of patterns and so forth, the price of a moving coil instrument is only slightly higher than that of the moving iron type. For alternating current, on the other hand, the moving iron is greatly superior to the hot-wire or induction pattern on the score of both accuracy and durability. The former is always uncertain in its readings owing to the unequal expansion in the various parts, and the latter is seriously affected by frequency, wave form, and temperature. The moving iron pattern, if properly designed, is entirely free from these errors. Induction instruments have one advantage over others, viz., that a scale covering 300 degrees can readily be obtained. The fact is often overlooked, however, that this is no new innovation, and that moving coil instruments can be quite easily arranged to give such a scale; in fact, some of the earliest were so constructed, but the idea was abandoned in favour of a 90-degree scale for various reasons.

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It may be asked what accuracies can be legitimately demanded in the case of the various forms of switchboard instrument. The following may perhaps serve as a rough guide :—Moving coil ammeter, 1 per cent. of the maximum scale reading. Moving coil voltmeter, ½ per cent. of the maximum scale reading in the neighbourhood of the normal point. Moving iron ammeter, alternating current, 1 per cent.; direct current, 2 per cent. of the maximum scale reading. Moving iron voltmeter, alternating current, ½ per cent.; direct current, 1 per cent. of the maximum scale reading in the neighbourhood of the normal point. Induction ammeter, 2½ per cent. of the maximum scale reading. Induction voltmeter, 2 per cent. of the maximum scale reading. Induction wattmeter, 3 per cent. of the maximum scale reading. Hot-wire ammeter or voltmeter, 2 per cent. of the maximum scale reading. Electrostatic voltmeter (low tension), 1 per cent. of the maximum scale reading. Electrostatic voltmeter (high tension), 2 per cent. of the maximum scale reading. Dynamometer wattmeter, 2 per cent. of the maximum scale reading. Recording ammeters and voltmeters (pen type), 2½ per cent. of the maximum scale reading. Recording ammeters and voltmeters (inkless type), 1½ per cent. of the maximum scale reading. Ampere-hour meters, one-fifth load to 20 per cent. overload, 3 per cent. Watt-hour meters, one-tenth load to 20 per cent. overload, 2½ per cent.

Accuracy, however, by itself is of little use; several other features have to be taken into account. For example, if the instrument has to be seen from a distance, the scale should be open and the pointer and figures bold. If the case is of cast-iron with a semi-closed front (a pattern, by the way, which is much more satisfactory all round than the once popular brass case), the opening through which the pointer and dial are seen should be fairly large.

An electrical measuring instrument is a somewhat delicate apparatus, and must be treated with a little care.

It is always best to remove the instruments from the switchboard and pack them separately, when sending by rail. Care should be taken that dangerous shocks are not transmitted to the jewels and pivots through excessive vibration on the switchboard after erection. When vibration cannot be avoided, rubber washers inserted between the instrument and the slate will, to a large extent, get over the trouble.

Before removal from a switchboard, it should be noticed whether there is any clamping arrangement for the pointer or armature, and if so, this must be seen to. Any liquid also, such as oil or mercury, must be carefully removed, or the instrument will be ruined. Before switching on the current it must be seen that all the pointers are accurately at zero; if spring controlled, by adjusting the spring; if gravity controlled, by setting round the whole instrument. A very small zero error may make a considerable difference in the reading, so that care should be taken that the adjustment is accurate, the instrument being gently tapped meanwhile to eliminate any possible friction. In the case of shunted ammeters, the length of the connecting leads should not be much altered, since the instrument has doubtless been calibrated to them. If too long, they can usually be neatly coiled up out of the way; and, if too short, new leads of correspondingly increased area should be employed so as to keep the resistance approximately the same. In the case of voltmeters, this precaution is unnecessary, owing to the much greater resistance of the instrument. If a shunt is found to get too hot when only the normal maximum current is passing, it is probable that there is a bad contact at one or other end, due to a dirty cable socket or to a bolt having worked loose; or it may be that the leads bringing the current to it are too small in area, so that the heating comes from them. When an instrument works erratically, the reading fluctuating with a steady load, the connections should be seen to. If a voltmeter takes to reading too high, there is a short circuit in the series resistance; if too low, in the coil itself. If an integrating meter will not start with so low a load as usual, it is probably the brushes and commutator which are at fault, and the latter should be carefully cleaned. If, on the other hand, a watt-hour meter starts without any current flowing through the series coil—that is, if it "runs on its shunt," as it is called—it is a sign that the starting coil is too close up. The starting coil is a winding in series with the armature, and is provided to overcome friction. It is easily adjustable, and should be pulled further away. In an induction watt-hour meter the starting device usually takes the form of an aluminium plate, which can be moved slightly in one direction or the other. To make an integrating meter run slower, the break magnet should be moved towards the periphery of the disc, and *vice versa*.

Now that the introduction of some new type of incandescent lamp is a matter of almost daily occurrence, it becomes of the utmost importance to be able to determine the efficiency and general behaviour of the various lamps. Few of us are so fortunate as to possess an elaborately equipped photometer room, yet the equipment needed for what may be called "commercial" lamp testing is extremely simple.

The most satisfactory photometer consists of two cards inclined at an agle, each illuminated by one of the lights and so placed that one card is seen behind the sharply cut edge of the other. A glow-lamp whose candle-power at the normal voltage is known, forms the standard, and is set at a given distance on one side of the cards. Another lamp—the candle-power of which is immaterial—is placed on the other side, and is moved to and fro until the two cards appear to be equally illuminated, after which this lamp must not be again moved. The standard lamp is now replaced by the lamp to be tested, which is in its turn moved up to and away from the photometer until a balance of illumination has again been obtained. This is the method in its crudest form; several small refinements and modifications are possible.

In order to be able to determine the efficiency of a lamp, the consumption must be measured, and for this purpose a dead-beat ammeter or wattmeter, provided with a lamp-holder, is the most suitable. The instrument should also be furnished with a fine wire fuse, and even when so protected, it is best to temporarily short-circuit the ammeter when the lamp is first put into circuit, in order to prevent any damage in the event of a faulty lamp being put into the holder

A brief discussion followed the reading of the paper.

ELECTRICAL SCIENCE

British and American

An Electrical Thermometer for Measuring Gas-Engine Temperatures.—H. L. Callendar and W. E. Dalby describe in the Royal Society *Proceedings* for December a form of platinum thermometer which measures directly the temperature of the gas in the cylinder of a gas-engine at some one point of the cycle. In order to avoid uncertain corrections, it is necessary in any attempt on this problem to employ wires fine enough to follow the changes of temperature of the gas very closely during suction and compression. If such a wire be employed under working conditions, it must be perfectly screened from the flame during explosion. The arrangement designed by the authors is such as to introduce the thermometer into, and withdraw it from, the cylinder at the proper instants, and to do this without making any change in the usual form and extent of the clearance surface during the time interval comprising the end of compression. The thermometer itself consisted of a loop of platinum wire 0·001 inch diameter and 1 inch long, and a compensation loop of similar wire was provided to eliminate the end effects arising from conduction to the leads. The current employed in measuring the change of resistance (which was about 1 ohm for 100° C. rise) was about $\frac{1}{250}$ ampere. This thermometric arrangement was contained in a small valve inserted through the spindle of the admission valve, which was bored out to receive it. This thermometer valve was introduced into the cylinder by a cam operated by a simple gear. In order to measure the temperature at a definite point of the cycle, a periodic contact-maker was inserted in the testing battery circuit. At first an ordinary wiping contact was employed, but, owing to certain disadvantages, a novel form of periodic contact was designed and made. This consisted of two cams on the same axle and two brushes. The shape of each cam was a flat spiral, which lifted the corresponding springy brush away from the axis as the shaft rotated, and the spirals each terminated with a step which allowed the brushes to fall suddenly. The steps were staggered in angle, so that the brushes fell at different instants. Now one side of the electrical contact was carried by one brush, and the other side of the contact by a projection on the second brush; and thus, by setting the cams initially at the proper angle, any desired period of contact could be brought about at any desired point of the gas-engine cycle.

Properties of Selenium.—It is well known that the increase in conductivity of selenium which results from illumination is not an instantaneous effect, and that the recovery of normal conductivity takes time. In the December *Physical Review* is a note in which E. Merritt gives the results of his measurements of the relation between conductivity and time after cessation of exposure to light. The cell used had a resistance of about 50,000 ohms. It was placed in a circuit containing a dead-heat galvanometer and an E.M.F. of about 1 volt, and was excited by an acetylene flame at a distance of 40 cm. The author, guided by his experience of a similar study of the decay of

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phosphorescence in Sidot blende, plotted his results by taking as ordinates the square root of the difference between actual conductivity at any time and the normal conductivity, the abscissæ being the times of observation. The curves so obtained are seen to consist of two straight parts joined by a "knee" at about abscissa ten seconds. It seems not unlikely that the bend at the "knee" in the early stages of the decay of the photo-induced conductivity may be due to the fact that the exciting rays penetrate only a short distance below the surface. The surface layer is, in consequence, excited far more strongly than the interior, and decays with corresponding rapidity. After a short time the conditions will be more nearly uniform throughout, and the decay will be more gradual. The author believes that if experiments could be made with a sufficiently thin layer, the curves would be straight lines throughout.

Continental

Fixation of Nitrogen.—A summary of the present state of the problem of fixing atmospheric nitrogen is given by J. Blondin in *Bulletin* No. 269 of the French Physical Society. Of the four chief processes hitherto proposed, three utilise electric energy direct. The fourth, that of Frank and Caro, obtains calcium cyanamide from the carbide, itself an electrical product. The other processes use the electric arc, in which the process takes place according to the simple formula $N+O=NO$. Nernst's discovery that an increase of temperature from 1,811° to 3,200° absolute increases the yield fifteen times has been turned to account in the process carried out by Kowalski and Moscicki at Vevey, where frequencies as high as 8,000 and 12,000 are used. The large number of condensers used in this process has been reduced by Moscicki's recent device of rotating the arc by means of a magnetic field. The voltage used is 3,000, and the yield is said to be 60 grammes of nitric acid per kw.-hour. But this process is not yet carried out on an industrial scale. The Norwegian works of Birkeland and Eyde at Notodden also use a magnetic field, and claim to produce 500 kgr. per kw.-year, or 17,000 tons annually. The cost comes to something like a shilling per kg. of nitrogen fixed.

Electrolytic Reduction of Indigo.—Indigo has hitherto been reduced from the blue to the white form by fermentation or by chemical processes. In the *Comptes Rendus* for December 30th, however, H. Chaumat describes an electrical method in which the reduction is accomplished by bringing nascent hydrogen to bear upon the substance as it is evolved at the cathode of a cell containing sodium carbonate in solution. Blue indigo contained in such a cell is not reduced, most likely because the hydrogen passes too rapidly into the molecular state. The author, therefore, took care that the hydrogen was evolved on the iodine itself by mixing it intimately with carbon and piling it about the cathode, dividing off the anode by means of a porous diaphragm. The mixture of graphite and indigo is tied round with a linen bag. The reduction of the indigo gives a highly concentrated solution of white indigo, the efficiency of the current being as high as 30 or 40 per cent. The porous diaphragm is necessary to prevent the oxygen evolved from re-oxidising the indigo. Alkaline sulphites or sulphides may be employed for the same purpose, but with a loss of quantity produced.

Radioactive Substances in the Atmosphere.—K. Kurz, in No. 15 of the *Annalen der Physik*, calls attention to the errors in readings of atmospheric ionisation produced by the deposition of the solid radioactive matter suspended in the air upon the measuring instruments. When gold-leaf electroscopes are used with a charged dissipation body, a disturbing effect is only produced when the body is negatively charged. The deposition of radioactive matter then produces an effect simulating the presence of a greater number of positive ions. In Ebert's aspiration apparatus the number of ions is made some 4 per cent. too great, and their velocity 4 per cent. too small. If, instead of working with a saturation current, the instruments were to work with a free current, these errors would be eliminated. The author has made the necessary corrections on the various instruments, and has found the very simple relation that positive and negative ions supply the same conductivity to the atmosphere. Since the positive ions are less mobile, they must be present in greater proportion. This state of things is automatically regulated by the adsorption of ions at the surfaces of dust and smoke particles, which is proportional to their mobility. The saturation current at Giessen is $7{\cdot}16\times10^{-5}$ electrostatic units.

ELECTROCHEMISTRY AND ELECTROMETALLURGY

IN the *Centralblatt für Accumulatoren und Galvanotechnik* of January 5th there is an article entitled "Some Novelties in Plating Baths." Owing to nickel anodes not passing into solution at the same rate as the nickel is deposited out upon the cathodes, nickel plating baths in course of time become acid. The acidity is usually got rid of by addition of ammonia, but this has the disadvantage of saturating the electrolyte with ammonium sulphate, which after a time commences to crystallise out, rendering it necessary to renew the bath. It is now suggested that nickel carbonate should be added to the bath to neutralise the acid. The nickel carbonate should be freshly precipitated, and is best added in the form of a paste. An excess of the nickel carbonate does not interfere, as it simply remains in the bath and neutralises the acid as it is formed, and the concentration of the nickel in the bath remains constant. On the other hand, an excess of ammonia is harmful, as it causes the deposited metal to be brittle, and it does not then adhere so well.

When articles are plated with an alloy of silver and nickel, the appearance is more brilliant, and is harder and also cheaper than when pure silver is employed. R. H. Marshall gives the following receipt for preparing the bath:—1 kilogram each of the double-cyanide of nickel and silver is dissolved in 100 litres of water and electrolysed, using an anode of pure silver. From time to time extra potassium nickel cyanide is added to the bath to take the place of the deposited nickel.

Metallic deposits, which are sometimes difficult to obtain in a dense and coherent form, will, according to A. Classen, be deposited in a dense, brilliant, and homogeneous condition by adding to the bath some glucoside such as the decoction obtained by steeping liquorice root in water, or, according to L. Trunkhahn, a mixture of syrup and a ferment such as yeast. Thus, for example, 20 kilog. of zinc sulphate, 1 kilog. of zinc chloride, 4 kilog. sodium sulphate, 0·5 kilog. of boric acid, and then 5 kilog. of liquorice decoction, are added to 100 kilog. water. Or, 25 kilog. zinc sulphate, 15 kilog. aluminium sulphate, 1 kilog. chalk, 4 kilog. glucose, and 0·5 kilog. yeast. In both these cases information as to the anode employed would be of interest. If in the second case an insoluble anode is employed, then the calcium carbonate might very well be replaced by zinc carbonate or oxide.

According to J. Schiele, if iron is to be plated with silver or gold, it should be first coated with a thin layer of tin-aluminium-magnesium alloy, and the following method is recommended. In 9 litres of water dissolve 500 gm. sodium pyrophosphate and 100 gm. tin chloride; add to this solution 1 litre of a solution containing 50 gm. aluminium nitrate and 50 gm. magnesium. Use as anodes tin and aluminium sheets. Such a solution with such electrodes would not, as a matter of fact, deposit an alloy of tin-aluminium and magnesium. In the first place, the tin anode alone would function, because it is well known that aluminium anodes will not after a few seconds allow the passage of the current—hence rectifying action with alternating currents. Secondly, neither aluminium nor magnesium are deposited from aqueous solutions.

E. L. Lecoq recommends the following bath for depositing brass upon steel, cast-iron, or wrought-iron. In 100 litres of water dissolve 3 kilog. sodium carbonate, 4 kilog. sodium sulphate, 6·5 gm. potassium cyanide, 2·25 kilog. copper acetate, 1·1 kilog. zinc sulphate, 0·1 kilog. tin chloride, 0·1 kilog. lead acetate, 0·25 kilog. zinc chloride, and then add 2 litres of ammonia. Whether anodes of brass or of copper and zinc should be employed is not mentioned. Further, one is rather inclined to ask which of these numerous ingredients could be left out without hurting the results.

Celluloid is often used in accumulators to prevent contact between the negative and positive plates. It is therefore of interest to notice that F. Schoenbeck finds that when cuttings of celluloid are put in a closed flask with accumulator sulphuric acid and allowed to stand for some months, the acid at the end of the time shows reactions for nitric acid. Under working conditions this would probably be reduced to ammonia, which is always considered to be harmful to accumulators.

E. F. Kern and H. S. Auerbach describe a series of experiments on the cathodic reduction of artificially prepared lead sulphide with different fused electrolytes (*Society of Chemical Industry*, December 31st, 1907). In each case the lead sulphide was crushed to about 30-mesh size, and placed on the surface of a molten lead cathode, in a clay crucible with chloride electrolytes or graphite crucible with fluoride electrolytes. Pieces of Acheson graphite were employed as anodes. Alkali chlorides or calcium chloride were found to act satisfactorily as electrolytes. With the former the E.M.F. is about 5 volts lower than with the latter, but calcium chloride gives a more fluid bath, and is less readily volatilised. With a mixture of cryolite and fluor-spar as electrolyte, a higher current efficiency is obtained, but the bath is apt to become viscid. With chloride electrolytes, chlorine is evolved at the commencement of the electrolysis, but as the electrolysis proceeds, and sulphides begin to be formed by the reduction of the lead sulphide, then chlorine ceases to be liberated, because the critical voltage of the sulphides is lower than that of the chlorides. Finally, sulphur commences to separate at the anode, and may be collected or allowed to burn away. When chloride electrolytes are employed the current efficiency increases with the temperature. In some experiments in which natural galena was used and an electrolyte of calcium chloride, the current efficiency was at first very low; but when the reaction-product was re-melted underneath calcium chloride and the mixture heated to 1,200°, the calcium which had alloyed with the fused lead was liberated, and then reduced a further quantity of galena which was floating upon its surface, the current efficiency being increased from 26·5 per cent. to 43 per cent.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published Jan. 9th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

1906 Patents

23,009, B. T. H. Co. & DALTON. This relates to improvements in electric arc lamps of the converging carbon or the parallel electrode type. A downward feed controlling mechanism is used, consisting of a slider hung on a flexible suspension for the electrodes, between the ends of the suspension and a clutch, one of the members of which is carried by the slider to control its movement. In another form of controlling mechanism the clutch is shaped like a nut, having an angular-shaped aperture, through which an angular twisted rod passes, which is untwisted by the regulating mechanism, allowing the movement of the slider to permit a downward feed of the electrodes. Three claims, two figures.

27,520. KANDO. This relates to the control of groups of polyphase electric traction motors, in which the current taken by the motor or group of motors first reaching full speed is arranged to control the rheostats governing the remaining motors or groups of motors in such a manner that the latter are prevented from taking more current than the first-mentioned motor or group of motors. A rheostat having a transformer, the primary winding of which is connected in one or more of the phase circuits of the motor, and the secondary winding is connected in the circuit of the regulating magnets of all the rheostats of the system, each of the transformers being arranged to be inoperative except when the secondary winding of its corresponding motor or group of motors is short-circuited. The voltage can be regulated by hand for controlling the operation of the rheostats of all the motors or groups of motors until they reach full speed. Four claims, two figures.

1907 Patents

3,078. C. G. NOBBS and C. G. NOBBS, Jun. This specification relates to an electric steam radiator, in which resistance coils are inserted in the bottom chamber of the radiator. The coils may be of iron wire or other suitable material, immersed in a quantity of water, which may be very small in volume compared with the capacity of the radiator. The coil may be placed in the receptacle or bottom of the radiator, which is connected to it by pipe coils. The radiators may also be provided with coils for superheating the steam, if necessary. The radiators may work singly or in series with one another, and thus do away with steam piping round the buildings. Suitable switches are provided for cutting out one or more heating elements as required. Four claims, one figure.

3,214, G. HOOKHAM, W. S. SPRAGUE, relates to improvements in the counting trains of electricity meters, by which the counting train is driven in such a manner that there will be no sudden resistance offered to the rotation of the driving spindle, while at the same time there is no uncertainty as to the correct reading at any time. The first disc is driven through a spring which causes the disc to remain fixed just before it is desired to operate the train, while the continued revolution of the driving spindle puts the spring in tension, and at a predetermined position in its revolution releases the disc, causing the spring to operate the next disc of the train. Three claims, three figures.

4,801, POULSEN. This relates to receivers for wireless signalling by electro-magnetic waves, so that the receiving vibration circuit is periodically brought out of resonance without opening the circuit itself, and the circuit transforms energy from space, and has the wave indicator connected to it, so that the energy accumulated by resonance is brought to discharge itself suddenly through the wave indicator. Two figures.

10,369. ATELIERS THOMSON-HOUSTON. This relates to improvements in the commutation of dynamo electric machines, and the object is to avoid unequal distribution of current in the different circuits of a parallel armature winding due to non-symmetry in the flux; or in the value of the contact resistances of the brushes. This is done by exciting the supplementary poles by the aid of ampere turns, which are a function of the current which flows through the different conductors which they influence. This relates particularly to drum-wound machines with their windings in parallel, each pole is excited from two coils connected to brushes of opposite polarity, and so arranged that the coils on adjacent poles are in series with each other and one of the brushes. Each supplementary pole is then excited by the aid of two coils, respectively in series with two different lines of brushes, and upon two supplementary poles there are two coils in series with one line of brushes. These coils are placed in different circuits, connecting the brush holders to the system serving to put the brushes in parallel. Three claims, one figure.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Names in brackets indicate communicators of inventions from abroad.

Summaries of the more important of these patents will appear in our next issue.

1906 Patents

20,928, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Operating electric motors for braking purposes.
21,504, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Manufacture of electric conductors of refractory metal, especially for electric lamps.
23,894, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric motor control systems and apparatus.
23,944, HIRST & GUNNER. Electrical conduit and junction-box.
26,644, LEITNER. Electric supply systems.
29,174, LEITNER. Electric motors.
29,320, LUBECK. Electric switch.
29,584, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Circuit-controlling mechanism.
29,618, SCIPLE. Sectional poles for telephone, telegraph, &c.
29,639. SCOTT. Electric circuit breakers.
29,639B, SCOTT. Electric circuit breakers or switches.
29,655, RUTHENBURG. Electrolytic apparatus.
29,665, DAWSON & BUCKHAM. Electrical signalling apparatus.
29,758, LEITNER. Systems of electric train lighting.

1907 Patents

795, KILROY, & EVERSHED & VIGNOLES, LTD. Automatic electric motor starter.
836, SMITH-SAVILLE. Portable tram rail grinding machines.
1,685, COUADE. Electric service motors.
2,029, HEWETT & FOSTER. Electrical advertising devices.
2,959, PURVES & SINNOTT. Electrical insulators for telegraph or telephone wires or the like.
2,973, LOWTHIAN. Electro-mechanical fog signals for railways.
3,212, TIERCELIN. Locks and electrical switches.
3,613, GUNNING. Automatic periodically-operated switches.
3,908, SUNDERLAND FORGE AND ENGINEERING CO. & BLAIR. Electric cranes, winches, and the like.
3,997, ELECTRIC IGNITION CO. & HALL. Dynamo-electric ignition apparatus of internal-combustion engines.
6,134, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Signalling systems for railways and the like.
7,065, ULLRICH. Coin-freed mechanism for electricity meters.
8,173A, MILTON. Inductor alternators.
8,462, MARCONI & MARCONI'S WIRELESS TELEGRAPH CO. Apparatus for wireless telegraphy.
8,463, MARCONI & MARCONI'S WIRELESS TELEGRAPH CO. Apparatus for wireless telegraphy
8,623, STONE & MIGOTTI. Means of propulsion of electrically driven trains and the like.
10,259, LE TALL (*Hewitt*). Wireless telegraphy.
17,707, HUNTER & WARREN. Electric switches.
21,842, KELLOND. Adjustable electric lamp-shade holder.

The following complete Specifications are open to Public Inspection at the Patent Office, but are not yet published for sale.

1907 Patents

12,635, GALLETTI. Wireless telegraphy.
26,530, GES. FÜR DRAHTLOSE TELEGRAPHIE. Radio-telephony.
26,622, CUMONT & COMPAGNIE DE SIGNAUX ELECTRIQUES POUR CHEMINS DE FER. Railway signal and point mechanism.
27,672, PIEPER. Driving of electric cranes and the like.
27,739, JANECEK. Arc lamp with a support electrode with which the other electrode is rigidly connected.
27,825, FELTEN & GUILLEAUME-LAHMEYERWERKE AKT.-GES. Electric igniters for internal-combustion engines.
28,138, ALLGEMEINE ELEKTRICITÄTS-GES. Electric lamps.
28,220, THOMAS. Starting means for vapour electric devices.

Expiring Patents

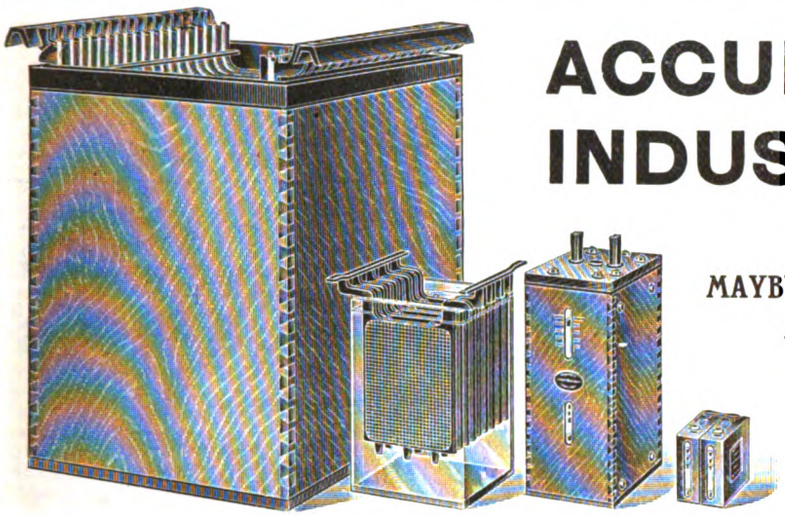
The following patents expire during the current week, after a life of fourteen years:

1,087, THWAITES & CAWLEY. January 20th, 1897. This describes a well-known system of haulage on canals or waterways, in which a motor is suspended from an overhead rail, and tows the vessel along the waterway.

1,417, January 23rd, 1894. G. H. WHITTINGHAM. This relates to an automatic device for removing resistance in starting electric motors, and replacing it again, its object being to gradually reduce the resistance in the armature circuit automatically, and replace the resistance when the current is shut off the motor.

For LOCAL NOTES, &c., see pp. 103 to 108

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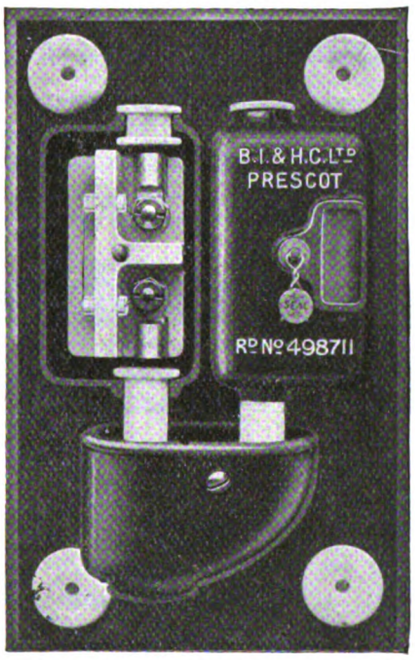
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(*Continued on page* vii.)

For LOCAL NOTES, &c.—See pp. 103 to 108

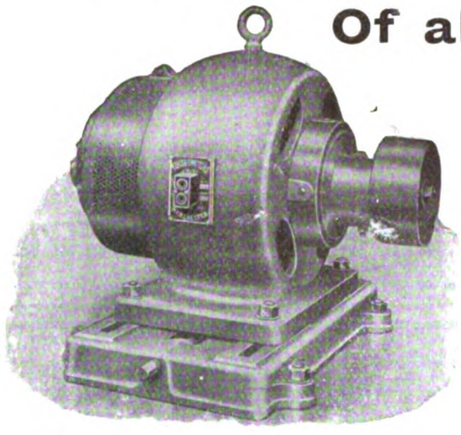
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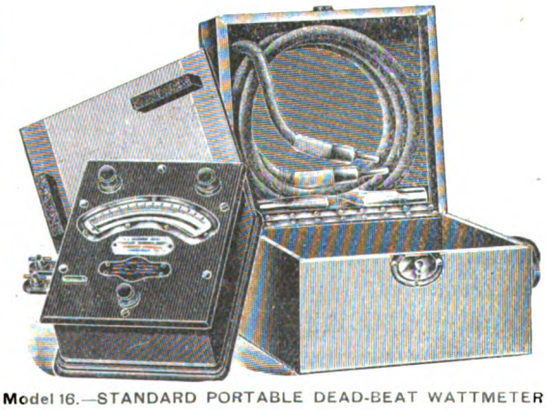
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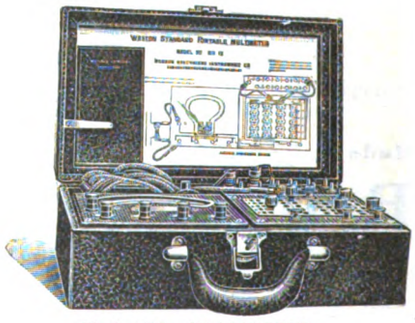
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LOCAL NOTES

AUSTRALIA: *Adelaide Tramways.*—The Adelaide Electric Supply Co. have entered into an arrangement to supply the Adelaide Tramways with power, pending the erection of the Tramways Power House, at Port Adelaide. The present generators at the Greenfell Station of the Supply Co. will be ample for the purpose for some time to come. The Supply Co. have ordered two new turbine generators, each of 1200 h.p., and one of these is to be used solely for the tramway work. Extensive alterations are now being made at the works, and the capacity of the station when the new sets are installed will be 5,000 h.p. The Tramways Trust hope to have the service in North Adelaide running before Christmas, 1908.

BARNES: *Proposed Tramways.*—At a general meeting of the Barnes and Mortlake Ratepayers' Association, held on Tuesday night of last week, the following resolution was carried unanimously :—"That the Barnes and Mortlake Ratepayers' Association, having held a public meeting with a view of ascertaining the wishes of the ratepayers on the tramways question, hereby urges the Urban District Council to oppose any Bill now before Parliament."

BELFAST: *Cavehill and Whitewell Tramways.*—A meeting of the ratepayers, convened by the Lord Mayor, was held in the Council Chamber at the City Hall, on January 7th, for the purpose of confirming the Council's resolution to promote the Belfast Corporation (Tramways) Bill. There was a big attendance of ratepayers present. The proposal was not favourably viewed by the ratepayers, who considered that the sum of £20,000, which it was proposed to pay for goodwill, was absolutely wasted, as the whole undertaking was only earning £4,500 a year, and they also objected to paying £60,000 for what was said to be practically a bankrupt concern. An amendment was proposed for taking a plebiscite to decide whether the Council should proceed with the Bill, and was carried.

BOLTON: *Electricity Station Matters.*—At a meeting of the Electricity Committee, held on Thursday, January 9th, it was announced that the Markets Committee had agreed to purchase the motors on hire at the Cold Stores.—A letter was read from the British Westinghouse Electrical Manufacturing Co., pointing out that a negative booster in use at their electricity works was an infringement of their patent rights. The matter was referred to the Chairman, Vice-Chairman, Town Clerk, and the Electrical Engineer.—As a result of an overwhelming vote of ratepayers, assembled in the Albert Hall on Tuesday evening, January 7th, against the proposal of the Town Council to construct tramways in Deans Lane, the Bill promoted in Parliament by the Corporation in relation to that work will now be dropped.

BOURNEMOUTH: *Assessment Cases.*—The Corporation of Bournemouth have appealed to the Quarter Sessions against the assessment of poor rate on the light railways within the Borough of Poole. The case came before the Recorder of Poole (Mr. Clavell Salter, K.C.). The appellants urged that they were not free agents when the agreement was made to take over the tramways. The effect of the agreement was to say that the tenants were holding property on certain very onerous terms, which affected the tenant in his relations to the public. The tenant was to run cars with certain specified services and fares on Sundays, so as to accommodate the public. Several valuers had made their valuation, but none had placed it upon the rent. The valuation was based, as far as possible, on the receipts per car mile. The rateable value was made out to be between £2,000 and £3,000. The Recorder, in giving judgment, said he thought the correct method was to proceed upon the estimated gross receipts and expenses per car mile in the parish of Poole, without regard to the rest of the system, and he came to the conclusion that this property might fairly be expected to let in the conditions prescribed by statute for a rent which would justify the rating appealed from, and therefore the appeal must fail. The appeal was dismissed, with costs.

BRENTFORD: *Kew Bridge Tramways.*—The District Council has decided not to oppose the Bill promoted by the London United Tramway Co., which seeks powers to cross Kew Bridge.

BURSLEM: *The Supply of Electricity Bill.*—The Electric Lighting Committee have resolved to ask the Board of Trade to re-introduce the Supply of Electricity Bill during the coming session of Parliament, and to take every means to have the same passed into law. A copy of the resolution was ordered to be sent to the local Members of Parliament and the Secretary of the Board of Trade.

BURTON-ON-TRENT: *Electricity Returns.*—The advantages of supplying power on the restricted hour principle, i.e., the restriction of the demand during the hours of the winter peak loads, has been shown at Burton. Taking the last three years for the periods of April 1st to the end of December :—Lighting and power units, 1905, 259,508; 1906, 382,318; 1907, 550,529. Motors connected in the above periods, kw. :—1905, 4·5; 1906, 128; 1907, 233. Lighting connected in kw. :—1905, 48.25; 1906, 35; 1907, 37. Total extra kw. connected :—52·75, 163, 270, for the three years. Maximum load in kw. : (1) 492 kw.; (2) 511 kw.; (3) 515 kw. The percentage increase in units was 47·4 per cent. in 1906, and 44 per cent. in 1907. From these figures it will be noticed that 112 per cent. more units have been sent out in 1907 than 1905, and only a 4·68 per cent. increase of the maximum load, and 433 kw. more was connected in 1907.

CARMARTHEN: *Electric Lighting Provisional Order.*—A special meeting of the Carmarthen Town Council was held on Friday to consider the draft arrangement with Messrs. J. B. Saunders & Co., of Cardiff, for the electric lighting of the town. Several objections were made on the ground that the electricians had not adhered strictly to the terms contained in the agreement entered into with the Council some time ago. Chief objection was laid to Clause 12 in regard to overhead wires, the Clerk (Mr. R. M. Thomas) being instructed to lodge an objection with the Board of Trade by the 15th inst., in case Messrs. Saunders & Co. did not acquiesce in the Council's demands.

CHISWICK: *Noisy Tramcars.*—The Works Committee of the Council, on January 9th, decided to support Ealing's application for an injunction against the London United Tramways Company on account of the noise occasioned by tramcars, and contribute £60 towards the cost. A resolution was also carried to call the attention of the Commissioner of Police to the noise of the trams, and request him to withdraw his licence in respect of those cars found to be unsuitable.

EALING: *Proposed New Tramways.*—At the last meeting of the District Council, Mr. Armriding, at the suggestion of the Mayor, moved that a joint committee consider the feasibility and expediency of providing a system of electric tramways or motor 'buses from the southern and south-western part of the borough to the main roads. General agreement with the proposal as regards tramways was expressed, but objection was taken to the portion of the motion regarding motor 'buses. The resolution was agree to.

KINGSWOOD: *Electric Supply Order.*—A communication has been received from the Board of Trade to the effect that they had decided to defer revoking the Order granted the Kingswood Electric Supply Company until May 1st.

LIVERPOOL: *Tramways Record.*—At a meeting of the Liverpool Corporation Electric Tramways Committee it was reported that last year's traffic as regards receipts, passengers carried, and earnings per car mile, was the greatest recorded. The passengers numbered over 124,000,000, nearly a million more than in the previous twelve months. The receipts were nearly £572,000, an increase of over £8,000; and the car mileage was over 12,200,000, an increase of nearly 116,000. The average earnings per car mile were 11·22d., an increase of 0·05d.

LONDON: *Camberwell:* Deputation to the Board of Trade.—A deputation from the Borough Council waited upon Mr. Hudson Kearley, M.P., and the Hon. T. H. W. Pelham, at the offices of the Board of Trade recently, with regard to the accounts and audit of the County of London Electric Supply Co., Ltd. The deputation pointed out that the Board of Trade admitted that the company's order constituted a separate and distinct undertaking within the Camberwell area, and therefore that the Borough Council were entitled to demand that accounts and information should be submitted in respect of the Camberwell area alone. Of the various forms of accounts the Board of Trade required electric lighting companies to prepare, the company had merely returned two—the capital account and the revenue account. The revenue account for 1906 showed a balance of £10,032 14s. 5d. This balance should be carried to the net revenue account. It should there be operated upon by means of transfers, a portion being allocated to reserve fund account, and another portion to depreciation fund account. According to the published accounts, the Camberwell profit balances appeared to have been merged in the general accounts of the whole of the company's business. In passing, the deputation suggested that the position of the reserve fund and the depreciation fund, from the commencement of the undertaking to the present time, ought to be disclosed, since the company year by year abstracted the cost of repairs and renewals from the Camberwell revenue accounts—thereby increasing the apparent profits—and placed this expenditure to the debit of the general depreciation fund, which would accordingly appear to be replenished in part by transfers from the Camberwell profit balances. Bearing in mind that on the construction of the Camberwell purchase clause the question of the sufficiency or insufficiency of dividends earned, as compared with the dividend of 5 per cent., referred to in the Camberwell Electric Lighting Order, would play an important part in determining the purchase price of the undertaking if sold to the Borough Council, the deputation considered it was essential that the Camberwell revenue accounts should be supplemented by net revenue, reserve fund, and depreciation fund accounts. The statement of electricity generated and sold—at present withheld—would give the Borough Council important information which would seriously influence any decision as to exercising powers of purchase, as it included data showing the proportions to the total quantities of electricity generated and distributed; of the quantities sold for lighting and for power purposes respectively. Mr. Kearley promised that he would carefully consider the points raised, and also whether the Board of Trade should exercise their

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wheel, &c., for the water and lighting scheme of Matatiele, Cape Colony (municipality); electrical equipment at the Bluff, the Point (Durban), and the Maritzburg Railway workshops (Natal Agent-General, London); telephone and other electric plant at the Roodepoort Post Office (Transvaal Agent-General, London).

SPAIN.—An American Consular report states that a royal order has been published in the Spanish *Official Gazette*, inviting tenders from native firms for the installation of a telephone system connecting with the French wires at the frontier towns of Irun and Portbou, the details being as follows:—The line will start from Madrid, and at Zaragoza branch off in two directions, one passing through Pamplona, Tolosa, and San Sebastian to Irun, and the other following the line through Lerida to Barcelona and Tarragona, and thence on through Gerona to Portbou on the French frontier, thus establishing communication between Barcelona and France. Tenders are also solicited for the construction and working of telephone systems connecting Madrid with Coruna and Ferrol, with Pontevedra by way of Orense and Vigo, on to Gijon, Santander, and several other smaller towns. This will be known as the North-western System. Another, the South-eastern System, will connect Madrid with Cartagena, Albacete, Alicante, and Murcia, Almeria, Lorca, Linares, Jaen, Granada, Baza, and Motril. Another system, to be known as the Southern Telephone System, will link up Madrid with Cadiz, passing through Ciudad Real, Almaden, Cordova, Seville, and Jerez; with Malaga, by way of Bobadilla, and with Huelva, Caceres, Badajoz, and Zafra. Inasmuch as only native firms are invited to compete for these contracts, their interest for exporters, it is pointed out, lies in the fact that large orders will naturally be given by contractors for wire, posts, insulators, and other material as soon as the contracts are finally signed, which it is expected will be in January next.

TURKEY.—The Turkish Minister of Public Works has received an application for a concession for the erection of an electric lighting and traction undertaking at Monastir. The applicant is Mustafa Shukri Bey, Vice-President of the Chamber of Commerce. It is also announced that Giovanni Passizzi and Ludovico Galeotti have applied to the Smyrna municipality for a concession for the electric lighting of the town.

WIMBLEDON.—The Corporation invite tenders for the supply and erection of the undermentioned plant at their electricity works, and are prepared to accept tenders subject to the sanction of the Local Government Board being obtained for the necessary loan:—(*a*) A 1,000 kw. turbo-alternator, with condensing plant; (*b*) two water-tube boilers, economisers, pipe-work, and feed pump; (*c*) high-tension main switchboard and switchboard gallery. Forms of specification and tender, with the general conditions, may be obtained from Mr. H. Tomlinson-Lee, the Borough Electrical Engineer, Electricity Works, Durnsford Road, Wimbledon (fee £1 each specification, returnable), and tenders to the Town Clerk by February 18th.

YARMOUTH.—Tenders are invited for the supply, delivery, and erection of a 400 kw. continuous-current traction generator. Particulars and forms of tender from the Borough Electrical Engineer, 20 King Street, Great Yarmouth (fee £1 1s., returnable), to whom tenders by February 1st.

TENDERS RECEIVED AND ACCEPTED

ABERDEEN.—With reference to the recent tender accepted for the supply of fittings for the street electric lamps, it has been remitted to the Lighting & Fires Committee to submit a report to the Council giving full particulars as to the prices charged under the new contract, compared with the prices formerly paid to the electricity department for the same articles together with the specification submitted to the contractors.

AUSTRALIA.—The Victorian Postmaster-General's department has accepted the tender of Messrs. J. Bartram & Son, Melbourne, for the supply and delivery of eleven sections of branching system magneto-telephone switchboard.

BURY.—The following contracts have been entered into for the year by the Tramways Committee:—Brake blocks, F. R. Cass (Bury); hire of ticket-punches, Bell Punch & Printing Co. (London); tickets, J. R. Williams & Co. (Liverpool); uniform clothing, H. Lotery & Co. (London).

CARDIFF.—The Electrical and Tramways Committee has accepted the tenders of the British Westinghouse Co. for two transformers for supplying the Great Western Railway Co.'s passenger stations with electric light—one of 50 kw at £53 10s., and one of 40 kw. at £47. These tenders were the lowest.

LANCASHIRE.—Messrs. Bruce Peebles & Co., Ltd., have received from the Ray Mills Co., Ltd., an order for the complete electrical equipment of their spinning mill at Stalybridge.

LONDON.—The Kensington and Notting Hill Electric Lighting Companies Joint Works, Wood Lane, Shepherd's Bush, W., have ordered three Bennis-Miller-Bennett improved patent smokeless chain grate stokers for a Babcock & Wilcox water-tube boiler from Ed. Bennis & Co., Ltd., Little Hulton, Bolton.

Lambeth.—The Borough Council has placed an order with Messrs. Strode and Co., Ltd., to wire and fix the electric light fittings in the Council Chamber and the Council Chamber anteroom at £18. The same firm is to supply wood fixing blocks and screws for certain of the ornamental electric light fittings throughout the building at £3 15s.

St. Pancras.—The Board of Guardians has received the following tenders for the supply of electric lamps to the South Infirmary:—J. C. Christie (accepted), 8s. 6d. per doz.; Charles Harrison, 9s. 8d. per doz.; Thomas Sampson, 10s. per doz.

Stepney.—The Borough Council has received the following tenders for columns and brackets in connection with the lighting of Broad Street, Horseferry Branch Road, Medland Street, and Wapping High Street, by arc lamps, and for the provision of columns or brackets for arc lighting extensions up to December 31st, 1908:—R. A. Bradshaw & Son, Retford (provisionally accepted), £361 10s.; W. Lucy & Co., Oxford, £392 5s.; W. Macfarlane & Co., Glasgow, £533 10s. 6d.

MANCHESTER.—Messrs. Bruce Peebles & Co., Ltd., have received the Manchester Corporation's order for eight Peebles La Cour motor converters in sizes ranging from 250 to 600 kw., each machine receiving 6,600 volts, and converting to either 415/425 for lighting, or 500/550 for traction.

ROME.—An order for 12 Woodeson patent water-tube boilers for the generating station at Rome has been secured by Messrs. Clarke, Chapman & Co.

SOUTHAMPTON.—The Town Council have accepted the tender of Messrs. Willans & Robinson, Ltd., for the supply and erection of the steam generator, and the tender of Messrs. Babcock & Wilcox, Ltd., for the supply of the boilers required at the electricity supply station.

WAR OFFICE.—Messrs. J. B. Saunders & Co. have been given a second contract for electric lighting in connection with the War Office buildings.

WOLFRAM (TUNGSTEN) METAL FILAMENT LAMPS, LTD.—The tender for the erection of this company's new works at Hammersmith has been let to Mr. J. McManus, at £34,[illegible]. There were thirteen tenderers, and the quotations ranged from the price of the accepted tender to £41,588.

COMPANIES' MEETINGS AND REPORTS

BRITISH WESTINGHOUSE CO.—In a circular issued to the shareholders dealing with the financial position of the company, the directors state that the reason for the necessity to issue the £300,000 prior lien debentures was brought about by the conditions of the money market in America, which precluded the American company, as had been its custom hitherto, from either furnishing financial assistance itself or acting as guarantor. In order that the whole amount of the new debentures which have been sanctioned by the shareholders shall be available for present and future needs, the American Company had agreed to accept in liquidation of the £186,374 owing to them, shares in the Traction & Power Securities Company at par. The £300,000 prior lien debentures is required to repay advances from the bankers expected to be reduced by February and March to £100,000; to meet accounts payable now due to the extent of £110,000, and to meet additional requirements on account of expansion of business, £90,000. Incidentally the directors point out that it has been decided to change the date for the termination of the financial year from July 31st to December 31st. Thus the next accounts to be presented to the shareholders will cover two periods, one of five months from August 1st, 1906, to December 31st, 1906, and the other from January 1st, 1907, to December 31st, 1907. The circular goes on to point out that the eleven months of 1907 to November shows a trading profit of £76,000, and after providing for interest on loans and debenture interest, there is a net profit of £17,780. The accounts and business of the company is to be dealt with in detail at the annual meeting, but the directors believe that if there be no unfavourable developments in industrial conditions, the position of the company will continue to improve.

According to a Reuter telegram from Pittsburg, the United States Judge has issued an order permitting the receivers of the Westinghouse Electric & Manufacturing Co. to exchange a claim of $874,882 against the British Westinghouse Electric & Manufacturing Co., Ltd., for shares in the Traction & Power Securities Co., Ltd., of Great Britain, equal at par to the same amount and interest, provided that the British Westinghouse Electric & Manufacturing Co., Ltd., secures bona-fide subscriptions for a bond issue of £250,000.

GENEVA TRAMWAYS.—The report for the period from December 17, 1906, to September 30, 1907, states that it having been found impossible for the original Geneva Tramways Company, Limited, to meet the full 4½ per cent. interest on the [illegible],000 debentures, the company went into voluntary liquidation on October 4, 1906, and the present company was registered under a scheme of arrangement sanctioned by the court on November 10, 1906. The scheme provided for the sale of the old company's assets to this company. The four-and-a-half per cent. debenture-holders of the old company are entitled under the scheme to 510,000 shares of £1 each (fully paid) and £255,000 four per cent. debentures of this company, to be distributed amongst them *pro rata* in lieu of their holding in the old company. The third (five per cent.) debenture-holders of the old company received under the scheme, in lieu of their holding and all accrued interest thereon, a *pro rata* distribution of [illegible],000 £1 shares fully paid in the capital of this company. The rights of the shareholders and income-certificate holders in the old company were, under the scheme, extinguished.

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Applications for four per cent. debentures and shares in the company had been received to the date of closing the accounts in respect of £811,200 four-and-a-half per cent. debentures of the old company, and the equivalent four per cent. debentures and shares in this company have been allotted in exchange. Since the closing of the accounts further four-and-a-half per cent. debentures of the old company have been surrendered, the total to date being £843,700, in exchange for which £255,000 four per cent. debentures and 500,200 shares of this company have been allotted. The profit and loss account of the company for the period above referred to shows a gross profit on working of 502,148f., and, including the credit balance of 227,652f. brought forward from the previous period, makes a total of 789,800f. After making provision for the necessary contributions to amortisation, renewal, and reserve funds, amounting together to 179,332f., there remains a balance of 610,467f., out of which a dividend of 1½ per cent. has since been paid, leaving a balance of 310,467f. to be carried forward. New rolling stock is to be purchased to deal with the increasing traffic.

At the meeting on Monday, the report and accounts were adopted.

LOCH LEVEN ELECTRIC POWER.—At a meeting last week, the promotion of a Scotch provisional order, seeking an extension of the time limited by the Loch Leven Water Power (Amendment) Act, 1904, was unanimously agreed to.

NEW AFRICAN.—At the ordinary general meeting of this company on Friday, Sir Charles Euan-Smith, K.C.B., who presided, made some reference to the work of the Marconi Company, in which undertaking the New African Company has an investment of several thousand pounds. The chairman stated that after seven years of incessant work, the Atlantic had been successfully bridged by wireless telegraphy by Mr. Marconi, and the very difficulty of the task secured, in a sense, the Marconi Company from the possibility of competition. He expected on Saturday (January 11th), that the Marconi Company would establish a full service for the transmission of ordinary private messages. One of the main reasons for this not having been done before was that the Marconi Co. had been depending on single units of plant at their stations, and it had been considered advisable to duplicate parts of the running machinery in order to present risks of breakdown. Another reason for delay in throwing the service open to the public was the imperfect land line connections. This however would not be done away with until the Marconi Company was granted similar land-line facilities to those possessed by the cable companies. When these matters were settled, he saw no reason why wireless telegraphy across the Atlantic should not attain to a speed and accuracy of transmission equal to the present cable service.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith and Son, of 5 Philpot Lane, E.C., inform us that the price of electrolytic wire bars net c.i.f. port of arrival quoted on Tuesday night, was £65 to £65 10s. per ton (last week £64 10s. to £65 10s.).

LIQUIDATIONS, BANKRUPTCIES, &c.—Creditors of the City of Wellington Electric Light and Power Co. are required to send in particulars of their claims by January 24th to the Liquidator, Mr. H. E. Salt, 251 Winchester House, Old Broad Street, London, E.C. This company has been acquired by the municipality.

The trustee in the bankruptcy of F. E. Williams, electrical engineer, 328 Coventry Road, Birmingham, has been released.

A receiving order has been made against George Kaye Spiney, electrical engineer, 34 Pinderfields Road, Wakefield, Yorks. The debtor started in business as an electrical engineer at Dewsbury in 1899. His capital consisted of about £25 in tools and cash. About six years ago he was in partnership with Harry Birch, and they traded under the style of Spiney & Co. for three years, and the debtor was then appointed as electrical engineer for work for the Yorkshire Woollen District Tramways. The partnership with Mr. Birch was dissolved, and shortly afterwards the debtor was joined by another partner, who introduced £1,000 into the business. The debtor's capital was then £500. In October, 1905, he was paid out of the business, receiving £150 as his share. His statement of affairs shows gross liabilities amounting to £116 8s. 1d., all of which are expected to rank. The assets consist of cash in hand amounting to £10.

THE WESTMINSTER ENGINEERING CO.—The Westminster Engineering Co. inform us that, in order to devote their attention particularly to the manufacture of dynamos, motors, switchboards, arc lamps, and other specialities, they have disposed of the wiring, fittings, and installation branch of their business carried on since 1890 and up to this date at 16 Davies Street, Berkeley Square, W. Mr. Walter Riggs, who managed the branch for seven years, retains his position with the new proprietors, who will continue the business under the name of Girdlestone & Co., but neither the Westminster Engineering Co. nor Mr. J. O. Girdlestone, the managing director of the company, will have any interest in, or be in any way connected with, the business. The offices and sales department will remain at Victoria Road, Willesden Junction, as before, but customers who find it more convenient may still deal with Messrs. Girdlestone & Co., who are agents for the sale of the company's manufactures.

MISCELLANEOUS CITY NOTES

DIRECT UNITED STATES CABLE CO.—An interim dividend of 4s. per share, free of income-tax, being at the rate of 4 per cent. per annum, for the quarter ended December 31st, has been declared; the sum of £5,000 has been allocated to the reserve fund account; and £6,396 carried forward.

DUBLIN UNITED TRAMWAYS CO.—Subject to final audit, a dividend at the rate of 6 per cent. per annum for the half-year ended December 31st, 1907, has been declared upon both the preference and ordinary shares, together with a bonus of 1s. per share upon the latter. The sum of £5,000 has been set aside to the reserve fund, £1,000 to accident insurance fund, £10,000 for reconstruction and renewals, and £2,000 further provision against Exhibition guarantee, and £8,740 11s. 6d. has been carried forward.

MEXICO TRAMWAYS CO.—A dividend at the rate of 4 per cent. per annum for the three months ended December 31st, 1907, has been declared.

RIO DE JANEIRO TRAMWAY, LIGHT AND POWER CO.—Owing to increasing business in Europe, this company has opened offices at 46 Threadneedle Street, E.C., to which the registers, &c., will be transferred February 14th. The company also announce that, owing to the pressure of other engagements, Mr. William Mackenzie, of Toronto, has resigned the presidency, but will remain chairman of the board. Dr. F. S. Pearson has been elected president, and Mr. R. M. Horne-Payne and Mr. E. R. Wood, additional vice-presidents. Mr. George Flett, managing director of Dick, Kerr & Co., Ltd., has also been elected an additional director.

SIMPLEX CONDUITS.—The usual 6 per cent. dividend on the preference shares has been paid for the half-year ending December 31st, 1907. Dividend warrants have already been posted.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.—In a recent issue of the *Tribune* it was stated that the scheme for dealing with the profit-sharing notes of the Underground Electric Railways of London would, in all probability, be issued within the next few weeks.

APPOINTMENTS AND PERSONAL NOTES

At the meeting of the Manchester City Council on Wednesday last week the recommendations with regard to the appointment of Mr. S. L. Pearce, Chief Electrical Engineer (which we gave in our last issue), were agreed to.

Mr. O. F. Francis, Borough Electrical Engineer, Kirkcaldy, who, as we announced last week, was appointed to a similar position at Carlisle, has decided to remain at Kirkcaldy. At the monthly meeting of the Carlisle Town Council on Tuesday, when the confirmation of Mr. Francis's appointment came up for consideration, Mr. Johnstone, chairman of the Electricity Committee, said Mr. Francis had acted honourably in the matter, an offer on the part of the Kirkcaldy Town Council having been spontaneous. The salary offered by Carlisle was £300 a year, with increments of £20 a year until it reached £400, but the Kirkcaldy Town Council had offered him £350 a year, with increments of £25 a year until the salary reached £400. The Electricity Committee has decided to offer the Carlisle appointment to Mr. Allen, chief assistant borough electrical engineer of Plymouth, who was second on the list of selected applicants.

Mr. W. S. Smart, of the northern branch of the Post Office engineering department, has been presented by his colleagues with a valuable petrolite lamp and case of pipes upon his retirement at the age of 60. Mr. Smart has served at Gloucester, Cardiff, and Hull, and was transferred to Darlington about three years ago.

NEW COMPANIES

A. B. CARTER & CO. (GERMANY).—This company was registered on January 9th, with a capital of £1,500 in £1 shares, to adopt an agreement with J. Wenk, of 107A Strand, W.C., and to carry on the business of electricians, mechanical engineers, suppliers of electricity, manufacturers of and dealers in electric, magnetic, galvanic, and other apparatus, builders, signmakers, printers, photographers, advertising agents, &c. The subscribers are:—T. H. Bower, J. Wenk, G. C. N. Perkis, G. R. Bell, T. Hulme, F. Partington, C. Ivory. No initial public issue. J. Wenk is the first manager and permanent director. Qualification, £150 shares or stock. Registered office: 107A Strand, W.C.

MERSEY MACHINERY CO.—This company was registered on January 9th, with a capital of £1,500 in £1 shares (500 10 per cent. cumulative preference), to act as selling agents for the Neville Machine & Tool Co., Ltd., in Southport, Ormskirk, Bootle, Widnes, Newton, Ince, Liverpool, St. Helens, Warrington, Wigan, Wirral, Northwich, Eddisbury, and Flintshire. The subscribers are:—J. U. Neville, engineer, T. J. Knowles, Mrs. M. A. Knowles, R. Hughes, A. E. Waterhouse, E. D. Symond, Mrs. M. E. Neville. No initial public issue. The number of directors is not to be less than two nor more than three; the first are J. U. Neville and T. J. Knowles. No remuneration. Registered office: 7 James Street, Liverpool.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906 %	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£				
Bournemouth & Poole E. S. Co. Ld.	10	7	5/-*	9¾—10¾	+¼
Do. 4½% Cum. Pref.	10	4½	4½%*	9¾—10¼	+¼
Do. 6% Cum. Second Pref.	10	6	6%	10—10½	+⅛
Do. 4½% Debenture, Red.	Stock	4½	4½%	99—102 xd	+1
Bromley (Kent) E.L.& Power Co., Ld.	5	5½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	95—98	
Brompton & Kensington E. S. Co., Ld.	5	10	4½%*	7—8	
Do 7% Cum. Pref.	5	7	7%*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	97—100	+1
Ch. Cross. W. E. & City E. S. Co.	5	5	5%*	4⅛—4⅜	+¼
Do. 4½% Cum. Pref.	5	4½	2¼%*	4⅛—5	+⅛
Do. 4% Deb. Red	Stock	4	4%*	95—99	+1
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%*	4⅜—4⅝ xd	+⅛
Chelsea Electric Supply Co., Ltd.	5	4½	2 -*	3⅜—4⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	100—104 xd	
City of London Elec. Lt. Co., Ltd.	10	6	5%*	10—11	+⅛
Do. 6% Cum. Pref.	10	6	6%*	11⅛—12¼	+¼
Do. 5% Deb. Red	Stock	5	5%	120—123 xd	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	96—99 xd	+2
City of Durham E. P. Dis. Co.	5	4	2/1½*	3⅛—4⅛	
Do. 5% Pref.	5	5	5%*	4⅜—4⅝	
County of London Elect. Sup. Co. Ld.	10	5	4%*	6½—7⅛	
Do 6% Cum. Pref.	10	6	6%*	10¼—11	
Do. 4½% Deb. Red	Stock	4½	4½%	10 —106 xd	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	95—98	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅜—⅞	
Do. 6% Cum. Pref.	5	3½	—	¾—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	70—80	
Folkestone Elec. Supply Co., Ltd.	5	5½	2-*	4½—5	
Do. 5% Cum. Pref.	5	5	2/6*	5—5½	+⅛
Do. 4½% 1st Deb. Red	Stock	4½	4½%*	96—99	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6⅜—6⅞	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%*	96—99	+1
Kens. & N'tng Hill E.L. Cos. Db. Rd.	Stock	4	4%*	99—103	+3
London Electric Supply Corporation	3	4	2/4½*	1¼—1⅜	
Do. 6% Pref.	5	6	6%*	4⅜—4⅝	+⅜
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	88—92	+1
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	5⅜—6⅛	+⅜
Do. 4½% Cum. Pref.	5	4½	4½%	4⅝—5⅛ xd	+⅛
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	100—101 xd	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90 xd	
Midland E. Corp. for P. Dist. 1st Mt. D	100 & 500	4½	4½%	95—98	+1
Newcastle & Dist. E. L. Co., £9 paid	10	5	3/7½d.*	8½—9½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99 xd	
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6⅛—6⅜	
Do. £2 Pm.	5	8	1/4½d*	6⅛—6⅜	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5⅛	
Do. 10/- Pm.	5	5	1/4½d	5—5⅛	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	6%*	11—12	+½
Oxford Electric Co., Ltd.	5	7	2/6*	5⅛—6	
Do. 4% Deb. Red.	Stock	4	4%*	95—97	
St. James and Pall Mall E. L. Co. Ld.	5	10	5/-*	7⅛—8⅛	+¼
Do. 7% Non-Cum. Pref.	5	7	3/6*	6⅞—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90 xd	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—1⅛	
Do. 4% Deb. Red	Stock	4	4/-*	71 -75	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2⅛—3	
South Metropolitan E. L. & P. Co.	1	2½	6d*	2⅜—2⅝	
Do. 7% Cum. Pref.	1	7	8½d.*	1⅛—1⅜	+⅛
Do. 4½% 1st Deb. Red	Stock	4½	4½%	100—103	+1
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1⅛—2⅜	
Do. 5% Cum. Pref.	5	5	2/6*	2—2⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	5%*	8½—9¼	+⅛
Do. 4½% Cum. Pref.	5	4½	4½%	5—5½ xd	+¼
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%*	89—92	
Central London	Stock	4	3½%*	65—68	+1
Do. 4% Preferred	Stock	4	4%*	84—86	
Do. Deferred	Stock	4	—	44—47	
Do. 4% Debentures	Stock	4	4%*	101—104	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	72—76 xd	
City and South London Cons.	Stock	2½	2½%	44—46	
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%*	116—119	
Do. 5% Perp. Pref. 1895	Stock	5	5%*	113—116	
Do. 5% Perp. Pref. 1901	Stock	5	5%*	113—116	
Great Northern & City Pref. "A"	10	4	11d.	1½—2	-¼
Gt. Northern, Piccadilly & Brompton	10	4	4/-*	4—5	
Do. 4% Perp. Deb.	Stock	4	4%	80—83 xd	+2
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1%*	41½—42½	-2
Do. 3½% Preference	Stock	3½	3½%*	87—90	+1
Do. 3½% "A" Pref.	Stock	3½	3½%*	77—80	
Do. 3½% Convertible Pref.	Stock	3½	3½%	74—77	+1
Metropolitan District	Stock	nil	—	10—11	-½
Do. 6% Perp. Deb.	Stock	6	6%	102—107 xd	
Do. 4% Pref. Deb.	Stock	4	4%	70—75 xd	+2
Do. Extension Pref. (5%)	Stock	nil	—	18—23	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	—	47—52	
Underground Elec. Railways Co of London 5% Profit Shg. Sec. Notes	Various	5	5%	35—39	
White hapel and Bow 4% Deb.	Stock	4	4%	103—105 xd	
ELECTRIC TRAMWAYS.					
Lata Electric Tramways, Ltd.	1	5	1/-*	1⅛—1⅜	
Do. 5% Cum. Pref.	1	5	5%	1⅝—1⅞ xd	
Do. 4½% Deb. Red.	Stock	4½	4½%	90—95	-1
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93 96	+1
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	5—5½	
Do. 5% Perp. Deb.	Stock	5	5%	90—93	
Do. 4½% 2nd Deb.	Stock	4½	4½%	69—74	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4¼—4¾	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	96—99	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906 %	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£				
Dublin United Trams Co.	10	6	6%*	13—14	
Do. 6% Pref.	10	6	6%*	12¾—13¾	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	⅜—1⅝	
Do. 4% Deb.	Stock	4	4%	58—63 xd	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	92—95 xd	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7⅞—8½ xd	+½
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—84 xd	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	95—98	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	6d*	1⅜—1⅝	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	91—94 xd	
National Elec. Construction Co. Ltd.	1	10	2/-	⅛—⅜	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅜—1⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅛—⅜	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92 xd	
Potteries Electric Traction Co. Ltd.	1	4	9½d*	⅞—1	
Do. 5% Cum. Pref.	1	5	5%*	⅜—⅝	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4⅛—5	-⅛
Do. 6% Cum. Pref.	10	6	6%	9½—10½ xd	-½
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	6¾d.*	⅞—1⅛	
Do. 4% Deb. Red.	Stock	—	4%	78—82 xd	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	60—70 xd	-8
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1½	
Do. 6% Cum. Pref.	5	nil	—	3⅛—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	81—84 xd	+3
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅜	30/-	57—60	
Do. 6% Pref. Ord.	Stock	6	3%	100—102	
Do. Def. Ord.	Stock	1¾	—	16½—16¾	-½
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	80—84 xd	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3½—3¾	
Do. 10% Cum. Pref.	5	10	5/-*	8½—8¾	
Do. 4½% Debs.	50	4½	4½%	97—100 xd	
Direct United States Cable Co. Ltd.	20	4½	4⅝%	13¾—14¼	+¼
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	99—101 xd	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	5/-	12⅜—12⅞	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99½—102½	
Eastern Telegraph Co.	Stock	5¾	3¾%	130—135	
Do. 3½% Pref.	Stock	3½	17/5	83—86	
Do. 4% Mort. Deb.	Stock	4	4%	99—102	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	30—32	-½
Indo-European Telegraph Co. Ltd.	25	13	65/-	52—55	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	
National Telephone Co., Ltd., Pref.	Stock	6	6%*	110—112	
Do. Deferred	Stock	5¼	6%*	107½—109½	
Do. 6% Cum. 1st Pref.	10	6	6%*	11—13	+½
Do. 6% Cum. 2nd Pref.	10	6	6%*	10—12	
Do. 5% 3rd Pref.	5	5	5%*	5¼—5⅝	+⅛
Do. 3½% Deb. Red	Stock	3½	3½%	96—98 xd	
Do. 4% Deb. Red.	Stock	4	4%	99—101 xd	+1
West African Telegraph Co. Ltd.	10	4	4/-	10—10¼	
Western Telegraph Co., Ltd.	10	7	6%	12⅞—13⅜	+¼
Do. 4% Deb.	Stock	4	4%	97—100 xd	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	3⅛—3⅜	
Do. 6% Cum. Pref.	1	6	7½d	1⅛—1⅜	
Babcock & Wilcox, Ord.	1	20	1/7½*	3½—3¾	
Do. 6% Pref.	1	6	7½d	1⅛—1⅜	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6¼—6⅝	
Do. 6% Cum. Pref.	5	6	3/-*	5⅝—6⅛	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	100—103 xd	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%*	85—89	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅝—1	-⅛
Do. 4% Mort. Deb. Red.	Stock	4	4%	38—48 xd	-2
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅜	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	83—86	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66 xd	
Callender's Cable and Const. Co., Ld.	5	15	15/-	9½—10½	
Do. 5% Cum. Pref.	5	5	5%	5¼—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	104—106 xd	
Consolidated Electrical Co., Ltd.	1	3	8½d*	7/16—7/8	
Crompton & Co., Ltd.	3	5	5%	1⅛—1⅜	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	94—97 xd	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1⅛—1⅜	
Do. 6% Cum. Pref.	1	6	7½d	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	99—102 xd	
Edison & Swan United "A." £3 paid	5	4½	2/6	2⅞—3¼	
Do. do. (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81 xd	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	⅛—⅜	
Do. 7% Cum. Pref.	2	7	—	⅞—1⅛	+¼
Do. 4% 1st Mort. Deb.	Stock	4	4%*	59—64	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8½ xd	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	10½—11½	
Do. 4½% Cum. Pref.	5	4½	2/-*	4⅜—4⅝	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	104½—106½	
I. R. & G. P. Co., Ltd.	10	10	10%	14½—15½ xd	
Do. 4% Deb. Red.	100	4	4%*	96—99	
Tel. Const. & Maintenance Co.	12	15	5%*	28½—30¼	
Do. 4% Deb. Bds. Red.	100	4	4%	99 —102 xd	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9 xd	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	+¼
Do. 6% Cum. Pref.	5	nil	6%	3¼—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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ELECTRICAL ENGINEERING

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SUMMARY

March 3rd has been fixed as the date for the inquiry into the proposed Home Office Regulations for factories in which electricity is employed. Mr. James Swinburne, F.R.S., is the Commissioner appointed to hold the inquiry. (Page 111.)

A report on a recent burn out on the District Railway has been issued by the Board of Trade. (Page 112.)

The Law and Parliamentary Committee of the Westminster City Council have presented a report on the electric supply Bills which will come before Parliament this session. The report is least unfavourable to the London and District Electricity Supply Bill, as it favours on general principles the advent of a new bulk supply company, whose operations would not affect the position of the Council with regard to the ultimate purchase of the existing companies supplying in Westminster. The Camberwell Borough Council have also considered the two Bills, and have decided to oppose both, in order to obtain amendments. (Page 112.)

Among the new metallic filament lamps which are already on the market in Germany, and will shortly be available in this country, are a 100-volt, 16-c.p. tantalum lamp, and 200-volt osram lamps of 40 50, and 100 c.p. It is claimed by the makers that the new osram lamps, both for 100 and 200 volts, will be suitable for use in any position. (Page 113.)

Prof. G. Kapp, in an afternoon lecture on the electrification of railways, delivered last Saturday at the Royal Institution, outlined the main features of the continuous-current single-phase and three-phase systems, and drew particular attention to the impending electrification on a large scale of the State railways of Italy and Sweden on the three-phase and single-phase systems respectively. (Page 113.)

In the discussion on Mr. G. W. Worrall's Paper on "Magnetic Oscillations in Alternators," read last week at the Manchester Local Section of the Institution of Electrical Engineers, several speakers referred to the application of the results to explain the phenomenon of humming in continuous-current machines. There was a disposition to question how far general deductions should be drawn from experimental results on a machine of special design, and some questions were asked regarding points still requiring elucidation. (Page 114.)

A Paper was read last Thursday by Mr. Horace Boot before the Society of Architects on the design of buildings for power-houses, in which the general requirements to which attention should be paid by architects when designing generating station buildings were dealt with. (Page 115.)

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AN unusually large number of new students were elected at the last meeting of the Institution of Electrical Engineers. (Page 116.)

A PAPER was read by Mr. I. V. ROBINSON on Tuesday last before the Institution of Engineers and Shipbuilders in Scotland on the cost of power production, in which he compared the cost of power generated by water-power with that from stations driven by large gas-engines under the conditions of high load factor obtaining in electrochemical work on a large scale. (Page 117.)

THE Electrical Engineering Department of the Northampton Institute offers many facilities for young electrical engineering students, as well as for the more advanced. The course of instruction is spread over a period of four years for day students, and five years for evening students, and is divided into junior, intermediate, and senior classes. The more important features of the laboratories are described. (Page 119.)

IN this year's pantomime at Drury Lane a number of new electrical effects are introduced. (Page 120.)

THE Paper read by Mr. T. M. BARLOW before the Birmingham Local Section of the Institution of Electrical Engineers on January 15th contained the results of a series of experiments on the heat conductivity of assembled insulated iron stampings both in directions parallel and at right angles to their surface. The results emphasised the importance which should be given in dynamo design to the amount of edge surface of the stampings of a laminated iron core exposed to a cooling medium. The most efficient ratio of the linear dimensions of the edge side to the plate side of the core is given as 1 : 10, a much higher ratio than commonly in use. We are obliged to hold over our report of the discussion in which Dr. Sumpner, Prof. Kapp, Dr. D. K. Morris, and others took part, until our next issue. (Page 121.)

THE more recent additions to the generating plant at the Fulham Electricity Works include examples of high-speed reciprocating sets, and also a vertical shaft steam turbine, which form a remarkable contrast to the original slow-speed alternators. A new boiler-house has been erected recently, but a supply of steam is also obtained from the Horsfall destructor plant. This has now been altered so that no coal is ever burnt under the boilers, and the arrangement of the flues has been improved. (Page 125.)

AN automatic signalling system has been installed on a section of the Burton & Ashby Light Railway. (Page 128.)

IN an exhaustive report upon British trade with Canada, Mr. RICHARD GRIGG, a special Commissioner of the Advisory Committee to the Board of Trade, gives many reasons why British trade with the Dominion does not amount to a greater percentage of the whole than is now the case. He first admits that the geographical position of the United States is the all-important reason for the great disparity in the amount of trade done with Canada by that country and the United Kingdom, but he nevertheless believes that the British trader has himself to blame for the present position to a large exent. Little trouble, he says, has been taken to deal with the needs of the market. Goods are produced under British conditions and sent to Canada, where totally different conditions prevail. Direct communication between producer and buyer is recommended, and less reliance placed upon merchants and agents. The adoption of Canadian standards with regard to iron and steel, and the Canadian system of weights and measures is also necessary, whilst quotations should be in dollars and cents, and c.i.f. instead of f.o.b. (Page 132.)

THE discussion in London on Mr. J. F. C. SNELL'S Paper on "The Cost of Electrical Power for Industrial Purposes" was continued last Thursday. Mr. C. P. SPARKS and Mr. R. HAMMOND thought that his figures for the cost of electrical energy generated by independent plants was too low, while Col. CROMPTON supported them. Mr. G. W. PARTRIDGE thought he had over-estimated the diversity factor, and under-estimated the cost of laying mains in London. Messrs. E. W. COWAN, G. L. ADDENBROOKE, C. H. WORDINGHAM, W. H. BOOTH, G. H. CORRINGHAM, and A. M. TAYLOR also spoke. Several gentlemen desirous of taking part in the discussion were obliged to send their remarks in writing. These included Ald. Pearson, Messrs. W. C. P. Tapper, A. W. Heaviside, A. H. Shaw, G. H. Cottam, W. B. Woodhouse, and L. H. Hordern. A large proportion of the writers and speakers found fault with Mr. Snell's statement of the "correct" price that should be charged for power by existing undertakers, and the full discussion of the subject, together with the large number of numerical data given, was of considerable value. (Page 133.)

UNDER Electrical Science, in the British and American section, is a note on a null method of measuring ionisation. In the Papers abstracted in the Continental section, CATHIARD shows how to use a coal-gas flame as a rectifier. STARK draws some important conclusions from the Doppler effect in canal rays, and BORDAS describes the production of emeralds from sapphires by means of penetrating radium rays. (Page 138.)

LAST Friday evening Prof. T. E. THORPE gave a lecture at the Royal Institution upon "The Centenary of Davy's Discovery of the Metals of the Alkalis." A short review of the progress which has been made in the last few months in connection with electrolytic metallurgy shows that considerable work has been done in this direction, and points out directions in which future research would be of interest. A portion of the Notodden Atmospheric Nitrate Works was destroyed on January 7th by fire, when damage amounting to £8,500 was done. (Page 139.)

AMONG the specifications published by the Patent Office on Thursday last is one by the British Thomson-Houston Co. relating to the control of alternating current motors of the commutator type, and providing a means of braking for such type of motors. Another specification by the same firm relates to controlling devices which automatically open circuits in case of overload, and also prevent their being closed, while the overload continues. A specification by W. D. KILROY and EVERSHED & VIGNOLES covers an automatic electric starting switch. THE SUNDERLAND FORGE & ENGINEERING Co. and W. BLAIR have patented a device which relates to electric cranes and winches fitted with hand-operated or foot-power brakes, and provides a means for returning the starting-switch to its original position when the brake is applied. THE BRITISH THOMSON-HOUSTON Co. have also a patent automatic block signalling system for railways. A specification by G. MARCONI and the MARCONI WIRELESS TELEGRAPH Co. for a form of wireless telegraph transmitter which obviates the use of sparks or arcs in the oscillating circuit is also published. (Page 140.)

THE Southwick Electricity Works of the Brighton Corporation are in danger, owing to the weak state of the beach in front of them; an action for injunction against the Corporation is proceeding, as it is alleged that the old works and sub-station in North Road interfere with the service in a neighbouring church. The Clydebank Town Council are considering the transference of the Clyde Valley Electrical Power Co.'s order to the Stuthelyde Co. A breakdown of the electrical plant at Hull has had serious results, as three of the

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largest sets are practically destroyed. The Corporation are ordering three new dynamos from the Lahmeyer Co. The Battersea Borough Council has agreed to the terms laid down by the L.C.C. with regard to the electrification of the tramways on Battersea Rise and St. John's Hill. The Southwark electricity undertaking shows a profit this year, for the first time; the council has refused the offer of a supply of electricity from the London Electric Supply Co. The Manchester Tramways Parcels Delivery continues to be successful. The Uxbridge and District Electric Supply Co., Ltd., are seeking to transfer a portion of their area of supply to the Metropolitan Electric Supply Co., Ltd. (Pages 116 and 141-142.)

TENDER forms, specifications, &c., in connection with the supply of 33 switchboards for private branch exchanges for common battery work required by the Australian Postmaster-General's department may be inspected at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, E.C. The Bristol Docks Committee invite tenders for cables and electric lighting installations at the Avonmouth Docks. Cable is also required by the Croydon and West Ham Corporations, and tenders for an extension to the switchboard at Edinburgh are invited. The Ilford Council are about to extend their generating station at a cost of £27,000. The Lowestoft Corporation has accepted a tender of Messrs. Siemens Bros. & Co. for an electric locomotive for use on their coal siding. A meeting has been held by the Dutch holders of profit-sharing notes of the Underground Electric Railways Co. of London, when a committee was appointed to examine any proposals for reorganisation. (Pages 144-146.)

THE Union Electric Co. on Thursday last held a reception at their works in Park Street, Southwark, and in the evening gave a dinner to their provincial representatives, staff, and friends at the Café Royal, Regent Street, W. (Page 145.)

As will be seen by a notice appearing in our advertisement columns, a date has been fixed for the inquiry to be held with regard to the proposed Home Office Regulations relating to the use of electricity in factories and workshops. As these regulations, if adopted, will apply on the one hand to electrical generating stations and sub-stations, and on the other hand to all places that are a factory within the meaning of the Factory and Workshops Act, it will be seen that their effect will be far-reaching. The owners of many electricity works may be put to large expense in reconstructing their switchboards and sub-stations if the regulations are passed in their present form and are made retrospective, although these places are not accessible to any but the engineers and skilled workmen who have a full knowledge of as to what are the dangers to be avoided. At the other end of the scale, even the small dressmaker who uses a ¼-h.p. motor for running her sewing-machine would be subject to further regulations than at present, and would probably be badgered by a second inspector, in addition to the one who makes calls to see that she conforms with the rules as to the overtime and meal-times of her assistants. As we have already emphasised in these columns, the very fact of the issue of a new set of regulations controlling the use of motors is to be objected to far more than any details in the draft regulations themselves. The latter can easily be modified, and doubtless Mr. G. S. RAM, the electrical adviser to the Home Office, has already made alterations to meet many of the specific objections that have been raised. In selecting Mr. James Swinburne as "Commissioner" to hold the inquiry, no better choice could have been made, for he is one of the few leading men concerned with the heavier branches of electrical engineering who has an interest neither in electricity supply or power companies, or in manufacturing companies. From the reference to him, moreover, it would appear that it would be quite competent for him to advise in his report that no further regulations were necessary, should he be satisfied on the evidence that electric driving is no more dangerous than other methods of driving subject to no such restriction. The date of the inquiry is March 3rd, and "objectors" should carefully peruse the notice advertising it on p. vii of our present issue, in order to see in what way they can avail themselves to the utmost of the privilege of appearing either in person or by counsel.

IN another column will be found a report by Major PRINGLE and Mr. A. P. TROTTER, of the Board of Trade, referring to an occurrence which has been described as an explosion a week or two ago at Sloane Square Station. A good deal of unnecessary alarmist writing has been allowed to appear in the general Press, and we are pleased to see that this report has been widely circulated, for it clearly shows, by describing the details of an actual case, how small is the danger from fire in properly constructed electric railways. The authoritative voice of the experts of the Board of Trade is of the greatest use in helping to remove the real source of danger which, in such circumstances, is not fire, but panic.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, JANUARY 23RD.

Institution of Electrical Engineers: Leeds Local Section.

7.15 p.m. Meeting at the University, Leeds. Paper to be read:—"Notes on the Development of Turbo-Alternators," by Dr. Pohl.

Institution of Electrical Engineers.

8 p.m. Meeting at the Institution of Civil Engineers, 25 Great George Street, London, S.W. Paper to be read:—"Standard Performances of Electrical Machinery," by Rudolph Goldschmidt.

FRIDAY, JANUARY 24TH.

Physical Society.

5 p.m. Ordinary meeting at the Royal College of Science.

SATURDAY, JANUARY 25TH.

Royal Institution.

3 p.m. Afternoon Lecture II., on "The Electrification of Railways," by Prof. Gisbert Kapp.

North-East Coast Institution of Engineers and Shipbuilders.

7 p.m. General Meeting at 4 St. Nicholas Buildings West, Newcastle-on-Tyne. Among the subjects down for discussion is "Electricity Compared with Gas for both Lighting and Power."

TUESDAY, JANUARY 28TH.

Institution of Electrical Engineers: Manchester Students' Section.

7.30 p.m. Meeting at the Municipal School of Technology, Whitworth Street, Manchester. Paper to be read:—"The Design of Polyphase Induction Motors," by W. D. Redfern.

WEDNESDAY, JANUARY 29TH.

Society of Arts.

8 p.m. Ordinary Meeting, at John Street, Adelphi. Paper to be read:—"The New Patent Act," by J. W. Gordon.

FRIDAY, JANUARY 31ST.

Royal Institution.

9 p.m. Evening Discourse by Prof. Ernest Rutherford, F.R.S., on "Recent Researches on Radio-activity."

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FIRES ON UNDERGROUND ELECTRIC RAILWAYS

THE following report, by Major Pringle and Mr. A. P. Trotter, addressed to the President of the Board of Trade, referring to an occurrence at Sloane Square Station on January 8th, has been sent us by the Board:

SIR,—We have, in the usual course of our duty, inquired into the circumstances under which an explosion and electric flashing took place in a car, on the evening of January 8th, at Sloane Square Station on the Metropolitan District Railway. We made a very careful examination of motor-car No. 34, which alone was concerned in this case, before any repair work had been carried out, or any of the effects of the explosion and flashing had been removed.

Above floor level there was some blistering of the varnish on the woodwork surrounding the end left-hand window and doorway, and two panes of glass were blackened with smoke and fumes. No glass was broken, and it was possible by rubbing off the blistering on the wood to see that the red paintwork underneath was undamaged. Below floor level the metal pipe carrying the electric lighting wires and a metal junction box were fused. The underside of the timber flooring immediately above this pipe and junction box was charred in places. The charring nowhere exceeded a quarter of an inch in depth. No mark of fire could be found inside the car on the flooring, seats, or sides.

We may here remark that all the woodwork on the company's cars in proximity to electric conductors has been rendered non-inflammable. This and other occurrences of a similar kind have proved that the wood will char under the effect of intense heat from electric flashing, but will not catch fire. The real combustibles in this fire, if we use the word, were copper, iron, and brass. Such electric arcs continue until they exhaust or burn themselves out, or until the current is cut off, as was done at Sloane Square. The ordinary method of extinguishing a fire is useless for electric arcs.

This particular case was caused in all probability by failure of the insulation of the electric lighting wires owing to damp. The heating of the wires resulted in the liquefaction of a small plug of bitumen. An explosion of bitumen vapour followed, causing smoke and fumes. Subsequently, electric flashing took place along the pipe and at the junction box under the car. The conductor in charge of the car states that he immediately entered the door at the corner where the explosion had taken place, and worked the air valve which actuates the double doors in the centre of the car. The doors opened in the usual way; they had not to be forced or held apart. The passengers, eight in number, stepped out on to the platform through the open doorway without any apparent panic or alarm. No complaint of injury or danger was made to either the station inspector or any of the company's officials. Arrangements also exist, on underground as well as on tube railways, to allow passengers in case of need to descend from a train at either end.

In our opinion the apprehensions of danger which have been expressed by writers to the newspapers are not justified by the facts. The main danger in any such cases of fire will be from panic. For this reason we deprecate the writing for publication of alarmist letters.

We are, Sir, your obedient servants,

(Signed) J. W. PRINGLE (MAJOR),
Inspecting Officer of Railways.
(Signed) A. P. TROTTER,
The Electrical Adviser to the Board of Trade.

TO THE PRESIDENT OF THE BOARD OF TRADE.

Wireless Telegraphy.—The North of England Steamship Owners' Association has decided to continue urging upon the Board of Trade the advisability of establishing communication between the Newarfs and Cockle Lightships, and the shore, as a medium whereby ships' orders might be readily transmitted. The Margate Corporation have forwarded a resolution to the Board of Trade urging the desirability of installing a system of wireless telegraphy between the Long Sand lightships and the shore.

Audit of Electric Lighting Companies' Accounts.—Several of the London borough councils are protesting against the proposal of the Board of Trade to dispense with the services of an official and separate auditor in connection with the annual audit of the accounts of electric supply companies. Camberwell, Battersea, Paddington, Lambeth and Bermondsey have taken the matter up, and an appeal will be made to the Board of Trade. We gave the letter of the Board of Trade in reference to the proposal in question in our issue for December 12th, page 944.

THE LONDON POWER BILLS

THE Law and Parliamentary Committee of the Westminster City Council has drawn up a long report with regard to the electric supply Bills to be presented during the coming Session. The committee state that it seems probable that Parliament will be compelled to sanction some scheme for cheapening bulk supply, and in the absence this year of a municipal scheme the contest lies between the creation of a new bulk supply company, and the practical amalgamation of the existing companies. The latter scheme would involve an entire change in the character of many of the existing undertakings, by gratting on to them what would be practically a separate existing undertaking; and it would inevitably lead to such an intermingling of assets and interests, and to such an overlapping of areas, as would render insuperable the difficulties of ultimate purchase on anything resembling the original lines. The establishment of a new and distinct bulk supply undertaking, the report continues, need not have these effects, and might be an advantage to the present undertakers, whether companies or local authorities, as it would furnish them with a cheap bulk supply supplementary to the supply of those who possessed generating stations, whilst saving the expense of the erection of new generating plant in the numerous cases where the powers of purchase will extend merely to distributing plant. It would seem, therefore, that, from the point of view of the local authorities, as prospective purchasing authorities, the better course would be to seek to restrict the existing companies to their present functions and areas, and to keep intact the powers of purchase under the Electric Lighting Acts, whilst entrusting a separate undertaking with bulk and power supply. In one way the position of Westminster is at present exceptionally favourable, inasmuch as the City Council is in the position that if in 1931 they exercise their powers of purchase of the undertakings of the St. James and Pall Mall and Westminster companies, they will at the same time acquire on very favourable terms the generating station in Marylebone, and will thus have a source of supply which, independently of any other generating station, would go a long way to meet the needs of the whole of Westminster, as far as regards electric lighting. The committee recommend, therefore, that the most favourable course for Westminster would be the maintenance of the present position, with the addition of a bulk supply undertaking, which could be optionally resorted to should the Marylebone generating station prove insufficient. The report points out, however, that the London and District Electricity Supply Bill would give its promoters the power of direct supply to the consumer, practically in competition with the authorised distributor, and would also give them large powers of street breaking. Referring to the London Electric Supply Bill, promoted by the companies jointly, the committee states that the measure threatens to destroy the power of Westminster to purchase the Central Company's generating stations, and thus to deprive the City of a valuable asset expressly conferred by Parliament only three ago. In regard to the London (Westminster and Kensington) Electric Supply Company's Bill, the committee express the opinion that the effect of the measure, if passed, would be to render more difficult the question of purchase by local authorities. Petitions are to be presented against each of the three Bills.

The Camberwell Borough Council have also considered the London Electric Supply (Joint Committee) Bill and the London and District Electric Supply Bill. Reporting on these Bills, the Town Clerk and Borough Engineer, having pointed out at the outset that the former Bill is promoted by the fourteen electric lighting companies having powers for the supply of electrical energy within the administrative County of London and adjoining districts, expressed the fear that if the combination and amalgamation of the electricity companies concerned is permitted it will further complicate the difficult problem of electric lighting in London, and that it would be far better for the existing system to remain than for a huge new vested interest to be created. If the Bill proceeded, it was suggested that several amendments are required, one of which should be for the maximum charges to extend to light as well as power, and further that all capital raised by the company should be devoted only to the construction of works required for carrying on the business. It was thought by the Town Clerk and Engineer to be also necessary for the purchase clause mentioned in the Act of 1888 to be reinstated in place of the purchase clause in the Bill, and it was further urged that the authority for ultimate purchase should be the London County Council, or otherwise the whole question would again have to be fought out in Parliament. It was thought that the clause providing for the appointment of an auditor by the Board of Trade should be amended so as to provide for power to the local authority to send representatives to the auditor with the right to appeal to the Board upon any point which may arise pertinent thereto. The recent value placed upon electricity undertakings under arbitration was shown in the case of Marylebone, and what the goodwill of a monopoly was worth was shown by the fact that the goodwill realised practically twice the amount of the whole capital expenditure upon the works by the various water companies when acquired by the Metropolitan Water Board. The Council was recommended to petition against the Bill on the preamble, in order to obtain amendments and also clauses for the due protec-

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tion of the exclusive right which the Borough now enjoys with regard to the special purchase clauses on undertakings as applied to Camberwell, which, if the Bill be passed in the present form, would, it was said, disappear without compensation, and the goodwill value of which is now worth many thousands of pounds. The Council adopted this recommendation, as also a proposal to petition against the London and District Electric Supply Bill.

NEW TANTALUM AND OSRAM LAMPS

THE principal disadvantages in connection with the metallic filament lamps at present on the market in this country which have prevented their more universal adoption, especially for private lighting, have been the fact that two lamps in series are required for 200-volt circuits, and the inconveniently large units of light which have to be adopted. The announcements, therefore, that in the case of the tantalum lamp a 16-c.p. lamp has been produced, and in the case of the osram lamp single lamps for 200-volt circuits have already been made, are of the greatest interest.

The new small tantalum lamp is already being advertised by Messrs. Siemens & Halske in Berlin, although we understand from Messrs. Siemens Brothers' Dynamo Works, Ltd., that deliveries will not be commenced in this country for a month or two. It is of 16 (Hefner) c.p. for 100 to 120 volts, and takes a current of 0·22 to 0·25 amperes, or 1·5 to 1·7 watts per Hefner c.p., and in general appearance is similar to the more familiar 25-c.p. lamp. The average life is stated to be 800 to 1,000 hours. The addition of this lamp to the series gives four sizes of 16, 25, 32, and 50 c.p. respectively for circuits in the neighbourhood of 100 volts.

We have already referred to the 200-volt osram lamp for 100 c.p., which will be obtainable in this country in a few weeks' time, and it is interesting to know that 40 and 50 c.p. osram lamps for 200 to 250 volts have also been made. We understand that it will be some considerable time before they will be obtainable in this country in any quantity, although they are already advertised for sale in Germany. Another improvement which is to be applied to the new osram lamps both for 100 and 200 volts is a new form of flexible support to the filament which will permit of their being used in other than the vertical position.

The Poplar Boiler Explosion.—A Board of Trade report by Messrs. A. A. Hudson and J. H. Hallett has been issued on the boiler explosion which occurred on August 16th last at the Poplar Electricity Works, when two stokers were killed. The boiler in question was of the Stirling type, with three main steam drums, a mud drum, and 630 tubes. A superheater was also fitted. By the explosion one of the tubes in the front bank of tubes was split and bent, and the tube drawn out of the front upper drum of the boiler, and vapour and ashes were blown out through the cleaning doors of the combustion chamber. The cause of the explosion was overheating of one of the tubes in the front bank of tubes, owing to its being blocked with scale; the tube in consequence split and bent, and withdrew from the front upper drum. The Commissioners consider that the staff employed to look after the works were highly efficient. Upon an examination of the boiler after the explosion, it appeared that a tube in the fourth row of the front rank had bulged and split, and had also become bent, so that it had drawn itself out from the upper drum, leaving an aperture the size of the tube in the upper drum. It was also found that the tube which had split was completely blocked with deposit at the bend at the lower end of it, while seven other tubes just round the burst tube were considerably choked with deposit in a similar position, not absolutely choked, but choked so much that Mr. Clark, the inspector from the Stirling Boiler Co., stated that he was only just able to force up them a ⅜ in rod. In dealing with the possible causes of the accumulation of excessive deposit in the burst tube, the opinion is expressed that during the last examinaton the particular tube must have been missed by an oversight, and attention is called to the exceptional care in cleaning which is required with bent tubes of the description used. The report continues:—"With regard to the supply of water, there is no doubt in our minds that the failure of the softener to perform its work did accelerate the deposit in this boiler." The defective action of the softener was not discovered till after the explosion.

RAILWAY ELECTRIFICATION

AT the Royal Institution on Saturday last Prof. Gisbert Kapp, of the University of Birmingham, delivered the first of a course of two lectures on the electrification of railways. The lecturer dealt briefly with the history of electric traction, and then passed on to consider the advantages to be gained by the electrification of existing railways. There is no doubt that a more frequent, quicker, and more comfortable service is obtained with electric traction, but it has yet to be shown that electric traction is more economical than steam traction; indeed, we cannot expect the short lengths of line already electrified to show much economy, but when the extensive electrifications now being carried out in Sweden and Italy are completed a great saving, as compared with steam traction, may be expected. The economy will, of course, be greatest in such countries where coal is dear.

The high acceleration due to the large starting torque obtainable with the electric motor, to the high value of the adhesion weight in the case of motor-cars, and to the capacity of an electrical equipment for developing an amount of power far in excess of its rated output for a short time, has increased the frequency of the service, while the steam locomotive is limited in these respects by the size of its boiler. The maximum safe speed round curves is also higher for an electric locomotive than for a steam locomotive, as the centre of gravity is much lower in the former case. The greatest difficulty to be encountered in any electrification is the arrangement of the contact rail or wire. The third rail is dangerous and creates even greater difficulties at points and crossings than the overhead wire, which latter, however, may in some cases interfere with the driver's view of the signals.

The lecturer described the Wilgus-Sprague protected under-running third rail as used on the New York Central and other American railways (see ELECTRICAL ENGINEERING, January 9th, p. 38), and various typical forms of catenary suspension. The different systems were classified with regard to the motors used., *i.e.*, whether continuous-current, three-phase, or single-phase. The single-phase motor must be heavier for a given torque than the continuous-current motor, as the effective torque is only about 70 per cent. of the maximum. The three-phase motor is lighter than either the single-phase or the continuous-current motor for a given output, as the only limit to the armature strength is the heating, whereas the field distortion with the resultant commutation troubles is the principal limiting factor in the other two types.

Prof. Kapp then passed on to the two different methods of obtaining variable speed with three-phase motors. First, the stator winding may be arranged so that two different numbers of effective poles can be produced. In such a motor, however, the rotor must be provided with two independent windings and two groups of slip-rings. Secondly, cascade working may be employed, in which the stator of the second motor is supplied with current from the rotor of the first motor. If the two motors have different numbers of poles, three running speeds can be obtained. The stator of the first motor in the cascade arrangement is wound for the line pressure, say, 3,000 volts; the rotor pressure is, however, necessarily much lower, and the stator of the second motor must be wound for this low pressure. Consequently, if the second motor is to be used by itself for a third running speed, a transformer must be included in the equipment. A recent improvement, introduced by C. de Kandó, however, renders the use of a transformer unnecessary: the stator of the second cascade motor has three winding groups per phase, which are arranged in series with star connection for working direct at the line voltage, and in parallel with delta connection for working in cascade from the rotor of the first motor, the pressure in the latter case being rather less than one-fifth the pressure in the former case. (A full description of this system was given in ELECTRICAL ENGINEERING, Vol. I., p. 988, in connection with the new locomotives in use on the Vallellina Railway.)

The Italian Government is electrifying some 340 miles of track of the State railways on the three-phase system, the estimated cost of which will be £3,000,000. The chief engineer for the Swedish Government, Mr. R. Dahlander, has decided to adopt the single-phase system. Five large hydroelectric power stations will supply current at 50,000 volts to thirty-seven substations, which will transform down to the trolley-wire pressure of 15,000 volts. The first report of the Special Commission appointed by the Swiss Government has been published, but this deals only with the probable amount of power necessary, which is estimated to be some 100,000 h.p. on the average; the maximum load may be from twice to five times this amount.

The second lecture will be delivered on Saturday next, and will include descriptions of recently electrified lines

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MAGNETIC OSCILLATIONS IN ALTERNATORS

Manchester Discussion

A DISCUSSION of some length followed the reading of Mr. G. W. Worrall's Paper on "Magnetic Oscillations in Alternators" on Tuesday, January 14th, before the Manchester Local Section of the Institution of Electrical Engineers. The Paper itself, in which Mr. Worrall gave an account of the continuation of a series of experiments described in a former Paper making a distinction between "pulsations" and "to and fro" movement of the flux, and investigating the conditions under which each is a maximum, was given in our last issue on p. 95.

Mr. S. L. PEARCE (Chief Electrical Engineer, Manchester Corporation), who was in the chair, made a few remarks before calling on other speakers, in which he emphasised the importance of Mr. Worrall's results to dynamo designers.

Dr. E. W. MARCHANT (Liverpool University) thought that the author's observation of the effect of the pole width on the ripples in the E.M.F. wave produced by an alternator was a very interesting one. The method of getting rid of ripple by altering the size of the air gap at the edges of the pole shoe was, of course, very well known; but the fact that shaving off the edges of the pole affects these ripples so much had not, he thought, been hitherto noticed. Mr. Worrall had said that the experiments of Fischer-Hinnen showed that the noise produced by a dynamo was greatest when the pulsation in the magnetic flux was a maximum. In Fig. 2 there was a maximum for this pulsation when the ratio between the polar arc and the tooth pitch is 6, a whole number. In Fig. 3 it is seen that the best wave is obtained when the ratio of polar arc to tooth pitch is 5·5, so that when there is a maximum magnetic pulsation there is a minimum magnetic swing, and *vice versa*, so that it would appear that a machine that is not noisy must have a bad wave, and, on the other hand, if the machine has a good wave, it is bound to be noisy.

Mr. W. CRAMP suggested that there were three types of machines concerned with this question of magnetic oscillation. First, there is no doubt that a great many D.C. machines have given trouble on account of the noise due to the flux changes. In any case, there is a vibration set up by the armature teeth which seems at some particular speed to correspond with the natural period of vibration of some part of the machine, such as the pole tip. But he had come across a case in which the noise was very loud at a particular speed, although the machine had a cast steel pole and no pole tips. The question arose whether such noise was due to the "swing" or the "pulsation." If the latter, one must conclude from the Paper that a ratio of polar arc to toothpitch at 5·5 must be used; but if it is due to the "swing," a ratio equal to a whole number would be required. Next, there was the case of the alternating current motor. Everyone who had dealt with alternating current motors knew that there was a good deal of difficulty in avoiding what was known as "cogging," and that such cogging is due to variations of reluctance in the magnetic circuit due to the effect of the teeth passing the slots. To get rid of "cogging," it was usual to choose a prime number of slots for the rotor. If this cannot be done, then, according to this Paper, a number of slots must be chosen, so as to get the minimum main magnetic change, *i.e.*, corresponding to that which Mr. Worrall gives as 5·5. Lastly, there was the case of the alternating current generator, in which there was with one ratio a big change of flux, and with the other the ripples, both of which should be avoided. Mr. Worrall said that in order to obtain the minimum change of flux a ratio 4 polar arc to tooth pitch $5\frac{1}{2}$ should be used, and in order to get rid of the swing a whole number should be used for the ratio. Now, it seemed to follow from Fig. 4 that the swing entailed a complete movement of flux right over the pole face. For the production of the ripples on the top of the no-load E.M.F. wave probably means that the whole flux moves across the pole face, which would not have been expected. If the whole flux does move across the pole face, it was evidently possible to get rid of the ripples on the top of the wave by putting slots in the pole piece itself, so that the reluctance of the part under the pole should change in the opposite direction to that in which it changed when the slots and teeth left the pole. Thus it ought to be possible to design an alternator with practically no magnetic oscillations. There were one or two further questions which he would like to ask Mr. Worrall. In Fig. 2 the change in the flux seemed very abnormal, and one wondered whether there was anything curious in the construction of the machine. The air gap seemed small for the size of machine, so that he questioned whether the conditions were quite those met with in ordinary practice. The width of the slot and the ratio of the air gap to slot were not very extraordinary, but the ratio of the air gap to slot depth was rather less than one would meet with in ordinary practice. In some of the figures ripples were only apparent in the tops of the waves, but he did not know why they did not also appear down the side. Lastly, he asked Mr. Worrall whether he had anything to offer us in the way of conclusions as to the effect on this particular alternator of using closed slots.

Mr. J. S. PECK (British Westinghouse Co.) agreed as to the importance of eliminating the ripples from the E.M.F. wave. The semi-closed slot would help matters very much, as would also increasing the number of slots. He was rather surprised at the statement:—"As successive slots pass a given point in the pole-face the armature current opposite that point would not be quite constant, but the flux displacement was not found to vary within the possibilities of measurement." He would have thought that even with a three-phase alternator there would be sufficient difference between the currents in the slots at different times to make quite a decided difference in the measurements. Mr. Worrall stated that with a single-phase armature the effect would be marked, and he would like to ask whether he had ever made any tests on a single-phase alternator to find out what this flux displacement amounted to.

Dr. E. ROSENBERG (British Westinghouse Co.) said:—What we must always bear in mind is that these facts have been attained only on one particular machine, and that the results are valid only for this machine, and we must not generalise. For this particular machine, with this particular air-gap, and particular size and number of slots, the magnetic pulsations are the smallest for a pole-face equal to $5\frac{1}{2}$ slots, and the biggest for a pole-face equal to six slots. If we alter the air-gap, and alter the number of slots per pole, the results may be different. It is interesting that the author has come to the same conclusion as Fischer Hinnen in his researches on humming, but I may also say that the results obtained by Prof. Hinnen are not applicable to all kinds of machines, and there are many motors which could not be made noiseless by applying Fischer-Hinnen's rule. Figs. 5 and 6 apparently give a theoretical explanation for the results obtained. Mr. Worrall took exactly a fringe of 45 degrees, but, of course, the fringe has no definite limits. We know that it gradually decreases, and if we choose any other angle for the fringe the result is quite different. The ripples on the E.M.F. wave have a specially marked result if a dynamo works in parallel with another dynamo, or is driving a synchronous motor with another wave shape. Then the higher harmonics produce a current in a circuit that contains nothing but the self-induction of the two machines, and this current may be higher than the main current. I once published a no-load current curve of a synchronous motor with harmonics of the 5th 6th, 7th, and 11th order, that were nearly three times as big as the value of the fundamental current. The fundamental curve shows 2·6 amps., and the current measured was 7·2 amps. In another case the ratio was 5·5 and 15. I should like to ask Mr. Worrall in what manner he succeeded in getting exact resonance in his Fig. 7.

Dr. C. C. GARRARD (Messrs. Ferranti, Ltd.) made some remarks upon the higher harmonics in the E.M.F. waves of star-connected machines and the effects produced when the neutrals were earthed.

Mr. J. FRITH referred to similar experience with regard to the humming of machines to that of Mr. Cramp. He believed it was entirely a mechanical effect on the pole tip due to the intermittent magnetic pull of the teeth. He had noticed it quite as much with machines with laminated pole shoes, and it would nearly always be cured by using the same average width of pole, but staggering it across the slots. With regard to the tooth ripples being very much more marked on the top of the curve, he suggested that this was partly due to the fact that they did not show so much when they were on the sloping sides of the curve.

Mr. G. W. WORRALL, in reply, said:—In this Paper I have referred to only one machine, but I have attempted to generalise the results as far as possible, and although I must admit that any other machine will have results either similar or perhaps somewhat different to the results I have given, I have endeavoured to lay down the laws governing these results, so that if we understand the machine we are dealing with, we shall be able to understand the cause of the phenomena which we may have observed. If we have a machine that will give a large fringing, then we must know that there is some effect on the oscillations, although it is remarkable that the Fischer-Hinnen results gave the same impressions that I have obtained. The P.D. waves that I gave in Fig. 8 rather point to a confirmation of my results. There we have machines radically different to those on which I conducted most of my experiments. Referring to the remarks of Professor Marchant as to the humming, according to my ear the pitch remained the same for all sizes of polar arc. Respecting the remark that if you want a good smooth wave we must have a loud noise, and if you want a silent machine we must have a bad wave, that is at all events true as regards my machine, for I noticed that the humming distinctly

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diminished in intensity as I reduced the polar arc. Mr. Cramp made some remarks regarding the oscillations in the zero portion of the wave. One reason for their apparent absence has already been given in the discussion, and that is the wave is more or less steep at the side, and, therefore, the ripples would not appear to be so heavy; but I think there is another reason, which is probably due to the fact that any variation in the main flux is bound to be subjected to a damping effect of the iron. If we consider a magnetic circuit, then we have the flux threading through, and any variation of that main flux is subject to a certain damping action of the whole circuit. The actual percentage is not very large; the maximum in the pole shoe is only 0·2 per cent. The maximum under the limb is 0·0094. When we consider the main flux that is subject to a damping action, we must consider the movement of the flux in the air gap, that is subject to a very much greater damping action. Mr. Cramp made some suggestion regarding placing teeth in the pole face in order to get the backward movement of the flux. In order to discuss that point it would require some greater knowledge than I possess at present of the nature of this swing. One gentleman asked me if the swing took place over the whole pole face. I must admit I have not yet devised any method of observing that swing independent of the local oscillations. I think we must distinguish between the flux swing of the total flux and the local swing over a single tooth, and I cannot yet see how to actually carry out any oscillograph record of measuring this total swing, and distinguish it in that record from the main pulsation or from the local swing over the tooth, so that whether this main swing takes place over the whole pole face, as it certainly appears to do, or whether it takes place in any other way, I cannot say. With regard to the point *re* closed slots. In a previous Paper I just touched upon the subject of the main variation of the total flux. I showed there that the introduction of a bridge in magnetic contact over the slot made very little difference to the change in the whole flux as the teeth passed, *i.e.*, taking a smaller armature, one with closed slots and the other with open slots, the main pulsations appear to be the same. Now that is probably due to the fact that when you consider the reluctance of the whole circuit and the reluctance of the air gap, then any thin bridge over the slot will hardly have much influence on the main flux, but of course it has a very great influence on any local oscillation in the local flux, but not in the main flux. Mr. Peck drew attention to the effect on single-phase generators, and asked me if I had made any observations on single-phase generators of the effect of the varying position of the line of symmetry of the flux entering the teeth. I have not made any observations of this, so that I cannot say, experimentally, whether it takes place, but it appears to me reasonable that, at all events, there would be more for a single-phase than a three-phase generator.

DESIGN OF BUILDINGS FOR GENERATING STATIONS

MR. HORACE BOOT read a paper last Thursday before the Society of Architects on the "Planning and design of buildings for power works for the generation of electricity." In the introductory portion of the paper he summarised the conditions to which attention should be paid when choosing a site for a generating station, mentioning particularly the importance of facilities for fuel and water supply, and carriage of heavy material, the question of nuisance to adjoining property owners, and the nature of subsoil and foundations. Passing on to the buildings themselves, he classified the requirements briefly as follows:—

(1) The main engine room, where the engines and generators are fixed. (2) The boiler-house, where the boilers and automatic plant relating thereto are fixed. (3) The pump house and auxiliary plant, where feed pumps and small machinery in general is housed. (4) Coal and fuel storage. (5) Workshops for undertaking repairs. (6) Stores and storekeeper's office. (7) A battery room, if batteries are used. (8) The testing room. (9) Baths and wash-houses for the engineers' department, general offices, men in charge and engine drivers, also for the stokers and men whose calling makes them require separate lavatories. (10) Chimney shafts. (11) Foundations for engines, boilers, pumps, main flues, and general work of a builder's character.

For the above, the details and space required, height, and depth of foundations, &c., should be given to the architect by the consulting engineer employed to carry out the work, and he should also inform the architect about how much the undertaking can afford to spend upon the buildings, as distinct from the other portions of the works.

A table was then given showing the enormous variation in the cost of buildings of different stations. The two extremes quoted were £2·76 per kilowatt of plant capacity installed at Brighton, and £23·55 per kilowatt at the Neasden power-station of the Metropolitan Railway.

Whilst in no way sacrificing efficiency, the cost of the buildings should be kept low, because capital outlay plays a very important part in the cost of production of electricity, and very often in the case of small works in their early days, the capital outlay on buildings is likely to hinder the healthy and rapid development of the undertaking, owing to the necessity of charging a higher price per unit than would have been the case had the capital outlay been kept moderate, or rather in proportion to the business undertaken.

In alluding to refuse destructors, Mr. Boot said:—"It is the practice of several authorities, and I venture to think the practice will increase rather than diminish, to combine the destruction of refuse for the generation of steam, and where such is the case, the refuse destructor house should be so designed as to provide for an inclined roadway for the carts to deliver into the place from which the charging of the furnaces can be done direct. The destructor building is better apart from the engine-house, otherwise trouble will be experienced by hot bearings caused by the dust. The refuse house should be well ventilated, and arrangements made for disinfection and cleansing."

Plans of typical power-houses were shown, and the different requirements of a station with gas or oil-driven plant were pointed out. In the case of producer gas plant, for example, of course a boiler-house is not required, but in its place it is usual to erect open outdoor buildings, so that noxious fumes given off by the gas making cannot concentrate, but are at once carried away. With regard to the engine-house, it is designed on much the same lines as that required for steam, with the exception that much more perfect ventilation must be provided for—either natural or forced. In the case of oil engine plant, the buildings become much simpler, especially in the case of works employing engines of the "Diesel" type for prime movers. Here, practically only an engine house and offices are required; the oil storage can be kept on the roof or somewhere adjacent outside the buildings.

When dealing with steam as the prime mover, the space required may vary very much; for instance, in the early days it was customary to use slow speed rope-driven dynamos; these have been replaced with high speed engines, taking up much less space, and again—certainly in big power stations—the steam turbine is rapidly taking the place of the reciprocating engine. In the case of steam-driven sets, the boiler and engine houses are practically one building; but in the case of gas engines, the gas houses are separate from the main engine-house, the gas holders are placed outside, and all is arranged for thorough ventilation. The space required by turbines is very much less than for reciprocating engines, although that is not altogether the reason why turbines have been adopted.

Some examples were mentioned to show the gain in floor space by the adoption of turbines in place of reciprocating engines. At Shoreditch the engine-room contains two 800 kw. sets, and two 1,500 kw. steam turbines side by side. In a space of 28 ft. by 50 ft., 3,000 kw. of steam turbine plant is installed; whereas the 1,600 kw. of reciprocating engines occupy 48 ft. by 46 ft. At the Metropolitan Railway power-house, Neasden, the total space taken is 324 ft. 7 in. by 102 ft. 6 in. for the engine-room, with an addition of 114 ft. for the chimney and economisers.

Dealing with the general style of buildings required, it was pointed out that buildings must be fireproof. The materials used are best left to local conditions, and whether the building is a brick or steel one depends upon the amount available for such building. If the buildings are situated in a town, there should be plain ornamentations: if the walls are of brick, the use of white glazed bricks up to a height of 10 ft., finished off with chocolate glazed bricks with a cornice, forms a neat and ornamental finish inside. The walls, or rather pilasters, must be of sufficient strength to carry rails on either side for the crane, which crane should be designed to lift not less than 10 tons, and in the case of big power stations, 20 tons. The question of what forms the best flooring for an engine room has often been debated, and so far as appearance goes it is hard to beat tesselated paving; but in this case, it is necessary to section it up in squares, and the author has found that if this is done, and a gap, of say half-inch left, this space can be run in with a very hard setting compound, having sufficient give in it to prevent the pavement cracking. Another form used is tiles; but the trouble is, that when heavy tools are often dropped, a tile is often broken. Wood block flooring has been used, but with oil and grease about, it is very difficult and expensive to

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keep clean. Where, however, appearance does not matter so much, he was in favour of using blue bricks placed sideways, which forms a most efficient flooring so far as wear goes, but it does not look so neat as a tessellated one.

It was mentioned that in America the boilers are often placed one above the other on different floors; but this practice has not been copied over here, except in one case, and there are undoubtedly objections to it. The height of roof varies according to the plant to be installed. Should it be decided to instal steam turbines, the height can be kept low; on the other hand, if reciprocating engines are installed, the height of the roof will be much more. Whatever form of plant is installed, a travelling crane is indispensable.

It is important in designing to take special care with regard to the levels, as where heavy machinery has to be managed the engine-room floor should undoubtedly be all on one level. Again, it is important where main flues have to be constructed, and economisers installed, to see that they are not constructed below the ground water level, as experience has proved it to be very difficult to keep the water out of the flues, although many schemes have been employed. With regard to drains, it has been found that large quantities of dirty oil, waste, and things of that nature find their way into the drains, so that special precautions should be taken, and arrangements made for cleaning them out, for inspection and accessibility. It is also important that the main blow down pipes from the boilers should not enter the drains, but should discharge into a large open sump and then overflow into the drains. With regard to chimneys, numerous designs are in use, but one design which deserves special mention is that of the Alphons Custodis Chimney Construction Co. It consists of hollow blocks, keyed with cement. The foundations required for engines, boilers, pumps, &c., are often elaborate so far as their requirements go, and it is usual to make these of concrete; the cable-ways and pipe trenches required should all be carefully shown on the plan, and undertaken at the time of the general building.

INSTITUTION OF ELECTRICAL ENGINEERS

THE following is the result of the ballot for new members on Thursday :—

As Members (2): Major W. B. Brown, R.E., War Office, Whitehall, S.W.; H. P. Gibbs, Chief Electrical Engineer to Government of Mysore, Bangalore, India.

As Associate Members (32): H. W. Arbuckle, Rifle Factory, Ishapur, near Calcutta: R. H. Bradbury, 49 Birmingham Street, Oldbury, near Birmingham; L. Burn, 13 Mayhill Road, Old Charlton; F. A. Cole, Sandymount, Helsby, near Warrington; E. Comerford, Abbots Grange, Chester; H. G. Cotsworth, Mining and Technical College, Wigan; R. W. J. Fletcher, 44 Garscabe Terrace, Edinburgh; J. K. Forrest, Tramway la Capital, Avenida de Mayo, 761, Buenos Aires; P. V. Gray, The Bombay Electric Supply and Tramways Co., Ltd., P.O. Box 192, Bombay; C. J. Grimes, c/o Port Commission, Calcutta; J. H. Harpin, 47 Temple Row, Birmingham; H. W. Hartnell, Corporation Electricity Department, Cheltenham; W. L. James, 22 Sutherland Avenue, Maida Vale, W.; J. Lloyd, Corporation Electricity Works, Norwich; C. H. Lydall, The Cleveland and Durham Electric Power, Ltd., Fylands Bridge Power Station, Bishop Auckland; J. J. McMahon, Clare Mount, Queen's Road, Cheetham Hill, Manchester; A. McPherson, 30 McCulloch Street, Pollockshields, Glasgow; A. W. Martin, Postal Telegraphs, Cambridge; W. L. Maxwell, Electrical Department, Central South African Railways, Pretoria; W. R. May, 134 Denmark Road, Lowestoft; W. F. Mitchell, Electricity Works, Dewar Place, Edinburgh; T. B. Naylor, c/o R. P. Wilson, Esq., 66 Victoria Street, S.W.; G. K. Paton, The North Wales Power Co., Ltd., Llanberis, R.S.O.; E. G. Phillips, "Heatherbrae," Priory Hill, Dartford, Kent; R. J. Roberts, Hopesay Rectory, Aston-on-Clun, R.S.O.; E. Rowarth, Battersea Polytechnic, S.W.; C. W. Smith, "Clandon," Woodside Road, Kingston-on-Thames; Professor W. Templeton, Ceylon Technical College, Colombo, Sandilands, M.A., B.Sc., Ceylon; S. W. Thomas, the Post Office, Sydney, New South Wales; B. Wiesengrund, Ph.D., 13 Woodside Park Gardens, North Finchley, N.; P. A. von Wildenrath, Box 36, Premier Diamond Mine, Transvaal; A. R. Woodhall, The Midland Engineering Co., 2 Victoria Square, Birmingham.

As Associates (4): Major J. Bruce-Kingsmill, R.A. (retired), Messrs. E. S. Hindley & Sons, Bourton, Dorset; H. Foulds, Faraday House, Southampton Row, W.C.; L. S. Simpson, Assistant Loco. Superintendent, Buenos Aires and Pacific Railway, Calle 25 de Mayo 277, Buenos Aires; W. B. Trafford, Sun Fire Office, Threadneedle Street, E.C.

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Birmingham and District Electric Club.—Mr. E. C. R. Marks delivered his presidential address to the Birmingham and District Electric Club last Saturday. His subject was the relation of the Universities to technical training. It was, he said, of supreme importance that a University should recognise and endeavour to ally if not incorporate with itself such organisations as the municipal technical school. Manchester University has a faculty of technology, embracing not merely its own students, but those also at the Municipal School of Technology. The University of Liverpool in the faculty of arts had arranged for the preparation of students by evening classes of study for graduation in that faculty. He complained that their own University in particular gave no support to evening classes, and would officially recognise no students but those trained on its own premises. He was afraid the result might be that many young men who were worthy of being admitted as graduates of the University would go elsewhere for that encouragement and recognition they would gladly receive in their native city.

Nuisance from Brighton Corporation Motor Generator Station. On Thursday, in the Chancery Division of the High Court, Mr. Justice Joyce heard an action brought by the Rev. Edward Heath, Colonel Grove-Morris, and Mr. Frank Harold, who asked for an injunction to restrain the Brighton Corporation from working their North Road works so as to cause a nuisance and annoyance to the worshippers of St. Mary and St. Mary Magdalene churches, in Bread Street, Brighton. The allegation on the part of the plaintiffs was that the noise from the machinery disturbed the Rev. Mr. Heath while he was conducting the services, and it rendered it at all times impossible to hold classes and meetings. It was pleaded on behalf of the Corporation that their machinery was of the most modern type. They denied that there was either a nuisance or inconvenience, and relied upon their statutory powers, which they said they had exercised in a reasonable and proper manner. His lordship inquired if it was only the noise that was complained of. Mr. Hughes, K.C., for the plaintiffs, stated that the noise was still intolerable, despite the efforts of the Corporation to reduce it. It was of a very unpleasant and humming character. The case was continued on Friday and Saturday. The Rev. Mr. Heath stated that the noise varied greatly, but it could sometimes be heard above the organ and choir. He had been obliged to give up one of his classes, and also preach from the floor of the church instead of from the pulpit. Dr. Robert Hill Shaw said he was at St. Mary's Church on the previous Sunday. He got headache, owing to the noise. On Saturday Mr. Dinnick, estate agent and trustee of a number of houses in Bread Street, stated that owing to the nuisance from the Corporation works he had difficulty in obtaining the rents he formerly secured. The noise in the church and class-rooms rendered it difficult to read or write. Mr. Wharton, organist of St. Mary's, said the noise from the convertors resembled the sound of large humming tops. It varied slightly in different parts of the church. Cross-examined, witness said it could not honestly be stated that the noise was sufficiently loud to cause a nuisance to reasonable people. On Tuesday Mr. R. P. Wilson, consulting engineer, Westminster, gave evidence as to having inspected the church and Corporation works at Brighton in June and July last. He supported the plaintiffs' claim as to the noise which the electrical works created. A number of other witnesses who attend the church, and also live in the neighbourhood, spoke as to the noise, and the hearing was adjourned.

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THE COST OF POWER PRODUCTION

MR. I. V. ROBINSON read a Paper on Tuesday last before the Institution of Engineers and Shipbuilders in Scotland on the cost of power production. The Paper consisted principally of a comparison of the estimated cost of power supply at a high load factor such as is obtained under the conditions of electro-chemical work from a water-power plant and from a gas-driven plant.

For purposes of comparison, a power station designed for a continuous output of 20,000 b.h.p. was taken and its capital cost was estimated, assuming (1) that waste gas from blast furnaces were available, and (2) that gas producers, and with them ammonia recovery plant, have to be provided.

As an up-to-date example of a water-power station, information was given of the cost of equipping two stations on the River Aveto in Italy, by the Societa Idroelettrica Ligure, Milan. Owing to the total head available being so great, it was decided to divide the fall between three power stations. The first station will generate 28,000 h.p., with a fall of 1,150 ft; the second, 17,500 h.p., with a fall of 625 ft.; and the third, 12,000 h.p., with a fall of 550 ft.

The total cost of the first and second stations is estimated to amount to £640,000, or slightly over £14 per horse-power developed.

This estimate includes the cost of the transmission line, transformers, and distribution system. For a comparison with a gas-power station, it was thought that the cost of the transmission line and transformers should be included. As the power station has to be built where the water is available, in the comparative cost must be included all expense entailed in bringing the power to the place where it is required. It is not necessary to include the distribution system, as for electro-chemical or electro-metallurgical work this would not be a very large item, such work usually being placed close to the power station or sub-station. It was assumed that £40,000 had been allowed for this item, reducing the capital cost to £600,000, or £13 4s. per h.p. developed. The electrical loss in the transmission line was taken as 10 per cent., so that then the capital cost per h.p. delivered is about £14 13s.

In a report recently issued, it is stated that the Mexican Light & Power Co. proposes the erection of a second water-power station to contain six units of 8,000 h.p. each. The total cost of the station containing in all 48,000 h.p. will be £417,000, or about £8 14s. per h.p. developed.

A Commission was appointed some time ago to report to the Canadian Government regarding the power obtainable in the Province of Ontario. The following details of the Cameron Rapids Development are abstracted from the fifth report of this Commission.

It is estimated that the Cameron Rapids are capable of developing 16,350 h.p., and that the bulk of this power would be transmitted to Port Arthur and Port William, 75 miles away. In estimating the total working costs, the Commission has allowed for the renewal of the so-called permanent works, such as dam, headworks, power-house, &c., in 40 years, and of the transmission and transformation plant in 15 to 30 years. Interest on capital has been allowed for at 4 per cent. The capital cost of the complete generating station, including all the headworks, &c., is estimated to be £168,300, or £10 6s. per h.p. developed.

The transmission line is estimated to cost £1,145 per mile; there will be a loss of 11·6 per cent.

The estimated annual generating and transmission expenses for the scheme are given as follows :—

Wages, labour, &c., £3,380; maintenance and repairs, £3,575; replacement fund, £3,450; administration, £1,000; interest at 4 per cent., £6,715; total generating expenses, £18,120. The generating expenses per h.p. per year work out at £1 2s. 3d.

The transmission expenses per mile are given as follows :—Interest, maintenance, repairs, and replacement fund, £63; right of way protection, £1 2s. 6d.; engineering and contingencies, £12 17s. 6d.; total, £77.

The total capital charges for 75 miles is thus :—£5,765, which, with the addition of £465 for patrol of line, gives the total transmission expenses as £6,230.

Taking the power transmitted as 14,450 h.p., the generating and transmission expenses per h.p. per year work out at £1 13s. 8d.

In the above estimate interest is allowed at 4 per cent. In the gas-engine estimate the interest allowed is 5 per cent. With the higher rate the generating expenses per h.p. per year would be £1 4s. 3d., and the generating and transmission expenses per h.p. per year would be £1 17s. 3d.

Some remarkable figures have been recently published by Professor S. P. Thomson regarding the cost of water-power used at Notodden for the Birkeland & Eyde nitrogen-fixation process. He states that the total costs per unit are 0·025d., and that they will be 0·0151d. at the new power station at Svaelgfos. The figures are equivalent to 13s. 7d. and 8s. 3d. per h.p. per year respectively. No information is given as to whether this includes replacement-fund charges, interest on capital, &c.

Various estimates of the cost of water-power have been made, and the cost per horse-power per year for a number of schemes is given in the following table :—

TOTAL COST PER HORSE-POWER PER YEAR.

Situation.	Price.	Remarks.
Svaelgfos, Norway.	£0 8 3	No transmission costs included. No information regarding capital charges, &c.
Notodden, Norway.	0 13 7	No transmission costs included. No information regarding capital charges, &c.
Cameron Rapids, Ontario.	1 2 3	Total generating costs. Interest 4 per cent.
Do. do.	1 4 3	Total generating costs. Interest 5 per cent.
Do. do.	1 13 8	Total generating and transmission costs. Interest 4 per cent.
Do. do.	1 17 3	Total generating and transmission costs. Interest 5 per cent.
Toronto, Canada.	2 17 9	Hydro-electric Power Commission's offer delivered to Corporation's boundary from Niagara.
Horahora Rapids, New Zealand.	3 0 0	Proposal of Waihi Gold Mining Co.
Montreal, Canada.	3 3 0	Average price obtained by Shawinigan Water and Power Co. for 19,000 h.p. delivered in Island of Montreal.
Do. do.	3 18 6	Montreal firm's contract with Shawinigan Water and Power Co. for 3,250 h.p.
El Oro Gold Mines, Mexico.	10 0 0	Purchase price of power transmitted 76 miles from Nexaca Station of Mexico Light and Power Co.

In considering the equipment of a gas-engine power station, engines were taken with double-acting cylinders 39½ in. in diameter by 43½ in. stroke (1,000 millimetres by 1,100 millimetres). A twin-tandem engine fitted with this size of cylinder would be capable of giving a continuous output of about 2,850 b.h.p. when running at 94 revolutions per minute. To ensure being on the safe side, the normal full load was taken at 2,500 b.h.p., eight engines would be installed for the full load of 20,000 b.h.p., and a ninth would be installed as a spare unit.

The foundations for a gas engine are generally more expensive than those required for a steam-turbine.

The approximate total cost of the complete power station is given in the following table :—

	Total Cost.	Cost per b.h.p.
Nine twin-tandem double-acting gas engines to develop 2,500 b.h.p. at 94 revolutions	£112,500	£5 12 6
Nine 50-cycle 5,000-volt three-phase alternators for direct-coupling to gas engines	£26,000	£1 6 0
Centrifugal-type gas-cleaning plant	£12,000	£0 12 0
Switchboard, motor-generators, and connections to alternators	£10,000	£0 10 0
Engine-house, 470 ft. by 80 ft., steel structure, brick-filled, with 20-ton crane	£24,000	£1 4 0
Foundations for gas engines and engine house about 14,000 cubic yards	£14,000	£0 14 0
Cooling towers for jacket-water 300,000 gallons per hour	£2,000	£0 2 0
Water pumps, air compressor, and reservoir for starting gas engine	£1,500	£0 1 6
Incidentals and supervision	£11,000	£0 11 0
	£213,000	£10 13 0

For a 20,000 b.h.p. gas-engine power station using producer gas, the equipment would not be altered, except that a gas-producing and ammonia-recovery plant would be substituted for the gas-cleaning plant. The capital cost of this plant complete with all producers, gas cleaners, ammonia-recovery towers, exhaust-gas-heated boilers for supplying steam required by producers would be about £75,000 or £3 15s. per b.h.p.

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The total cost of the station would be £276,000 or £13 6s. per b.h.p., as compared with £10 15s. for the blast-furnace-gas station. There would be two coal-fired Lancashire boilers for providing steam when the plant is starting up from all standing, and if all boilers were of this type instead of the exhaust-gas-heated boiler, the total price would be reduced by about £4,000.

With a gas engine the working expenses are low owing to the high thermal efficiency, but the capital charges are higher than for steam-turbine plant, owing to the heavier initial expense. With water-power the second item constitutes the bulk of the total cost, owing to the generally very heavy initial cost and the fact that no fuel is required.

Some figures were given in a Paper read by Mr. L. Greiner, before the Liège Association of Engineers last March, regarding the working costs of Messrs. Cockerills' own central gas-power stations. In 1900 all electric power required in Messrs. Cockerills' works was generated by steam engines with a total capacity of 1,000 kilowatts. They gradually replaced their steam engines by gas engines, and by 1906 all the steam engines were removed, and they had gas-engines in use developing 5,700 kilowatts.

The output for 1906-7 was of 24,000,000 units with a load factor of 50 per cent. calculated upon a full year of 8,760 hours, and the working costs per b.h.p. per hour were 0·047d. With a higher load factor, the working costs per unit are decreased. For a load factor of 95 per cent. which may be attained in electro-chemical or electro-metallurgical works, the total working cost per b.h.p. per hour would be about 0·024d. On analysis of the working costs it was seen that they could be divided approximately as follows:—Labour, including engine attendants, generator and switchboard hands, &c., superintendence, &c., 45 per cent; lubrication, 20 per cent.; cleaning, upkeep, and repairs, 35 per cent. With a total cost per b.h.p. per hour of 0·024d., these three items amount to 0·108d., 0·0048d., and 0·0084d. respectively.

The fixed charges depend upon the useful life, the capital cost of the plant, and the interest to be paid upon this capital. Large gas engines have not been in use yet for a sufficient length of time to say from experience what useful life they will have. As this has a very great effect upon the fixed annual charges, three cases are taken, assming that the life is (1) 10 years, (2) 15 years, and (3) 20 years. It is necessary to allow only the same useful life to the alternators and foundations, as they might not be utilised for new gas-engines.

For the gas-cleaning plant, switchboard, motor-generators, &c., a useful life of 15 years may be taken. A 20 years' life is assumed for the water-pumps and air-compressors, but only 12 years for the cooling-towers, depending upon the quality of the timber used in their construction. The engine-house should last at least 40 years. For depreciation it has been assumed that a sinking fund would be formed, and that 3 per cent. compound interest could be obtained upon annual payments. For the engine-house a separate sinking fund should be formed owing to its life being so much longer than the other items. To obtain the period in which the sinking fund should mature, the cost of each item is multiplied by its allowable life, and the sum of these products is divided by the total capital cost. The annual payment to the sinking fund for the engine-house amounts to £310 per annum. For the remaining items in the blast-furnace station £189,000 has to be redeemed in 20 years for the longer life of the engine, &c. For the 15 years' life the equated period is 15·35 or, say, 15 years, and for the 10 years 11·3 or, say, 11 years. The annual payments are £6,820, £9,810, and £14,280. In addition to the sinking fund there is the interest on capital to be allowed at the rate of 5 per cent. per annum. The station is assumed to work at an average load of 19,000 b.h.p. for 8,760 hours per year, or at a load factor of 95 per cent. The output is then 166,000,000 b.h.p. hours per annum.

With this output the total annual working costs of the blast-furnace gas-engine station will be as follows:—

Item.	Life of plant. 20 years.	15 years.	10 years.
	£	£	£
Labour 166,000,000 at 0·108d. ...	7,470	7,470	7,420
Lubrication 166,000,000 at 0·0048d.	3,320	3,320	3,320
Cleaning and repairs 166,000,000 at 0·0084d	5,810	5,810	5,810
Works cost	£16,600	£16,600	£16,600
Sinking fund, engines, &c.	6,820	9,810	14,280
Do. house...	310	310	310
Interest	10,650	10,650	10,650
Total costs	£34,380	£37,370	£41,840
Cost per b.h.p. per year	£1 14 4	£1 17 4	£2 1 10

To estimate the cost of power generated by a gas-engine power station using producer gas, the extra net cost of the gas has to be added to the expenses previously indicated. From experience gained with several large producer plants, it appears that the total cost of producer gas for engines with a capacity of 20,000 b.h.p., working with a 95 per cent. load factor, will be as given in the following table. Coal has been taken at 7s. 6d. per ton, although an ordinary price for fuel of a suitable grade in the Glasgow district is 6s. per ton. The coal consumption per b.h.p. per hour has been assumed at 1·2 lb., or 1·6 lb. per kw. hour. This includes the raising of all steam required for the ammonia-recovery plant, &c. The yield of sulphate of ammonia per ton of fuel has been taken at 92 lb. This figure depends upon the composition of the coal and is a fair average value. The sale price of the sulphate of ammonia obtained from the gas has been assumed to be £11 per ton.

For the 10 years' life of the engine the sinking fund has to mature in 12 years, owing to the fact that a 15 years' life is allowed for the gas-producing and ammonia-recovery plant.

Labour at the gas plant	£5,300
Acid, stores, repairs, &c.	9,300
Water	770
Fuel—89,000 tons at 7s. 6d. per ton ...	33,375
	£48,745
Less 3,660 tons of ammonium sulphate at £11 per ton	40,260
Nett cost of gas ...	£8485

	Life of plant. 20 years.	15 years.	10 years.
	£	£	£
Works cost (excluding fuel)	16,600	16,600	16,600
Nett cost of gas...	8,485	8,485	8,485
	£25,085	£25,085	£25,085
Sinking fund, engines, &c.	9,200	13,480	17,700
Do. house...	310	310	310
Interest	13,800	13,800	13,800
	£48,395	£52,675	£56,895
Cost per b.h.p. per year	£2 8 5	£2 12 8	£2 16 11

From this comparison it appears that power generated from blast-furnace gases costs about the same as water power, when the capital cost of the generating station, with or without transmission lines as may be required, is about £18 per h.p. delivered at the consumers' boundary Investigation shows, however, that the majority of water-power plants are estimated to cost more than this figure.

Power from gas engines using blast-furnace gas is, therefore, worthy of more attention than it has received up to the present time in Great Britain. During 1905 the various Scotch blast furnaces turned out 850,000 tons of pig iron. With this output the spare power would be about 71,000 h.p. on the assumption that the works are equipped with modern gas-blowing engines, &c. If this power were used for the manufacture of calcium carbide, aluminium, or nitrogenous manures from atmospheric nitrogen, it would be possible to get a return of at least £2 per h.p. per annum. There is thus an annual loss in the Scotch blast furnaces only of upwards of £140,000. To harness this power the capital cost would be about £750,000. A return of £2 per h.p. per year would give upwards of 18 per cent. on this capital expenditure in addition to the 5 per cent. interest allowed in estimating the cost of the power.

Institution Leeds Local Section.—A smoking concert will be held on Thursday, February 6th, at the Hotel Metropole, Leeds, at 8 p.m.

A Large Sub-station Battery.—One of the features of the Albula-Zurich power scheme is to be the provision of a battery of very considerable size, intended to act as a stand-by for the Zurich tramway system in event of interruption in the supply from the Albula station, about 130 kilometres distant. In this scheme, according to *L'Electricien*, two independent transmission lines are provided, one on each side of the lake, to the sub-station of Letten. At this sub-station a certain amount of reserve plant will be installed for use in event of breakdown or shortage of power at the main station. The chief object of the battery, which can furnish an output of 4,700 h.p. for fifteen minutes, is to carry on the supply while the reserve plant is being started up; but it can also be employed as a buffer battery to equalise the load. The cells are of the "Olten" type, and the battery is said to be the largest in Switzerland. As the system is alternating an automatically controlled motor generator is used for charging and discharging.

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THE NORTHAMPTON INSTITUTE, ELECTRICAL ENGINEERING DEPARTMENT

THE Electrical Engineering Department of the Northampton Institute is designed so that the students may have not only theoretical but also practical work in connection with their studies. The department is divided into three sections for instruction, which comprise junior, intermediate, and advanced classes, and the whole course of lectures covers a period of four years for day students and five years for evening students.

The senior engineering laboratory in the basement is divided into two sections: the generator room, and a meter-testing and standardising room. In the main laboratory are a number of small machines, both continuous- and alternating-current dynamos, and motors, upon which the students are allowed to practise starting, stopping, regulating, paralleling, synchronising, &c. The department is arranged so that the students can see exactly what happens in all their experiments. All the machines are connected by mercury distribution boards, in such a way that any machine or combination of machines may be simply and easily connected to the main distribution board, without altering the leads on the dynamos themselves. Machines brought in for testing can easily be placed in any part of the laboratory, as lines of sliding rails are provided. There is a motor generator, the generator of which has been manufactured entirely in the workshops of the department on the premises. The generator is three phase, and each set of coils is double wound, which enables it to be run either in series or in parallel. The field magnets are wound in sections on the Heyland principle, each having six slots and wave-form winding; each slot is independent of the others, and the whole can be short circuited by means of supplementary slip rings.

Each machine in the laboratory has its own ammeter and voltmeter, and regulating resistance, which are fixed, and has its own speed indicator. There is also a stroboscope for determining exactly the speed of each set. This instrument consists of a tuning fork, which has slits and shutters on the prongs, and when the tuning fork is vibrating light passes through the slits. On the end of the shaft of the machine is placed a disc in which a square is surrounded by a pentagon and a hexagon. The square appears for speeds between 1,500 and 3,000 revs., double for 750 and 2,250 revs., and triple for 500, 1,000, 2,000, and 2,500 r.p.m. A single pentagon appears at speeds of 1,200, 2,400, 3,600, and double for 600, 1,800, 3,000, and triple for 400, 800, 1,600, 2,000, 2,800, 3,200. The hexagon appears single at 1,000, 2,000, 3,000, and double for 500, 1,500, and 2,500, triple for 333·3, 666·7, 1,333, 1,667, 2,333, 2,667 revs. per min.

The plant in this testing laboratory contains a specimen of nearly all the best known types of motors and generators. The generator and motor-test bed has been arranged for the testing of either direct-current or alternating-current machines, and consists of a Westinghouse 10 h.p. generator running at speeds from 750 to 1,000 r.p.m. This machine is supported on ball bearings and knife edges, and has a telescopic shaft and an ordinary chuck coupling, so that any motor can be easily connected to it. A special method for getting the machines into alignment is provided. The motor is placed on rails on an iron table, which can be raised or lowered by means of screw gearing. The power supplied to the machines under test is measured by weighing the torque at the end of one of the two levers, a two-pound weight balanced at 1,000 r.p.m. being equivalent to one horse-power. The switchboard was constructed to the specifications of the professors of the Institute. The main and shunt terminals of the generator are connected to this. On this board the cables from the direct-current machines are connected by means of two single-pole switches, and by means of a reversing switch the excitation of the swinging generator is obtained from the negative pole switch. Reversing switches are also provided. The positive pole of the dynamo is connected through a short-circuiting switch, and overload circuit breaker and ammeter, to the centre of the positive main switch, which also is of the throw-over type. The right-hand contact is connected to the positive main and the left-hand to the negative terminal of the armature. Over the raising table, on which motors to be tested are placed, there is another switchboard, which is made up of eight switches and four terminal contacts. Six of the switches connect the terminals to any of the supply, either one, two, or three phase, for which the laboratory is specially wired. The other two terminals are connected to the direct-current supply. A voltmeter is provided for paralleling the generator, which is run up to speed by the motor under test, and then paralleled on the supply mains. A motor under test can be loaded either with the generator in parallel, or can be loaded up on resistance.

In this laboratory there is also provided a transformer station in the form of a table, which enables the transformers to be tested without danger to the students. It consists of a special bench, in which the transformers are enclosed in glass-fronted cases, and thus the windings and general construction are visible to the students without being readily accessible. There is at one end of this table a Kolben converter, which supplies power at 2,000 volts, and is on the three-phase system. The other transformers, which range from two to four kilowatts, can be connected to the converter and then transform down from 2,000–100 volts. The transformers can be loaded up by means of resistances, or can be directly connected to the main supply of the building. For taking the readings on these tests, two wattmeters are provided, which read either on the single or three-phase supply, and on the low- or high-tension sides. There is also in this department a special Ferranti alternator, with contact makers in connection with an oscillograph, which is also connected to an Addenbrooke electrostatic voltmeter, so that wave forms can be correctly determined.

The adjoining department is the standardising laboratory, just outside the machine room. This laboratory contains a long bench, upon which are mounted the secondary standards for current and potential difference. There are four Siemens dynamometers, and also a battery of three cells, which is capable of being used either in series or parallel, and a converter transforming from 200–5 volts, and capable of dealing with currents, either continuous or alternating, up to 400 amperes. Regulation is obtained by graduated Eureka wire resistances and connectors sliding in mercury trough resistances. Cables run from the testing bench to the main switchboard, so that any ammeter in the laboratory can easily be tested from its permanent situation. On this bench there is also a Kelvin electrostatic instrument, a Weston standard voltmeter, and a potentiometer, for standards for testing direct- and alternating-current potential difference at various voltages. There is a pair of voltmeter checking leads running round the laboratory for the testing of voltmeters, which can be fixed to the battens in the same manner as the ammeters, and each voltmeter is provided with a two-way switch, by means of which the voltmeter can instantly be switched off the testing machine and on to the standard checking leads. Each ammeter and voltmeter has at its side a small case, in which a card recording the number of the meter, and the amount of error on both alternating and direct currents.

In the junior laboratory there is a complete set of simple instruments, and specimens of all kinds of batteries and small motors, &c., with which the students are allowed to experiment; simple winding of motors and dynamos, and the construction of resistances and controllers and their general action are taught in this laboratory. In the intermediate laboratory more heavy machinery is provided, and motors up to 5 h.p. are supplied, of various makes, and the students in this department perform all kinds of experiments. The Institute provides a number of cards, on which different experiments are defined, and the students are each given one of these, and are expected to conduct the whole of the work themselves, doing all the necessary wiring and connecting up.

In the senior laboratory there are a number of tables on which different testing apparatus is set out, and which enables all kinds of instruments to be tested. The first of these tables is equipped with a standard Anthony-pattern bridge, with various shunts and cell regulators, connected to a Kelvin galvanometer with coils of various resistances. The bridge winding is of low temperature wire. The second table is provided with a Carey-Foster bridge, for the standardising of resistance coils, and for the testing of low resistances as used in potentiometer work. Oil baths for keeping the coils at any desired temperatures are electrically heated. The third table is arranged for testing insulations, &c. Here there is a 100,000-ohm Kelvin galvanometer of high insulation, and there is a secondary cell battery, consisting of 300 small cells, and from which 600 volts can be obtained. The cables to be tested are of various lengths and makes, and are contained in circular tanks. The fourth table is laid out for testing extra high insulations, by fall of potential theories. An Ayrton-Mather electrometer and small tanks containing various types of insulators are used for these tests. The fifth table is used for capacity measurements, and is arranged with various kinds of keys, a standard condenser, and a ballastic galvanometer, by Nalder Bros., of 10,000 ohms. A universal shunt, by Sullivan,

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enables all kinds of capacity tests to be made. No. 6 table is for induction instruments and measurements, and the set consists of a Wheatstone bridge, to which are connected variable and fixed standards of self-induction, and also a motor secchometer. On No. 7 table there is a Crompton standard potentiometer, which is used in connection with a Crompton moving coil galvanometer, and Board of Trade and Carhart cells are used for standardisation, and measurements can be made up to 750 volts, which pressure is obtained from the cells in the Institute. Tables 8 and 9 are used for measuring currents, and Kelvin deca- and centi-ampere balances, and regulating resistances are provided. Copper and silver voltameters, with a balance for standardising currents, are provided. Other tables are provided with iron testing and conductivity apparatus. For the testing of iron the experiments are carried on, in the ring and yoke methods, by magnometer. In the electrochemical laboratory all kinds of experiments are carried out. A large vacuum tube with adjustable electrodes is used for determining the various amalgams of the rarer metals used for the filaments of electric lamps, &c. There is also a complete laboratory for determining the candle-power of incandescent lamps. We are indebted to the Principal, Dr. R. Mullineux Walmsley, Dr. C. V. Drysdale, and Mr. Jolle for the facilities which they have given us for the compilation of this article.

"THE BABES IN THE WOOD"

IN this year's Drury Lane pantomime, "The Babes in the Wood," some highly ingenious and pleasing electrical effects are produced. One of these is in the "firework act." A huge imitation rocket is brought on to the stage, and the top, consisting of an ordinary squib, is lighted. The usual "fizzing" ensues, and at the instant when the squib explodes the switches of all stage circuits are opened; this is intended to represent the ascent of the rocket. Then, descending through the darkness, are seen half a dozen of the familiar coloured lights which make their appearance when a rocket explodes in mid air. These coloured lights are really electric lamps, lowered slowly and cautiously from the flies. At a given signal they are extinguished, and quickly drawn out of sight, upon which the stage circuit switches are once more closed.

Another delightful effect is that of the rising sun. This piece of apparatus consists of a shallow drum, with calico in place of the usual skin, while between the two ends or "heads" are several incandescent electric lamps of various colours, from ruby to clear, wired on a number of different circuits. The stage lights, which have previously been almost extinguished, are gradually brought up on the dimmers until a faint glow suffuses the stage. Then the sun, which measures 6 ft. 6 in. in diameter, is gradually raised from the stage behind a forest and cloud scene, only the ruby lamps being on. At this point only the upper edge of the sun's disc can be seen from the front, and it appears blood red. As it is raised it apparently passes through clouds—which are really painted on the back cloth—while at the same time some of the ruby lamps are switched out and amber lamps are switched on. Simultaneously the stage lights are brought still further up on the dimmers. This process is continued until the sun appears to be of a brilliant golden hue, and the stage lamps are then brought up to full brightness. The stage is then flooded in warm sunshine, and the effect is complete.

Another pretty scene is that in which about a dozen members of the chorus perform a moonlight dance. Each dancer is provided with a wire ring, a foot in diameter, around which are fastened 16 lamps, each taking 1½ amperes at 8 volts. The ring and lamps are covered with a blue fabric, and the whole contrivance is very aptly called a "halo." The lamps are supplied from portable accumulators carried in indiarubber bags and suspended from the dancer's shoulders at the back. A small tumbler switch, carried in the hand, completes the equipment.

In another scene, which depicts the search for the "Babes," some three dozen electric torches, of the familiar type, are employed. These, carried to and fro, on a dark stage, produce a very pleasing effect.

The above are only a few of the applications of electric lighting in the "Babes in the Wood," what are technically known as the "big scenes" being on the usual lavish and magnificent scale.

Mr. H. Mather, the theatre electrician, is to be congratulated on the success which has attended his efforts, and we are indebted to him, as well as to the management, for his courtesy in enabling our representative to obtain the above details.

While referring to Drury Lane Theatre, we may take the opportunity of congratulating the management on the fact that the old system of gas heating has been at last banished for ever. For some time after elaborate precautions had been taken to guard against fire risk, the old gas radiators were retained, having a bunsen flame clearly visible from the outside. Everything inflammable was removed; iron was substituted for wood wherever possible, and the ancient wiring in casing which had done duty for so many years was reconstructed throughout in screwed steel barrel. And still the gas heaters flourished. At last, however, they have been replaced by an admirable system of heating and ventilating, electrically driven throughout. The stage plant consists of a large washing drum, measuring about 6 ft. by 6 ft. This drum is covered with a hair matting, and the lower part of its periphery dips into a large tank of water; it is driven by a 1½-h.p. Taunton motor, and its surface is therefore kept continually in contact with fresh water. Air is drawn in through the interstices of the saturated matting by a 10-h.p. electrically driven Sirocco fan, situated at the end of the drum, remote from the entrance to the chamber. The air which has thus been cleaned is passed through a tunnel, and comes in contact with a nest of about 120 steam pipes, arranged vertically. From these pipes it enters a large brick tunnel, which passes completely round the stage. At intervals, galvanised iron ducts lead off from the tunnel to points where it is desired to have an influx of warm air. The exits of the ducts consist of gratings with circular holes. A row of such gratings has been arranged between the curtain and the footlights, so that when the former is raised, occupants of the stalls are not now treated to the chilly blast which used to follow the conclusion of the overture.

Above the "gridiron" is an extraction consisting of a Sirocco fan, driven by a 10-h.p. motor, so that the warmth of the stage can be regulated to any desired degree. Further regulation can be obtained by means of the valves with which all the air ducts are provided.

For the front of the house a similar washing plant has been installed, while the extractor consists of a 15-h.p. electrically driven fan, situated immediately above the sun burner.

All the controllers, supplied by the Electric Ordnance & Accessories, Ltd., are situated under the stage, and are provided with the usual iron cases; the wiring has been carried out in screwed steel barrel.

In summer-time the entire plant is used for the introduction of cooled air into the theatre, and the extraction of heated and vitiated air. This change is effected simply by passing the washed air through open doorways instead of through the nest of heated steam-pipes.

Steam is generated by a Paxton boiler of the locomotive type, the pressure being 65 lb. per sq. in., and the evaporative capacity about 1,800 lb. per hour. Feed water is obtained from the hot well by means of a steam feed-pump and a Penberthy injector. This boiler is also employed for heating the scene-painting room, which is provided with 1,000 ft. of steam barrel and four Geipel steam-traps.

The B.T.-H. Petrol-Electric Omnibus.—An account of a 10,000 mile trial of a Wolsely motor-omnibus fitted with the B.T.-H. electrical transmission gear, just completed in the service of the London General Omnibus Co., is given in the *Railway Times*. As was to be expected for a new departure of this nature, minor defects became apparent in the course of the trial. These were rectified, and it is stated that the last 3,700 miles were covered without adjustments being necessary. The actual mileage covered was 10,480 out of a possible 13,390 miles. It must be remembered that no spares were held in London, and that considerable time was occupied in investigating the defects that occurred instead of getting the vehicle on the road again as soon as possible, as would have been the case were it an ordinary vehicle in service. The consumption of petrol is given as 4·8 miles to the gallon over the whole trial. This is said to be slightly better than the consumption with the gear-driven 'buses running over the same route. This vehicle was always exceedingly quiet, and, although it has run upwards of 15,000 miles, it has not become any more noisy. After the trial the chassis was stripped for inspection, and the electrical equipment was found to be in excellent condition. An illustrated description of the British Thomson-Houston petrol electric system appeared in ELECTRICAL ENGINEERING, Vol I., p. 463.

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THE HEAT CONDUCTIVITY OF IRON STAMPINGS

THE object of the research described in the Paper read yesterday by Mr. T. M. Barlow before the Birmingham Local Section of the Institution of Electrical Engineers was to determine the heat conductivity of assembled insulated iron stampings, first in a direction parallel to the plane of their surfaces, and second in a direction at right angles to their surface through both iron and paper.

The theory of heat conduction was briefly considered, and, considering cylindrical surfaces, such as shown in Fig. 1, of a length, l, separated by a medium of heat conductivity, K, it was shown that difference of temperature, θ, between two points could be expressed as

$$\theta = \frac{1}{K}\frac{Q}{2\pi l} \cdot \log_e\left(1 + \frac{x}{r}\right)$$

From this formula the values of K (which is numerically equal to the quantity of heat which flows per unit time through unit

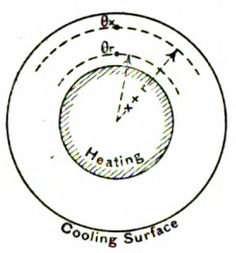


FIG. 1.

area of a plate of unit thickness having unit difference of temperature between its faces) for iron stampings, both in the direction parallel to the plane surface of the stampings and across the iron and paper at right angles to the surface, were calculated.

If K_a be the heat conduction coefficient for iron laminations in a direction parallel to the surface of one stamping, and K_b in a direction at right angles to this surface, and if C equals the ratio of the sides of two square surfaces, one being the edge surface of a packet of stampings and the other being the plane surface of the outside stamping of the packet, and if both these surfaces are made to dissipate the same amount of heat, *i.e.*, equal cooling, then—

$$C = \sqrt{\frac{K_a}{K_b}}.$$

To obviate the difficulty of calculating the heat leakage if the iron stampings were heated on one side, a cylinder built up of stampings was used, being heated on the inside edge and cooled on the outside (see Fig. 2). This was built up of stator

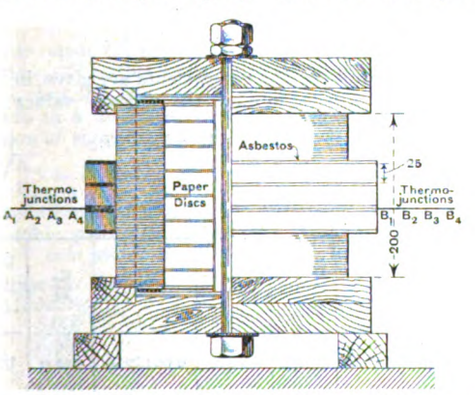


FIG. 2.—SECTION AND ELEVATION OF APPARATUS.

stampings made by Messrs. Sankey & Co., Bilston, 0·0345 cm. thick, and insulated with a preparation known as "Insuline." The plates were firmly clamped together, and the slots wound with twenty turns per slot of D.C.C. copper wire. The slots were insulated with paper tubes built up with shellac varnish. The thermo-junctions for the core were fixed between two fine sheets of condenser paper cut to the same shape as the stampings, the two leads of each junction being carefully brought out so that there was no fear of short circuit. The stampings were clamped together between two wooden rings, insulated with asbestos from the iron stampings. To prevent the iron bolt from getting hot and so allowing the nut and head to dissipate heat, the air inside was divided off into sections, so as to localise the heat currents by means of discs of paper. The bolt was also shielded by a paper tube. The top and bottom of the core were insulated also with asbestos sheet, cord, and cotton waste. These precautions ensured that practically all the power supplied to the windings would be dissipated in heat from the outside edge surface of the stampings.

For the second part of the work, *i.e.*, the measurement of the heat conductivity across iron and paper, iron strip was wound over the outside of the cylindrical core, each layer being interleaved with paper. The strip was 2·5 × 0·05 cms., and was of

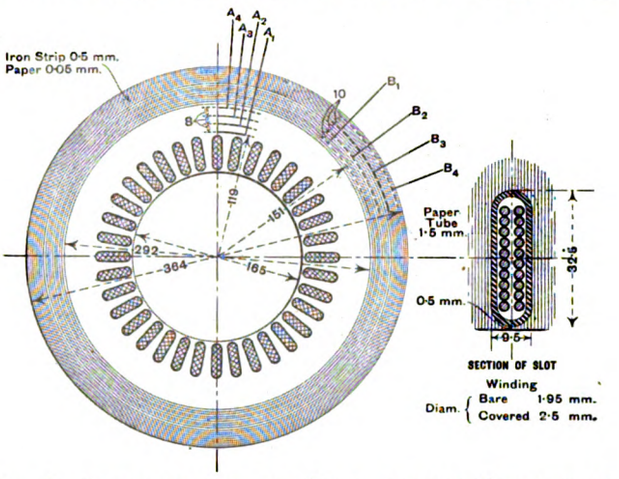


FIG. 3.—SECTION OF CORE AND STRIP, SHOWING POSITIONS OF THERMO-JUNCTIONS (ALL DIMENSIONS IN MILLIMETRES).

best soft steel of bluish colour. The paper was 0·005 cm. thick. Three coils were wound, the thermo-junctions being placed at suitable intervals in the centre one, the two outside rings acting as guard rings. The coils were insulated with asbestos sheet from each other, and the edges of the two outside coils were also insulated from the air with asbestos sheet rings.

The position and method of carrying away the leads of the thermo-junctions are shown in Fig. 3. In the core A_1, A_2, A_3, A_4 were placed 8 mm. apart. In the strip B_1, B_2, B_3, B_4 were 10 mm. apart, giving a total distance between A_1 and A_4, B_1

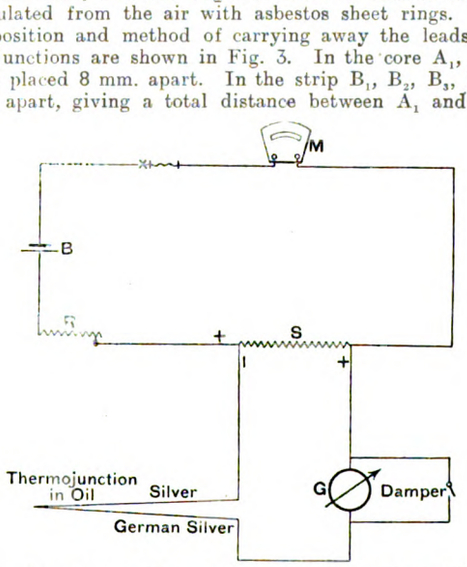


FIG. 4.—DIAGRAM OF CONNECTIONS (THERMO-JUNCTION TEST).

S. Shunt $\frac{1}{10}\omega$ resistance.
M. Milli-ammeter, reading 0—1·5 amperes for measuring current through *S.*
G. Galvanometer (moving coil type).
B. Two-volt accumulator.
R. Variable resistance for regulation.

and B_4, of 2·4 cms. and 3 cms. respectively. After the strip had been wound on it was found that A_3 and B_3 had become short-circuited or broken. As this could not be remedied without dismantling the whole apparatus, readings were only taken from the six remaining thermo-junctions, these being quite sufficient for calculating the results required.

The measurement of the temperature by electrical resistance thermometers was considered impracticable.

As the temperature was only to vary from 15–80° C., a new combination of metals was tried for a thermo-junction, and was found to give a straight line between the above limits. The positive wire was of No. 40 German silver silk covered,

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and a No. 32 pure silver wire bare was used as the negative. The actual junction was made by twisting the ends for about 0·3 cm., dipping in silver solder, and then flattening by light taps.

A series of tests was carried out on two of the thermo-junctions used. The elements were first heated in an oil bath to about 90° C. and allowed to cool slowly. The temperature of the oil, *i.e.*, the hot junction, and the temperature of the cold junction were measured by delicate mercury thermometers. The micro-voltage was measured by a potentiometer method. The diagram of connections is shown in Fig. 4. From these

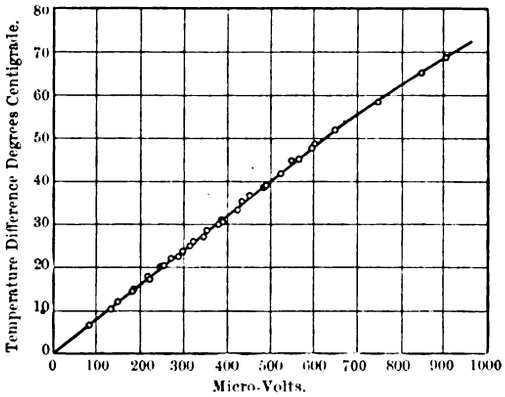


FIG. 5.—TESTS ON THERMO-JUNCTIONS A_1 AND B_1.

tests the micro-voltage per 1° C. rise of temperature was found to be 12·73. Other junctions tested gave points on the curve in Fig. 5, so this figure was accepted as correct for temperature measurement.

The experiments were conducted in a room kept as near at as uniform a temperature as possible, so that the temperature of the cold junctions would remain constant. The core was heated up for eighteen hours by passing current through the coils. Connection was then made through one of the junctions, the shunt, and the galvanometer. The galvanometer mirror was then brought to zero by passing a current through the shunt in the opposite direction. This was very finely regulated, giving the current through the shunt, and so the micro-volts for any particular junction, hence the temperature of the iron at the point where that junction was fixed.

The micro-volts A_1, A_4 were first taken. Then B_1 and B_4, and finally A_2 and B_2. The whole set of readings was repeated three times and the average taken if there was any slight variation. The instruments were all millivolt-ammeters by Siemens & Halske, and were used with suitable shunts. The main resistance, carefully calibrated, was made by the same firm, and was of 0·0005 manganin. The regulating resistances were of the ordinary wire type of 42 ohms and 31·5 ohms respectively. A carbon resistance, which was always kept tight during the tests, was placed in the circuit for final adjustment. A diagram of connections is shown in Fig. 6.

The instruments used for recording the watts supplied were a voltmeter, to read from 0–15 volts, and an ammeter, to read from 0–15 amperes.

The author then proceeds to a theoretical calculation of the conduction coefficient across iron and paper from the known values for iron, paper, and air, which, taking the proportion of the thickness of the iron, paper, and very small layers of

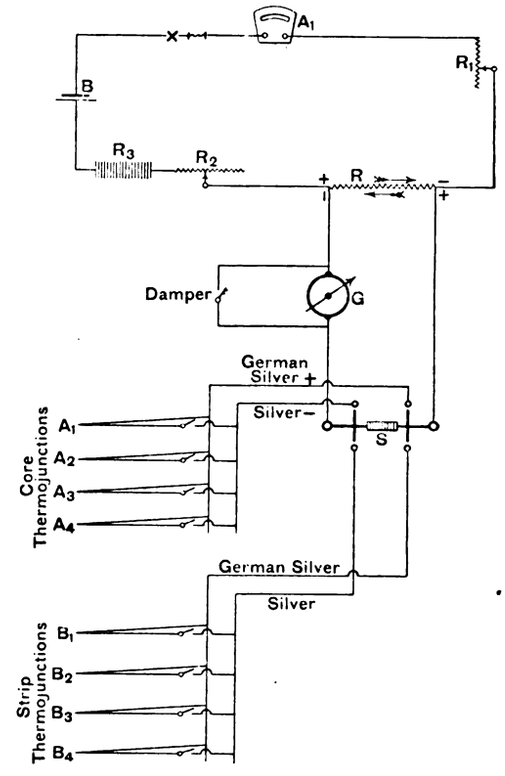


FIG. 6.—DIAGRAM OF CONNECTIONS (CONDUCTIVITY TESTS).

R. 0·0005 ohm manganin shunt.
R_1. Variable wire resistance, 42 ohms.
R_2. Variable wire resistance, 31·5 ohms.
R_3. Carbon rheostat.
A_1. Milli-ammeter shunted to read 0—1·5 amperes.
G. Galvanometer moving coil type.
S. Change-over paraffin block switch.

air between as 0·05 cm., 0·005 cm., and 0·00125 cm. respectively, and the following are values of K used for iron, paper, and air (C.G.S. Centigrade units) :—Iron, 0·152; paper, 0·0003; air, 0·0000528 (values obtained from the works of Hall, Lees and Compan), works out as 0·00138.

The constants for the experiment in formula for temperature difference are then worked out for the formula

$$\theta = \frac{1}{K} \cdot \frac{Q}{2\pi l} \log_e \left(1 + \frac{x}{r}\right)$$

The complete results of the experiments are given in Table I., from which it will be seen that the average values obtained are :—

$$K_a = 0{\cdot}1405 \text{ and } K_b = 0{\cdot}00137.$$

Table I.

Conductivity Tests.

Number of Test.	Date.	Watts to Heat Core = P	Thermo-junction Micro-volts.						Temperature θ_a.	Temperature θ_b.	Temperature of Cold Junction.	K_a.	K_b.	$\frac{K_a}{K_b}$	C.
			A_1.	A_2.	A_4.	B_1.	B_2.	B_4.							
1	6/2/07	122·8	708·70	707·15	705·000	630·00	432·00	222·0	0·2900	31·98	17·49	0·1470	0·0013210	111·0	10·53
2	6/2/07	140·0	762·00	759·50	758·150	680·00	505·00	236·0	0·3300	34·80	17·51	0·1471	0·0013820	106·0	10·30
3	13/2/07	121·0	711·00	709·00	707·250	647·50	451·00	265·5	0·2940	30·00	16·55	0·1430	0·0013900	103·0	10·16
4	14/2/07	81·1	515·50	514·40	512·900	467·50	342·50	211·5	0·2040	20·10	16·50	0·1376	0·0013820	99·5	9·98
5	19/2/07	68·5	472·50	471·55	470·290	424·50	315·00	206·5	0·1735	17·10	15·55	0·1371	0·0013790	95·6	9·79
6	20/2/07	75·2	500·50	499·35	498·075	447·00	325·75	207·5	0·1900	18·81	15·55	0·1374	0·0013735	100·0	10·00
7	21/2/07	92·8	589·50	588·40	586·525	537·20	400·50	230·7	0·2330	24·05	15·80	0·1380	0·0013250	104·0	10·20
8	22/2/07	99·3	611·70	608·89	606·995	549·25	402·00	237·0	0·2495	24·50	15·46	0·1381	0·0013920	99·2	9·97
9	23/2/07	108·0	650·50	649·90	647·070	579·50	428·53	236·5	0·2690	26·95	15·40	0·1390	0·0013800	100·7	10·03
10	27/2/07	117·5	679·45	676·90	675·940	597·50	448·50	245·5	0·2750	27·60	17·90	0·1410	0·0013920	101·2	10·06

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This gives an average value of C of 10·1. Hence the ratio of sides of square edge and plate surfaces of iron stampings for equal cooling averages about 10. In actual practice the pressure on the stampings would be slightly more than that used in the experiment. This would lower the value of C by raising K_b a little.

The temperature-drop curves shown in Fig. 7 are for Test 6.

A method of calculation of curves for temperature rise in iron stampings from the values of K and C is then given.

Consider the case of a packet of iron stampings heated internally by (we may suppose) hysteresis and eddy currents. Let the temperature at a mid-point distance t from either

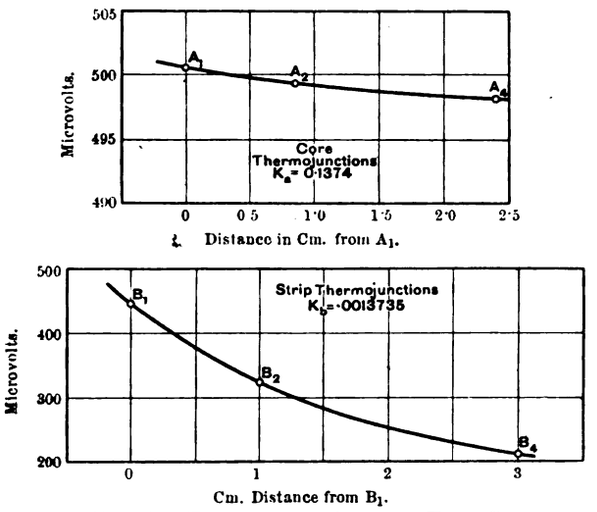


FIG. 7.—TEMPERATURE CURVES (TEST 6).

face be θ_2, and θ_1 be temperature at outside surface, then $\theta = \theta_2 - \theta_1$.

Consider an element distance x from ab having a cross-section of 1 sq. cm. The element has a temperature difference of $d\theta$ and a volume of x c.cms. Then heat transferred between $x=0$ and $x=x$ is $\frac{d\theta}{dx}$. K_a after a steady state has been reached.

But the heat transferred equals the heat generated. Also the heat generated in x c.cms. $= f(x) = \lambda x$.

$$\therefore \frac{d\theta}{dx} K_a = \lambda x$$

where λ = calories per cubic centimetre—

$$\therefore \frac{d\theta}{dx} = \frac{\lambda x}{K_a}.$$

Integrating—

$$\left[\theta\right]_{\theta_1}^{\theta_2} = \left(\frac{\lambda x^2}{2K_a}\right)_0^t \quad \therefore \theta = \frac{\lambda t^2}{2K_a}.$$

λ depends upon the induction frequency and thickness of the iron plates. Therefore curves can be drawn for various inductions showing the temperature gradient for any length of heat path, both in a direction parallel to the iron stampings, and in a direction at right angles—that is, across iron and paper, since $C = \sqrt{\frac{K_a}{K_b}}$ is known. The value of P_i—*i.e.*, watts lost per kilogramme corresponding to any particular induction—are taken from a table published by Sankey & Sons, Bilston, for their "Stalloy" iron stampings 0·35 mm. at 50 ∽ given below.

B (lines per cm.²) (Induction).	P_i (Watts lost per Kg.).
5,000	0·64
6,000	0·84
7,000	1·08
8,000	1·32
9,000	1·56
10,000	1·87
11,000	2·15

From the table we can obtain the loss in watts per kg. = to P_i.

This reduced to calories per cubic centimetre $= \lambda = \frac{P_i}{540}$.

$$\therefore \theta = \frac{P_i}{540} \cdot \frac{t^2}{2K_a}.$$

K_a average value = 0·1405—

$$\therefore \theta = \frac{P_i t^2}{152}.$$

The curves (Fig. 9) are applicable to the flow of heat across iron and paper by using the top scale, which is $\frac{1}{10}$ the bottom scale, C being taken equal to 10.

After the completion of tests as above the iron strip and paper were removed. The core was then heated up to various degrees and the temperature noted by means of the thermo-junctions. Two series of tests were conducted: (1) still air cooling, (2) moderate blast cooling. The latter was obtained by sending a blast from an ordinary ventilating fan round the core.

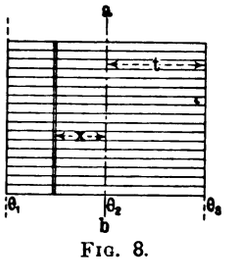


FIG. 8.

The results of these additional experiments are in Fig. 10, which is taken from an appendix to the Paper, together with the theoretical hyperbolas near to which they lie.

It will be noticed that for still air the theoretical hyperbola does not lie very well on the curve obtained by experiment. This is due to the convection currents which are set up in the still air by the dissipation of the heat. In the case of the strong air blast these have no effect. Hence the theoretical hyperbola, $T\sigma = 300$, more closely approximates to the actual curve obtained.

The main conclusion to be drawn from the values of the heat conductivities of iron insulated stampings found for a heat path (1) in a direction in the same plane as the plate surface of the stampings, and (2) in a direction at right angles to the stampings (across iron and paper), is the importance which must be given to the amount of edge surface of the stampings of a laminated iron core exposed to the cooling medium, either air or oil.

It is seen from Fig. 9, which may be drawn for any iron stampings of which the hysteresis and eddy current losses are

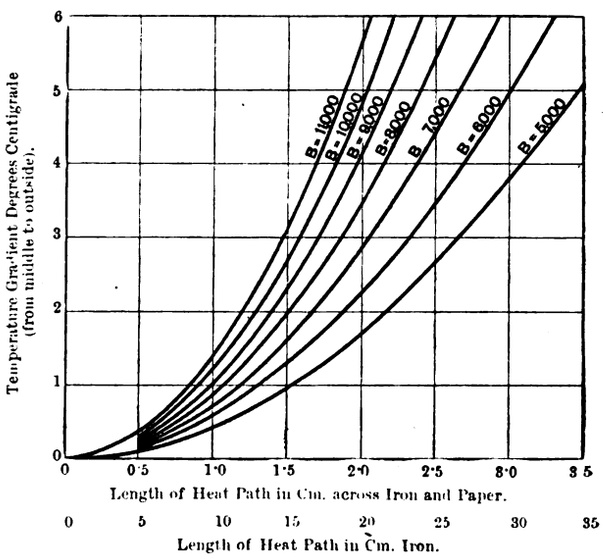


FIG. 9.—TEMPERATURE CURVES FOR "STALLOY" IRON.

known, that the temperature gradient will be almost a straight line in a direction with the plane of the stampings. Thus the internal temperature of the core is quickly reduced if the method of cooling employed, either air or oil, is used on this edge surface. On the other hand, if the iron laminated core is only cooled on the plate surface, the temperature will rise, comparatively, very rapidly as the core is penetrated across the iron and paper. This rise amounts to as much as 5° C. for a distance of 2 cms. for an induction of 10,000 lines per cm.² at 50 ∽ in the iron for which the curves are plotted. The effect of this steep temperature gradient in an iron core thus cooled is the increase of the hysteresis loss in the centre portion due to the decrease of the permeability of the iron with the rise of temperature. Also for any iron rectangular laminated core, which is heated internally, from the values of $C = \sqrt{\frac{K_a}{K_b}}$ (the ratio of the linear dimensions of the sides of the core, *i.e.* edge side to plate side) for the most efficient cooling must equal 1 : 10. This ratio is somewhat higher than is used at present in common practice, the figure averaging about 1 : 6 for

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small armature cores and transformers, and 1 : 7·5 for large cores. Further, dealing with the question of the ventilation of direct-current armatures, it will be noticed that the ventilating ducts between the packets of iron stampings are not so useful on account of the extra plate surface exposed to the cooling draught induced, but act more as an outlet for the air inside the centre space of the armature, which has been heated in cooling the inside edge surface and so the internal parts of the core. This also applies to the ducts in large transformer cores cooled by a direct air blast. In connection

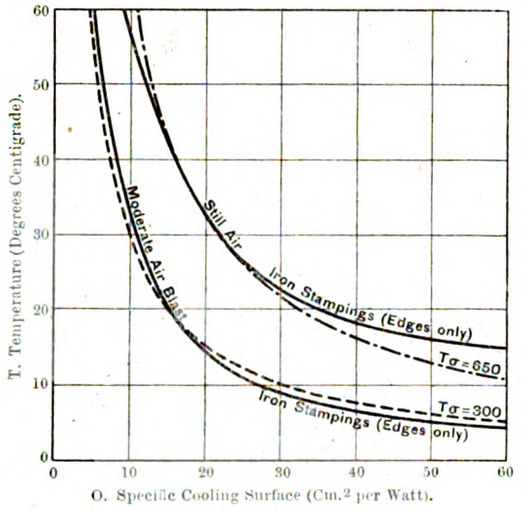


FIG. 10.—COOLING CURVES.

with the few tests for cooling coefficients for iron cores, these formulæ may be used for the temperature rise (surface) of the iron core of a transformer, where the effective plate surface for cooling, in comparison with the edge surface, can be neglected. Values of the coefficient may be approximated for different rates of air cooling, but further work is necessary on this part of the work before any definite conclusion can be inferred.

In conclusion, the author expresses his thanks to Professor Kapp, of the Electrical Department of the University of Birmingham, at whose instigation the research was carried out, for the facilities afforded.

Alleged Damage to Electric Cables.—Sitting as a Divisional Court in the King's Bench Division of the High Court, Mr. Justice Phillimore and Mr. Justice Walton had before them on Thursday the case of the Westminster Electric Supply Corporation v. The London County Council, which came up on the appeal of the plaintiffs from the judgment of the Westminster County Court judge.

Mr. A. B. Shaw represented the plaintiffs, and Mr. Horace Avory, K.C., and Mr. Radcliffe Cousins appeared for the defendant council.

Mr. Shaw, in opening plaintiffs' case, stated that the action was brought to recover damages said to have been caused by the Council's servants to their electric cables in the borough of Westminster. The plaintiffs had some trouble with their cables in October last, a short circuit manifesting itself. They traced it to Greycoat Place, Westminster, where in the previous February the defendant Council had constructed a fire station, and on opening the ground they found that the casing had been injured, letting in the damp, and eventually destroying the insulation. When the action came before the County Court judge, the defendant Council pleaded the Public Authorities Protection Act, maintaining that inasmuch as the writ was not issued within six months of the cause of action the plaintiffs had waived their right of action. He (Mr. Shaw), however, maintained that the defendants were by their own conduct precluded from relying upon the statute, for it was at the written request of their own superintendent architect that the plaintiffs allowed the matter to stand in abeyance till after the next committee meeting, thus delaying the issue of the writ. Counsel then quoted authorities in support of his contention, and argued that the County Court judge was wrong in holding that there had been a waiver by reason of the delay.

Mr. Horace Avory, K.C., denied that the County Council had done anything which precluded them from pleading the Public Authorities Protection Act. Counsel pointed out that all the superintendent architect wrote was that he presumed legal proceedings would not be taken.

Their lordships, in deciding the case, held that the superintendent architect had not actually requested the delay in the issue of the writ, and dismissed the appeal with costs.

CATALOGUES AND PAMPHLETS RECEIVED

ELECTRIC PUNKAHS.—A new pamphlet is to hand from Messrs. Bergtheil & Young in which the "Bandy" patent electrically-driven punkah is described. The method of driving is somewhat peculiar, but is the result of a careful study of the motion which gives the best results. The continuously running motor is suspended with its axis vertical, and by means of a friction drive gives the punkah a sort of "flick" as it swings past, allowing it to swing free at the end of its travel. An arrangement of springs is adopted which ensures that the friction strip passes alternately on each side of the motor pinion, so that with a constant direction of rotation of the motor impulses are given in both directions. A description of the arrangement was given in ELECTRICAL ENGINEERING, Vol. II., p. 611, in connection with the Engineering and Machinery Exhibition at Olympia. Several forms of punkah are made, suitable for ship, shore, and railway use, a number of which are illustrated.

VULCANISED BITUMEN CABLES.—Messrs. Johnson & Phillips have issued a new list dealing with Paterson's vulcanised bitumen cables. A number of illustrations, showing the cables in the process of laying, are included, and full particulars are given of twin and three-core cables up to 0·5 sq. in. conductors in the taped, braided, and single and double armoured varieties. Among the special cables illustrated is a three-core 2,200-volt cable for colliery work, paper insulated, bitumen sheathed, double-wire armoured and served, and a 6,600-volt concentric distribution cable, insulated with vulcanised bitumen, with the outer conductor arranged for bonding to the rail, as made for the London, Brighton & South Coast Railway.

SIMPLEX CONDUITS.—A new price list in the form of a wall sheet with rollers, formed of actual pieces of conduit tube, is to hand from Simplex Conduits, Ltd. We understand that from the beginning of next month the trade discounts for Simplex conduits will be considerably increased. The company also announce that the 1908 edition of their well-known pocket book has been completely exhausted, but that reprints are to be issued in about a week's time, which they will be glad to supply to any of our readers who may not have already received a copy.

STEAM ENGINES AND MACHINERY.—The latest illustrated catalogue from Messrs. E. S. Hindley & Sons is attractively printed in coloured ink, and contains a large number of well-executed illustrations, most of which are new since the last edition. The details and tables of dimensions are also more complete. A number of types of small horizontal and vertical engines are listed for low and high speeds, both separately and as self-contained sets with boilers. Illustrations are given of the firm's suction gas plant and high-speed vertical gas engine, but fuller particulars of these are contained in a separate list. The boiler section includes a large variety of portable and semi-portable patterns. A few pages are devoted to general machinery, including a series of circular and band saw benches.

Electricity in Medicine.—In a summary of the progress in medical applications of electricity, our contemporary, *Medical Electrology and Radiology*, remarks :—In reviewing the events of the year 1907, we can also look back with satisfaction upon the Exeter meeting of the British Medical Association, where electrotherapeutics made its first appearance with a section of its own, and our readers will be glad to see that the electrical section will meet under the presidency of Dr. Reginald Morton in 1908 at Sheffield. We wish the section all prosperity at that meeting. Another item of interest in the past year has been the opening of a new electrical department at St. Bartholomew's Hospital, to carry on the work of the old one founded in 1887. The new department, with its eight rooms, and its simple though complete equipment, should confirm St. Bartholomew's as the *alma mater* of electrotherapeutics in this country. In X-ray work the passing year has seen some progress, mainly in the general improvement of the average level of work. The new Bèclère break has done much to add to the comfort of workers, for it has swept away the uncomfortable and wasteful shunt resistances, the noises and messes of the old jet breaks, and the disagreeables of the Wehnelt. Thanks to the Bèclère break we can now work as comfortably from supply networks of 200 or 250 volts as we can at 100 volts, and also as economically. We note from the same source that there is to be an electrical section at the annual meeting of the British Medical Association at Sheffield, under the presidency of Dr. E. R. Morton.

Electric Light Failure in Paris.—In Paris an accident to two of the dynamos at the Clichy electricity station, on the evening of the 17th inst., caused some inconvenience to the inhabitants and shopkeepers of the 8th and 17th Arrondissements, who were deprived of the light. A good many of the shops immediately closed, and the people in the houses had to resort to candles. Rumours were spread about that another strike had occurred at the electricity works, but this was unfounded, and it was stated that the repairs would be effected in a few hours. The cafés, &c., had to be lighted, however, throughout the whole evening by candle-light.

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FULHAM ELECTRICITY WORKS

ONE of the principal points of interest in the works from which electric supply to the Fulham district is obtained lies in the fact that it is one of the most successful existing combinations of a generating station and refuse destructor under municipal control. There are features of interest, too, in the electrical history of the undertaking, but it is not our intention here to enter elaborately in the details of the early days of either side of the concern, but rather to give a few notes on the present conditions under which supply is being carried out.

It may be briefly said that it was in 1897 that a Provisional Order was obtained, although it was not till the beginning of 1901 that the combined destructor and generator station was completed. The original plant, consisting of a group of three 300-kw. two-phase alternators, driven by horizontal Musgrave engines, has come in for some criticism from time to time, but for some years took the whole of the load. These alternators were among the earliest machines built by the General Electric Co. from Oerlikon designs in this country. As will be seen below, the extensions added since form excellent examples of the transition stages from the low-speed to the high-speed reciprocating engine, and thence to the steam turbine. The original destructor plant with its boilers still stands, although certain minor alterations have been made in it to improve its efficiency, but of late years an entirely new coal-fired boiler-house has been added. Another feature of the station is the group of Ferranti rectifiers which are still used for the arc lighting supply. An idea of the general arrangement of the plant can be obtained from the plan in Fig. 1. It will be seen that the engine-room, which is still of its original size, adjoins the destructor-house, and that the new boiler-house has been added on the opposite side. The site is, of course, an advantageous one for condensing water and coal transport, owing to its position alongside the River Thames, but until recently a good deal of inconvenience was experienced through the choking up of the water intakes by sand and river mud. With the perfection of the arrangements for periodically reversing the direction of flow in the pipes, and provision for thoroughly flushing them, this trouble has practically disappeared. A pair of 24-in. pipes are run out into the middle of the river, and a large sump is provided in the quay wall. This can be filled at high tide, and the whole of its contents allowed to pour out through one or other of the river pipes at low tide, so that a powerful flush is obtained. Electrically-driven centrifugal pumps take the water to an overhead tank, from which it passes to the condensing plant. This tank is on the roof of the pump-room, which contains the three original pumps driven by continuous-current motors, and two pumps added later when the new generating plant was installed. One of these is driven by a continuous-current motor, and the other by a two-phase induction motor. Boiler feed water is obtained by a Potter direct-acting steam deep-well pump from an artesian well 500 ft. deep. An electrically-driven pump was formerly used for this purpose. It may be remarked here that, with the exception of this pump and the steam-driven boiler feed pumps, the auxiliary machinery is almost entirely electrically driven. In the case of some of the older plant the continuous-current motors taking current from the exciter bus-bars are retained, but all auxiliary plant put in at all recently is driven by two-phase motors.

A general view of the engine-room, which is 110 ft. by 42 ft., is given in Fig. 2. The plant therein forms a remarkable object-lesson as to the diminution in floor space required by the more modern forms of generating plant. In the foreground are the old 300-kw. Musgrave G.E.C. sets, running at 93 r.p.m., already referred to. Only two out of the original three sets are now standing, as the site of one, or rather part of it, is occupied by the 1,000-kw. Belliss G.E.C. set. This latter set forms the latest plant to be actually erected in the engine-room, although we understand that the order for the turbine set was given afterwards. The alternator, like the old machines, was manufactured by the General Electric Co., and is designed for an output of 167 amperes at 2,900/3,100 volts 50 cycles two-phase, at a speed of 250 r.p.m. The smaller Belliss engine seen behind this set was an earlier addition to the plant, and drives a 600-kw. Dick Kerr alternator running at the same speed.

The most interesting set, however, is that placed in the extreme corner, and occupying by far the smallest floor space. It consists of a vertical shaft Curtis turbine, driving a revolving field alternator of the British Thomson-Houston Co.'s manufacture, with a normal output of 750 kw. at 1,500 r.p.m., and, of course, the same voltage and frequency as the other

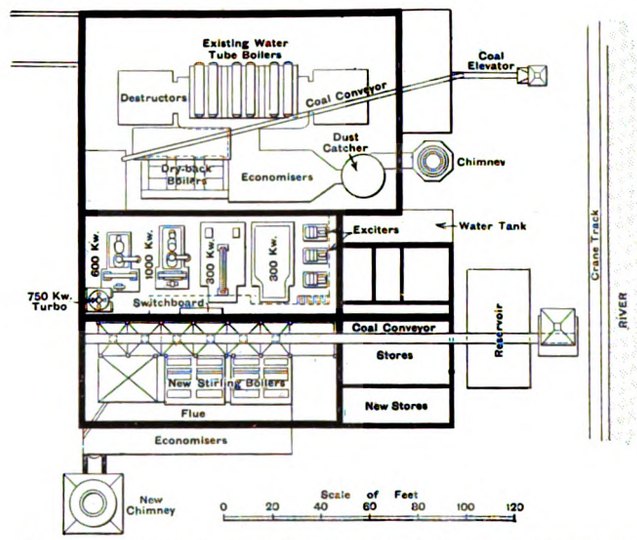


FIG. 1.—GENERAL PLAN OF GENERATING STATION AND DESTRUCTOR WORKS.

sets; the set has a considerable overload capacity, and has given as much as 1,250 kw. for two hours. A separate view of this unit is given in Fig. 3, and it should be pointed out that it was the first Curtis turbine to be actually manufactured in this country. In these days, when so much speculation is rife as to the possibilities of aerial propulsion, it is amusing to read the following inscription upon a licence plate affixed to the machine. "Sold to be used for any purpose except marine or aerial propulsion." The form of the governor-gear is slightly different from that in the more recent Curtis machines, but the general principle of opening and closing a varying number of the 7 or 8 nozzles electromagnetically by means of a commutator actuated by a centrifugal governor is the same. We are not inclined to enter here into comparisons between this and other types of turbine, but with regard to durability there would appear to be much to be said in favour of the very substantial blading employed, which is machined out of the solid, and as to steam consumption the following figures should speak for themselves:—

Steam consumptions of 750 kw. Curtis turbo-generator, as determined at maker's works, and subsequently verified on site, in lbs. per kw. for dry steam:—

Load—	¼.	½.	¾.	Full	50% overload.
Consumption guaranteed with 5 per cent. margin..	25·6	23·4	22·1	21·4	21·8
Consumption obtained from tests	23·35	21·2	19·85	19·35	20·75

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With superheated steam at 187°F. on a short test at three-quarter load, the result worked out at 16·5 lb. per kw. hour, which, for the size of the set, is very satisfactory.

The pressure-pumps for the footstep bearing are placed in the basement below. These are in duplicate, and each set consists of a small three-throw pump, gear-driven by a continuous-current motor. The condensing plant for this and the Belliss sets is also in the basement, but does not call for any special remark. Three-throw air-pumps of the Edwards & Worthington types are used, all driven by two-phase motors. The condensing plant of the old Musgrave sets was of the ejector type.

None of the sets have direct-coupled exciters, but excitation for all of them is obtained from the three original exciter sets at the end of the engine-room. These consist of four-pole G.E.C. dynamos, each for an output of 600 amperes at 100 to 110 volts, coupled directly to, and driven by, vertical Musgrave engines, running at 460 r.p.m. A historical interest attaches to these sets also, as the engines are among the first of the vertical high-speed type to be constructed by Messrs. Musgrave. It might well be wondered that, with the extensions which have increased the capacity of the station to about three times its original amount, it has not been found necessary to increase the number of these machines, but it should be pointed out that not only were the exciter sets put down of a size sufficient to run a considerable amount of continuous-current auxiliary plant, the place of much of which has been taken by two-phase motors, but also the original 300-kw. sets, which are not now of sufficient size to take the day load singly, are very rarely run. The excitation taken by the new plant, in spite of its greater output, is also considerably less than that required for the original sets. Thus the 300 kw. Oerlikon-G.E.C. machines required 300 amperes each, while the 1,000-kw. set driven by the larger Belliss engine requires 80 amperes, and the 750-kw. turbo-generator only 50 amperes.

The question of further extensions to the generating plant is under consideration, and to make room for this, it is proposed to remove another of the original sets.

Mention was made of the Ferranti rectifiers, by which the arc lighting is carried on; these are now eight in number, and are placed together with the arc lighting switchboard in a separate room adjoining the engine-room. We understand that, on the whole, they work well, but require a good deal of attention.

The main switchboard is on a gallery along one side of the engine-room. The original board was of the familiar Ferranti cellular construction. This is now used almost entirely as a feeder board. The only generator circuit which remains on it is that of one of the slow-speed alternators, which is intended to be removed. To the left of this board is an exciter switchboard, made by the General Electric Co., provided with machine switches and circuit-breakers, and with the exciter bus-bars mounted on the front. The circuits of the continuous-current auxiliaries are taken from this board. The new generating sets and one of the old 300-kw. sets are accommodated on a new board of Westinghouse manufacture on the right-hand side of the Ferranti feeder board. This is provided with oil circuit breakers placed behind the panels, worked by projecting levers, and fitted with time-limit overhead and reverse current releasing relays. The synchronising gear, which includes a Westinghouse rotary synchroscope, is carried on a bracket at the right-hand end of the board. The part of the gallery opposite this board has been fitted with a glass floor.

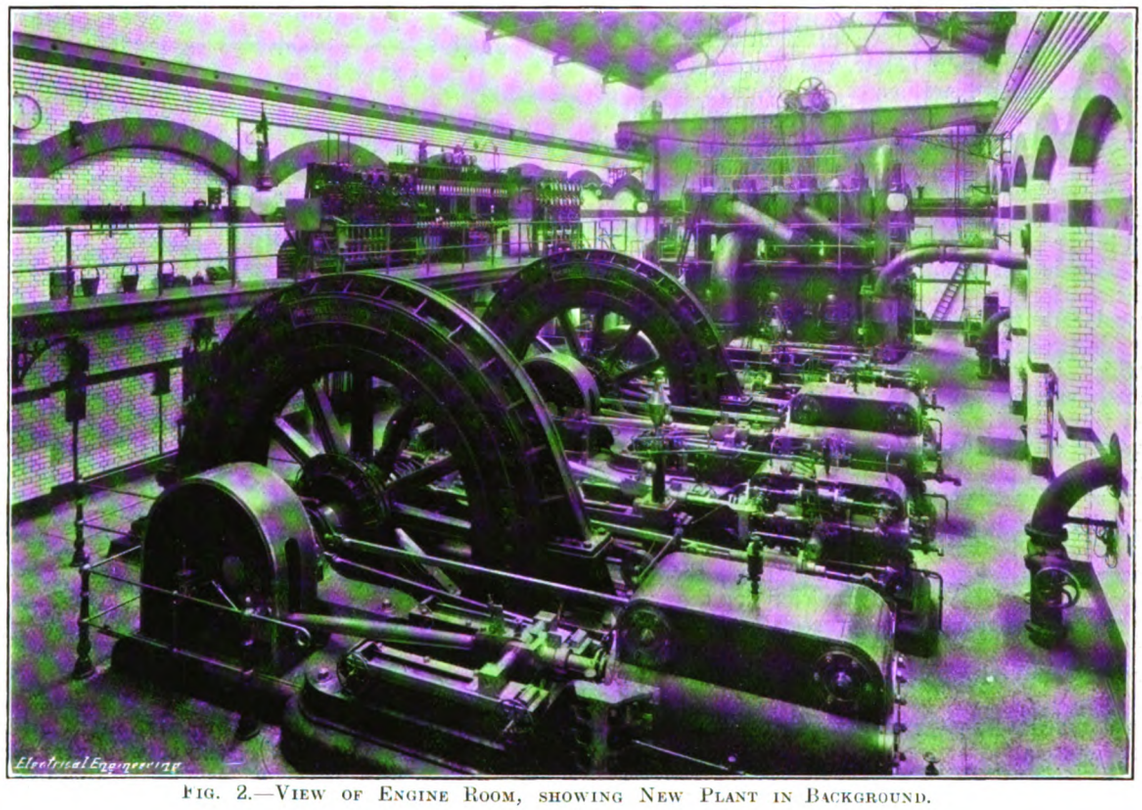


FIG. 2.—VIEW OF ENGINE ROOM, SHOWING NEW PLANT IN BACKGROUND.

Adjoining the engine-room is a small repair shop, equipped with a few machine tools. The equipment of this is to be added to in the near future, and some new lathes and radial drills are to be installed.

The new boiler-house contains a set of four Stirling water-tube boilers, each with an evaporative capacity of 14,000 lb. per hour, and fitted with internal superheaters. It should be remarked that what reaches the engines is really, so to speak, a mixture of superheated and saturated steam, as neither the destructor boilers nor the coal-fired boilers in the old boiler-house are provided with superheaters. Nevertheless, a resultant

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superheat of almost 100° F. is obtained. Since the construction of the new boiler-house, the original dry back coal-fired boilers in the oil-boiler house are very seldom used, except at times when one or more of the new boilers are laid up for inspection or alteration. When first installed, half the boilers were mechanically stoked, and the remainder hand-fired, but the success of mechanical stokers which are of the "underfeed" type has led to all being similarly equipped. The last boiler is now in process of having the stoking apparatus fitted. The type of stoker being put in varies a little from earlier patterns in the other boilers in having more relative movement between adjacent fire-bars and large air-channels through the bars. Two Green's economisers are installed, and a pair of Andrew & Cameron direct-action, vertical steam feed-pumps are provided. Forced draught is obtained by means of a couple of motor-driven fans. A CO_2 recorder of the "Sarco" type, supplied by Messrs. Sanders, Rehders & Co., is in continuous use in connection with the new boiler plant.

The destructor was constructed by the Horsfall

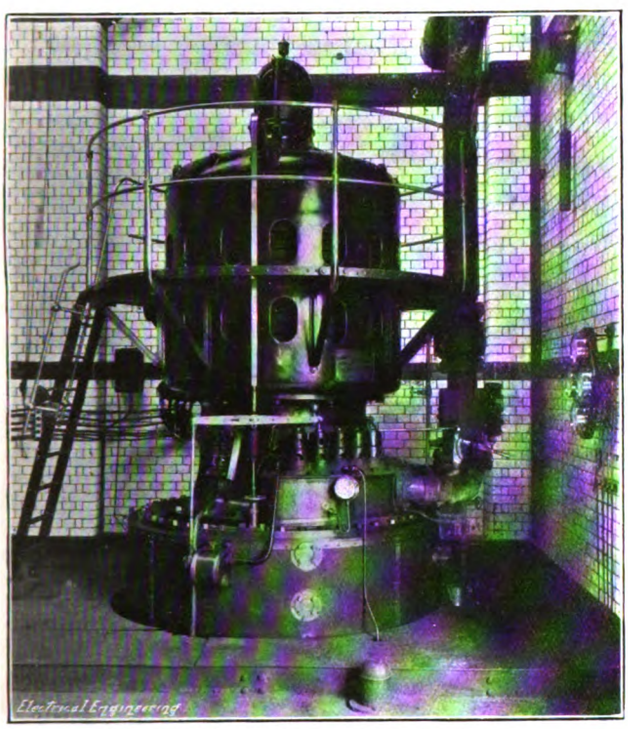


FIG. 3.—750-KW. CURTIS TURBO-GENERATOR.

Destructor Co., and consists of twelve destructor cells of the usual top-feed type, with a grate area of 30 ft. each, arranged six at either end in two rows, back to back, and a row of six Babcock & Wilcox boilers in the centre, heated by the gases from the destructor cells. A Green's economiser is provided in the flue leading to the chimney, and also a circular dust catcher. It is found that the calorific value of the rubbish to be dealt with varies as much as 10 to 15 per cent., but the 12 cells can under all circumstances deal with more than the contract quantity of 120 tons per day.

A very careful watch is being kept over the performance of the destructor, and we understand that very satisfactory results from the point of view of evaporations per ton of refuse are being obtained. The tests are not yet quite complete, so that at present we are unable to publish any figures.

Referring to the plant in its present condition, some alterations in the arrangement of the flues have been made since the plant was first installed, with the object of shortening the passage of the hot gases from the cells to the boilers, and reducing the number of right-angled corners round which they had to flow. The gases now come direct into the boiler furnaces from the side without passing underneath as formerly. Another alteration was the removal of all provision for burning even the smallest quantity of coal under the destructor boilers. The good combustion obtained is shown not only by the high evaporative efficiency but also by the excellent quality of the clinker produced. The treatment of the clinker is a special feature of the undertaking; it is raked from the cells direct into skips suspended from an overhead run-way. Adjoining the destructor-house is a works in which a good quality of clinker brick and paving-slab is made. Although originally under separate control, the department has been, since March 31st last, under the management of Mr. A. J. Fuller, the chief electrical engineer.

Of the steam produced in the destructor boilers, about 50 per cent. is passed into the steam pipes of the electrical generating plant, and the remainder utilised for the auxiliaries of the destructor itself, the clinker and brick making-plant plant and the adjoining municipal disinfector plant. During the earlier years of the undertaking the accounts were so arranged that the amount paid by the electricity department to the destructor department for the steam used was simply the loss on the destructor department's working, which in the year ending March 31st, 1906 (the last financial year during which this arrangement was in operation), amounted to £869, representing 5·8d. per ton of refuse destroyed out of a total destructor cost of 41·1d. per ton destroyed. During the succeeding year, however, a more rational method of charging has been adopted, based on the true value of the refuse. It was at first proposed to charge for steam the equivalent value of 4·5 lb. of coal per unit at the market price of coal during the year, but this figure was afterwards altered to 5·4 lb. per unit, corresponding to an average price of coal at 10s. 6d. per ton. During the first year of the working of this arrangement the figure was £910 or 6·2d. per ton of refuse destroyed. A feed water meter is used to determine the total steam output of the destructor plant.

The following particulars of the working of the destructor during the year ended March 31st, 1907, may be of interest:—

	Tons
Quantity of refuse destroyed	35,222
Largest quantity destroyed in one day	179
Smallest quantity destroyed in one day	48
Average quantity destroyed daily	96
Bye products:—	
Clinker, fine ash, and flue dust	10,340
Tins and scrap iron...	305
Total ...	10,645

The expenditure during the same year is given below:—

	Amount. £.	Per ton of refuse destroyed d.
Oil, waste, water and stores	143	1·9
Electricity for lighting	117	0·8
Wages for workmen	2,406	16·4
Rates, taxes, and insurance	261	1·8
Repairs and maintenance...	197	1·3
Clinker disposal, wages, and stores	(746) (143)	6·1
Management	296	2·0
	4,309	29·4
Interest on loans	663	4·5
Sinking fund	1,424	9·7
Total expenditure ...	6,396	43·6

During the same year the generating works costs of the electricity department averaged 0·8d. per unit, giving with management and other charges 1·123d., and with the inclusion of all capital charges 2·258d. per

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unit sold. The total units sold amounted to 2,523,417, and the maximum demand was 1502 kw., with a lamp connection of 110,723. There is a power load at Fulham represented by 1,167 h.p. of motors, and it is interesting to see the proportion in which this is divided among different trades.

Wood working, 247¾; lifts, 80; engineering work, 358½; brick making, 40; stone working, 25; cranes, 96; printing machinery, 5; meat mincing, 31¾; fans, 30; laundry work, 77½; dough mixing, 45½; tobacco cutting, 1; sugar refining, 30; chaff cutting, 15; boot burnishing, 16¾; hair brushing, 1½; coffee roasting, 2; electro plating, 1; private, 3¾; bookbinding, 30½; chocolate making, 9½; potato cutter, 1; polishing paste, 2; lamp making, 3½; bottle washing, 12½.

Fulham was, we believe, the first London district where the price of 1d. per unit for power was introduced, and now the average price received per unit is, with one exception, the lowest in London.

In conclusion, we should express our thanks to Mr. A. J. Fuller, borough consulting and electrical engineer, under whose specifications the extensions referred to have been carried out, for the facilities for the preparation of this article.

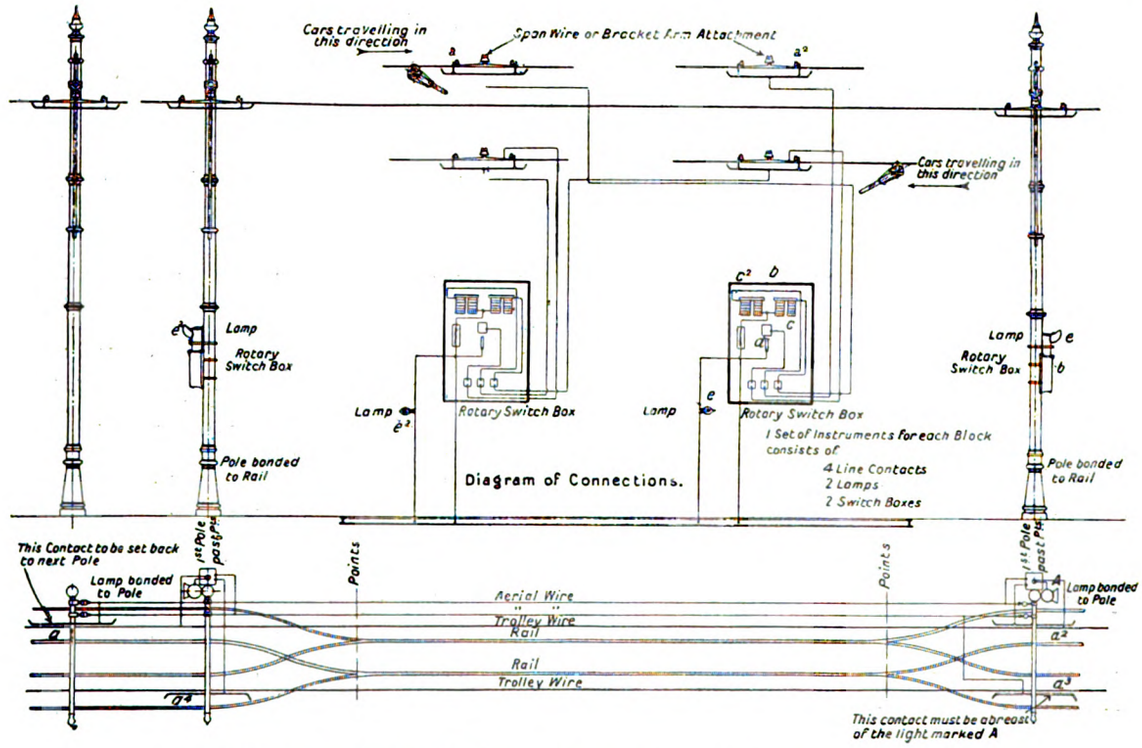
AUTOMATIC SIGNAL FOR TRAMWAYS

Burton and Ashby Light Railway

A METHOD of automatic signalling which has been applied on the Burton and Ashby Light Railway, belonging to the Midland Railway Company, is described in the *Railway Times*. The method allows for cars to follow each other through a section, but no opposing car may enter until all those from the opposite direction have arrived and passed off the single line section. For each section there are employed four overhead line contacts, two sets of lamps, and two switchboxes. Each road has an ingoing and an outgoing contact, which is attached to the trolley wire. The trolley wire is not broken, but goes straight through, and when the trolley head passes the contact the latter is pushed aside so that an electrical circuit between the trolley wire and the contact is closed. The general arrangement is indicated in the accompanying figure.

A car travelling from left to right first makes contact with a, which causes current to flow from the car into the rotary switch-box b, causing magnet c to be energised, so that the rotary switch d revolves one step forward and thereby switches in the light e. Should a second car enter the section before the first had left, the rotary switch is moved another step forward. When the first car leaves the section it makes contact with a_2, so that the magnet c_2 is energised, and this revolves the rotary switch d one step backwards. Were it the only car, the switch would have only moved one step, so that this backward movement would have put out the light e. If, however, there is a car still in the section, the light would remain burning until the rotary switch had been stepped back to normal. For a car entering from the other end, contact would be made at a_3, and broken at a_1, and the light e_2 would govern the movements One of the pair of ingoing contacts has to be 40 yards length back from the lamp, so that it may light the lamp at the other end before a car can enter from the opposing end, also that of two cars entering simultaneously one shall have a greater advantage of securing the road.

The lanterns may have a single light or may be provided with two or three lights, where it is considered necessary to advise a driver as to how many opposing cars are in the section. The lamps are shaded by a hood. The ingoing contacts are staggered, so that there is no possibility, in the event of two cars passing under them simultaneously, of their both entering the block section, as the driver coming from the end at which the contact is farthest from the points would see the danger light before he got to them.



ARRANGEMENT OF AUTOMATIC SIGNALLING ON BURTON AND ASHBY LIGHT RAILWAY.

Construction of Highgate Tramways.—In the King's Bench Division of the High Court on Friday, Mr. Justice Channell had before him the case of W. Griffiths & Co., against the Middlesex County Council. Mr. Salter, for the plaintiffs, said there was a contract between parties for the construction of an electric tramway, starting from Highgate and running north. The contract provided that the contractors were to commence the work when instructed by the defendants, and they were bound to finish in six months. When plaintiffs did commence the work it was found that all the usual arrangements and adjustments had not been made, and, in consequence, a series of delays began, with the result that instead of starting on February 11th, 1903, the plaintiffs were obliged to wait until August. Consequently the entire work was thus disorganised and altered, and instead of it being a summer job, it was turned into a summer and winter job, causing a loss to the contractors, the plaintiffs, of something like £10,000. Plaintiffs brought their action, alleging, in substance, that there was in a contract of that kind a duty on the part of the employers, the defendants, of co-operation to facilitate the work in reason. That was the duty plaintiffs alleged defendants had not carried out, and they had sustained damage in consequence. The defendants alleged that there was no such implied term in the contract. The case was continued on Saturday, and, after hearing arguments, his lordship reserved judgment.

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THE ELECTRICAL EQUIPMENT OF A MODERN ENGINEERING WORKS

A FINE example of a modern engineering works, throughout the whole of which electric motive power is employed, is to be found at the Dartford iron-works of Messrs. J. E. Hall & Co. These works, which were formerly driven by steam and gas power, transmitted by means of shafting and belting, in the various departments, were converted to electrical driving in 1901. The change over was carried out entirely by Messrs. Hall & Co.'s own electrical staff, and was accomplished without interfering in any way with the works. No inconvenience or delay was caused, and no portion of the works had to be shut down for this purpose. Motors were installed in all the departments, the power required having been previously carefully calculated, and each department was at the same time furnished with two distribution boards, one for power, and one for lighting, the lighting circuits being in all cases entirely separated from the power supply. Since the conversion took place, many additions and extensions have been effected, and ample provision for the application of the electric power has been afforded in all the different departments.

The plant in the power-house is excellently adapted for the driving of these works. In the boiler-room are two, 28 ft. by 7 ft. Lancashire boilers, with twin furnaces, which are hand-fired. Each boiler is provided with dead-weight safety-valves, and high and low water alarms, and the usual fittings. The superheaters are of the Bolton vertical tubular form, by Easton & Co., and these are placed in the flues at the end of the boilers. The feed water supply is passed through a caustic soda softener plant before entering the boilers, and the condensed water is passed through a Harris-Anderson oil-separator plant. The water is then passed through a Carter economiser, and thence into the boilers.

The plant in the engine-room consists of two three-cylinder compound high-speed sets (Fig. 1) by Messrs. Willans & Robinson, each for 350 b.h.p., running at 350 r.p.m. These are direct-coupled to two of the Electrical Construction Co.'s compound-wound generators, each rated at 220 kw., giving an output of 1,800 amperes at 120 volts. The engines work at a steam-pressure of 150 lb. per square inch, with superheated steam to 500° F., and have a steam consumption with saturated steam of 21 lb. per kw., and with superheated steam of 17 lb. per kw. The combined efficiency of these sets at full load is about 87 per cent., and the sets are capable of dealing with an overload of 25 per cent. for one hour. The exhaust steam from these engines is passed through a surface condenser, into which the exhaust steam from the auxiliary plant is also taken. There is also a 60-kw. direct-coupled motor-generator set by the E.C. Co. (Fig. 2), which obtains its motive power from the Dartford Council's supply station. The supply side is taken directly off the traction feeders of that supply at 550 volts, and the motor is shunt-wound, with auxiliary commutating poles, and works without sparking on variable voltages and fluctuations of load. This set is used when the works plant is shut down, principally through the night. The generator is compound-wound, with auxiliary poles, is arranged for 120 volts, and is capable of sustaining sudden over-loads without sparking or overheating. The set runs at 600 r.p.m. This set can also be employed to supply power to the Council mains when required, the only alterations necessary being the cutting out of the compound winding on

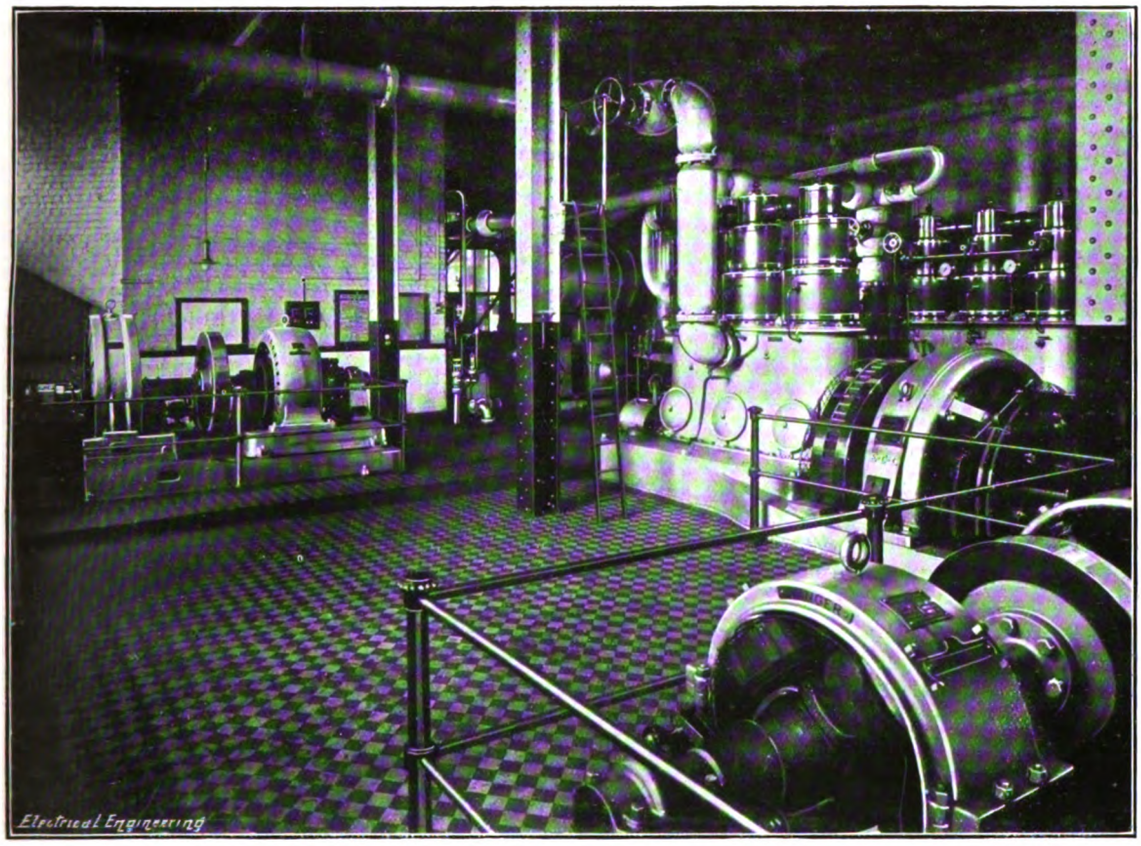


FIG. 1.—ENGINE ROOM, SHOWING GENERATING SETS.

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the generator side, for which due provision has been made.

A 21-kw. motor-generator set similar to the above in construction is also provided. The motor side was manufactured by the E.C. Co., and the generator by the Brush Engineering Co.; this machine was assembled and the combination effected by the works electrical engineer, and is used for light loads, so as to economise on the larger sets.

As a great amount of current is required in the works for the electric welders, an extensive plant has been installed for that purpose, and consists of a 52-kw. direct to alternating-current motor-generator (see Fig. 2), running at 750 r.p.m. The direct-current side consists of an 80-b.h.p., shunt-wound, six-pole motor, by the International Electric Co., and is coupled direct to a 52-k.v.a. (E.C. Co.'s) single-phase alternator, with an output of 150 amperes at 350 volts at 50 periods. The combined full-load efficiency of the sets is about 84 per cent. These units were also assembled on the premises, having been formerly separate units. A heavy fly-wheel is interposed between the two machines on the armature shafts, as the set has to deal with very sudden loads. This fly-wheel has the effect of ensuring excellent regulation. There are also two direct-current to alternating-current motor-generator sets, each of 35-kw. capacity, running at 1,500 r.p.m., the direct-current motors being 50 h.p. shunt-wound by Scott and Mountain, coupled to 35-k.v.a. single-phase alternators by the British Thomson-Houston Co. These sets are each used in turn with the aforementioned 52-kw. set, and are arranged to run in parallel, and, when this is done, very large welding operations can be carried out. The efficiency of these sets is 80 per cent. on full load.

The main switchboard, which is shown in Fig. 3, is situated on a gallery about eight feet above the engine-room floor, and overlooks the whole of the running plant, so that the attendant has complete surveillance over the generators. It is mounted on channel and angle iron frame work, and is practically fireproof, as no inflammable material enters into its construction. The conductors from the generators, and also to the power and lighting circuits, are of bare copper rods, mounted and secured in porcelain insulators, bolted to channel and angle iron supports. All the positive conductors are enamelled red, and the negative black. The alternating circuits are distinguished by blue and white enamel, so that any conductor can be identified without difficulty. All positive feeders are run overhead, and the negatives behind the board, so that the chance of short circuits occurring is very remote. The various field regulating and starting resistances have been manufactured on the premises and are fireproof, mounted beneath the steel plates which form the floor of the gallery. No soldered joints enter into their construction. They are operated by pedestal hand-wheels on the gallery, and are connected by means of chain-gear and sprocket-wheels. The controllers for the high-voltage motor-generators are connected by worm-gear, and fitted with an interlocking switch-gear, which makes it impossible to close the main d.p. switches, unless the starting rheostats are in the "off" position. All motor and generator circuits are provided with d.p. cut-outs and circuit-breakers, on their positive poles, and their negative pole is "earthed," to enable the various cranes to have the advantage of an earth return; this also provides for a three-ton Jessop & Appleby locomotive crane, which runs through the various yards. The synchronising gear consists of a rotary indicator and two step-down transformers for paralleling the welding alternators, all arranged so that it is almost impossible for a mistake to be made, and if the rotary synchroniser should fail, a synchronising lamp is available. The motor fields are controlled from variable resistances, wound and stepped to suit the peculiar field characteristics of each machine, to enable fine adjustments to be made, the exchange between the machines being very small on all loads. The switchboard consists of sixteen panels of slate, each being 6 ft. by 2 ft., mounted on channel steel frames, securely bolted to the gallery, and special girders built into the walls for this purpose. The total length of the board is 33 ft., with ample space both at the front and back, giving ready access to all cables, switches, and instruments. The panels are disposed as follows:—Nos. 1 and 2 are for lighting feeders only, and are provided with two moving coil ampere-meters for the output, and also a total output ampere-meter, a d.p. emergency main fuse, and switch fitted with duplex fuses, so that no delay occurs in replacing fuses, it being only necessary to throw over the switch should one blow.

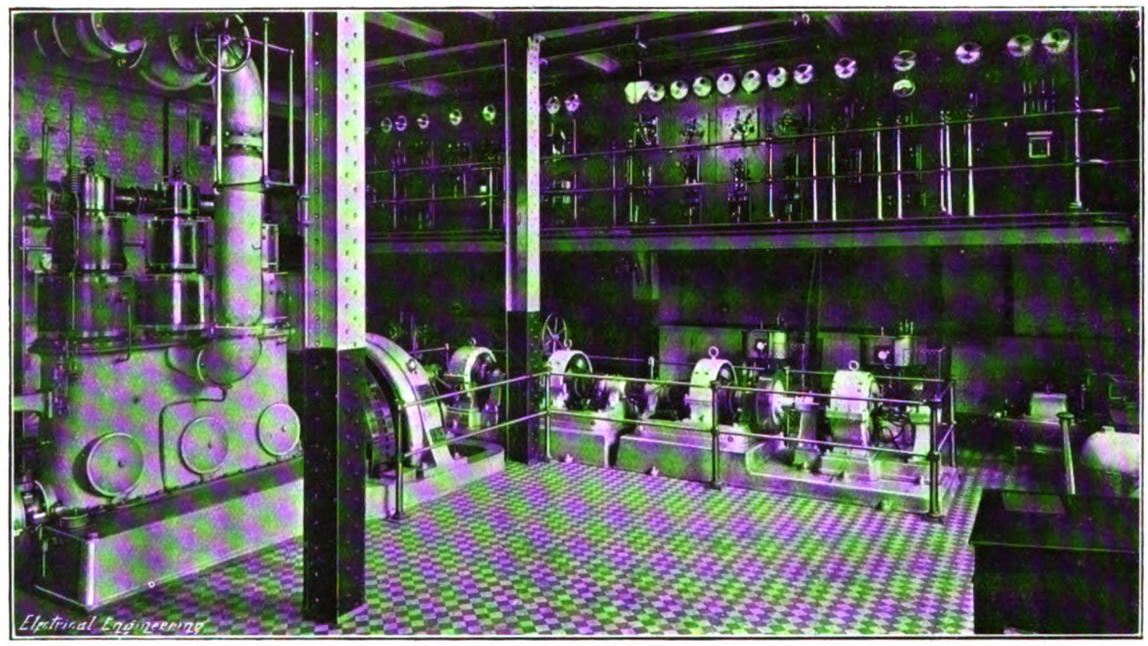


FIG. 2.—ENGINE ROOM, SWITCHBOARD, AND MOTOR GENERATORS.

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Nos. 3, 4, and 5 panels are power panels, supplying the feeders to all the different departments, and are fitted with d.p. quick-break switches, cut-outs, and ammeters, similar to those on the lighting panels. They have integrating and recording wattmeters for measuring the total output of the station. From these panels current is also supplied for the testing of the engines in the automobile shops, and a meter is provided on which debit and credit readings can be taken, as the generator in the automobile department is arranged to run as a shunt-motor when required. Nos. 6 and 7 panels are 220-volt generator panels, and are equipped with 9-in. ampere and voltmeters, and auto-reverse cut-outs with polarised coils, making reversals beyond 10 per cent. impossible, a d.p. main switch, two single-pole 2,000-ampere cut-outs, and a single-pole equalising switch, an equalising bus-bar being provided, to which all the generators are connected. Field regulating pedestals are placed in front of each panel. No. 8 panel is a spare, and No. 9 panel is for the low-tension side from the Dartford supply, and is provided similarly to Nos. 6 and 7 panels, and has in addition a horizontal edgewise double-scale voltmeter for paralleling purposes. Panels 11 and 12 are arranged for starting the 120-volt motor sides of the 52 and 35 kw. electric welding sets, each panel being provided with a moving coil amperemeter, voltmeter, starting-controllers with renewable contacts, double-pole main switches and cut-outs, and maximum load cut-outs on the positive poles, and each panel also has a motor and generator field controller for the parallel running. Panels 13, 14, and 15 are all alternator panels for electric welding work, and each is equipped with maximum alternating circuit-breaker, soft-iron ammeter, a three-way voltmeter, synchronising, and double-pole switches, double-pole field-switches, main, and feeder switches, and a double-scale hot-wire voltmeter for observing the voltage of the incoming machine. No. 16 panel contains the starting-controllers for the 550-volt side from the Dartford supply for both motor-generators, and has double-pole main switches, with interlocking gear, s.p. cut-outs, and worm-gear starters. A Thompson wattmeter is arranged to check the readings of the supply meter. This board has been fitted up by the electrical staff for the particular requirements of the works. The motors employed in the works are all of the direct-current type, and vary in size from ½ h.p. to 25 h.p. The various departments are arranged into the sections most suitable for the purposes for which they are employed. Raw hide pinions are largely used for the gearing of the motors. In the automobile engine manufacturing shops the motors are disposed overhead, thus economising space, and each motor drives a section of the shafting driving the lathes, except in the case of some of the heavier tools, when the motor is geared direct on to the machine. The switchboards for controlling these motors, and also for the lighting of the works, are built on iron galleries some 12 ft. above the floor, thus economising the space. The total number of motors installed throughout the works is 130, and these in many cases work on full-load throughout the whole day. Foolproof starting-switches are provided, to prevent accidents. All the travelling-cranes are electrically equipped, and a three-motor 10-ton crane installed some four years ago has, it is claimed, greatly increased the output, owing to its rapid and flexible manipulation. The testing of the completed petrol engines is conducted without waste of power, as the generator employed is placed in parallel with the mains, and its power is used to assist the general power plant. The electric welding is carried out on the "Thompson" welder, the primary voltage being 350, stepped down to about 4 volts. The controlling of the current is

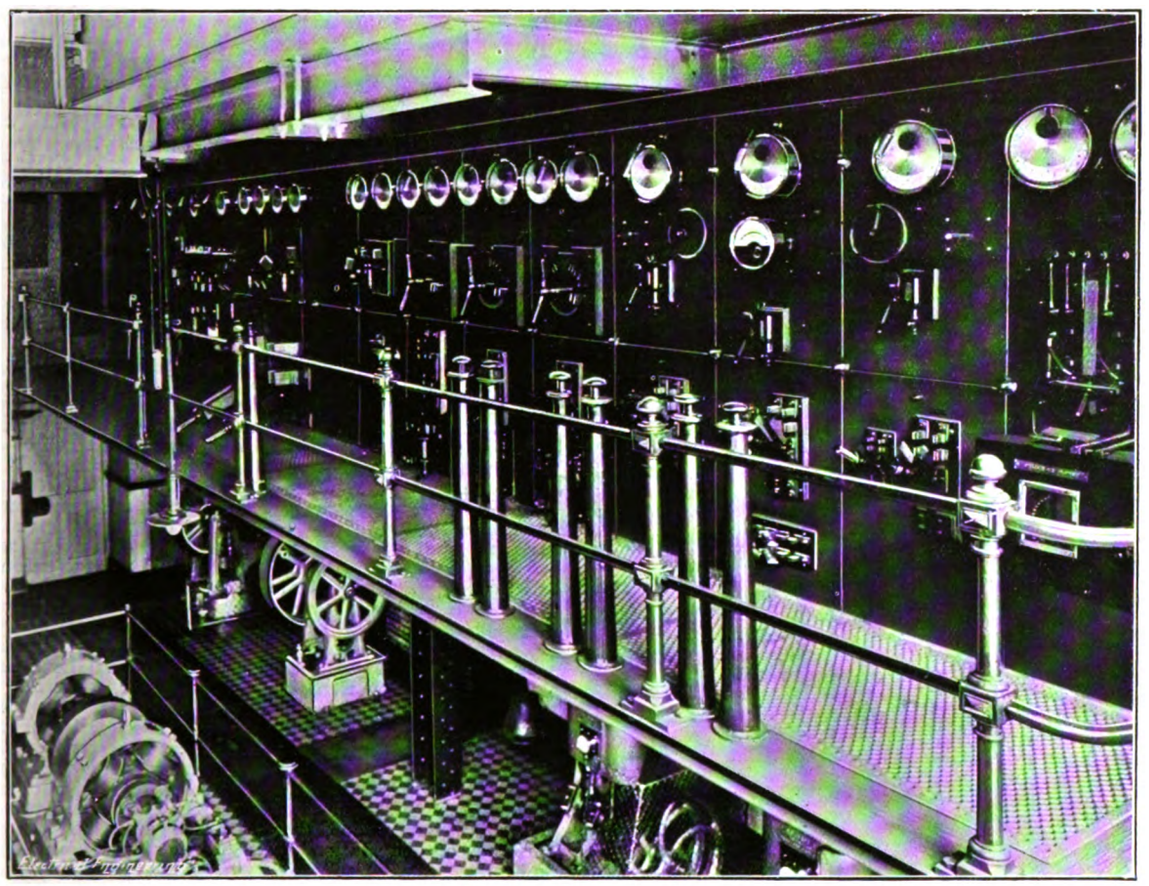


FIG. 3.—SWITCHBOARD.

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carried out by auto-transformers placed in the primary circuit, and controlled by worm-gear. The welding-machines are designed for carrying heavy currents, and are water-cooled throughout. The current used is single-phase alternating as mentioned previously, and is conveyed from the switchboard on 19/16 cables, which pass through an automatic switch, and render it impossible to switch on the current unless the controller is in the off position. The power required to make sound welds on iron and steel piping, &c., varies a good deal, but the average is about 35 k.v.a. per weld. All the machines, controllers, &c., are carefully earthed to ensure the safety of the operators. We are indebted to Messrs. J. & E. Hall & Co., and also to their electrical engineer, Mr. B. Smith, for the facilities and information given us for the compilation of this article.

BRITISH ENGINEERING TRADE WITH CANADA

IN September, 1906, Mr. Richard Grigg, a Special Commissioner of the Advisory Committee to the Board of Trade on Commercial Intelligence, commenced the task of an exhaustive investigation into our trade with Canada. His work was completed in May, 1907, and he has now presented a report upon the conditions and prospects of British trade in the Dominion. The document contains some passages specifically relating to the electrical industry, but inasmuch as his conclusions and advice are not intended to apply to any one particular industry, we give a general *resumé* of what he has to say.

Among all classes in Canada, he says, there undoubtedly exists a strong desire to buy goods from British sources whenever possible, and this desire is reflected in the tariff preference on British goods. The fact that his Majesty's Board of Trade had instituted an inquiry, and had decided to appoint correspondents to furnish regular information to its Commercial Intelligence Branch, has been received with marked approval as indicating a desire on the part of the Home Government to promote closer commercial relations with Canada. In a general review of the natural and industrial conditions prevailing, the report contains the following under the heading "Electric Power":—

"The development of electric energy from water-power and its transmission is a matter of the utmost importance in Canada, both because coal for steam-raising is dear (about $4 per ton in Ontario), and because of the very numerous waterfalls which are available for the production of power. Chief among these is Niagara Falls, where works now approaching completion on the Canadian side will have an ultimate capacity of 400,000 h.p. On the American side about 300,000 h.p. is being generated and successfully used, largely at Buffalo, a manufacturing city distant about 25 miles; but transmission wires (60,000 volts) have been carried 163 miles to Syracuse, and current is being delivered there. In Canada current is being delivered from Niagara to Toronto (81 miles distant) for both power and light, and it is proposed to run transmission lines from Niagara to London (Ont.), a distance of 119 miles, supplying a number of towns on the route.

"The manufacturing city of Hamilton is using about 20,000 h.p., generated 35 miles away, carried at 40,000 volts, and reduced to 2,500 volts, with a somewhat complicated scale of charges, but said to work out at $22.50 per annum h.p. in the case of a factory using 150 h.p. 10 hours per day for 300 days. The official report of the Ontario Power Commission (appointed by the Ontario Government) estimates the actual cost of production at Niagara at $4.95 per h.p. on the basis of a production of 100,000 h.p., and the cost of delivery to the municipal switchboard at Brantford, 69 miles away, at $11.37 per h.p. Immense reserves of water power exist at other points in Ontario (estimated at 1,000,000 h.p. within 50 miles of Ottawa), in Quebec, and, indeed, in all the provinces. It will be seen that such conditions have an important bearing on the problem of future industrial production. The Census of Production shows the amount of capital invested under the heading of electric light and power as $11,891,025 in 1900 and $80,393,445 in 1905. A large proportion of the increase is represented by the expenditure on the three electric light plants referred to at Niagara Falls, but the value of the production under this heading is shown as $2,038,017 in 1900 and $7,587,899 in 1905, and it should be remembered that neither of the Niagara Falls works had begun to supply power in the latter year."

The general characteristics of the Canadian market are that, as a whole, it reproduces to a very large extent the main features presented by the United States, both in regard to its industries and the habits and life of the people. At the same time, it is pointed out, there is not the slightest doubt that the desire of the Canadian people is towards trade with the United Kingdom, both for reasons of sentiment and also because of a belief in a real community of commercial and trade interests. The present preferential treatment of British goods varies from 2½ per cent. to 15 per cent. *ad valorem*, the rebate on many of the articles being 10 per cent. *ad valorem*. This tariff came permanently into force in March, 1907, in place of the previous general preference of 33⅓ per cent. So far, the electrical industry has not made any serious inroad into the trade to be obtained in Canada. Taking the import figures for 1906, it is seen that in the supply of electrical apparatus the United States was unchallenged. They imported to the value of $5,461,000, whilst only $81,500 is shown under this heading from Great Britain, although, no doubt, some electrical machinery has found its way into the country under the heading of "Machines and Machinery," in which again, however, American supremacy is especially marked. The geographical position of the United States is largely responsible for the circumstance that in the engineering industry in general, and the electrical engineering industry in particular, British trade has either been entirely defeated or retains only a small and relatively insignificant share of the market. But in the view of Mr. Grigg, having regard to the natural preference for British goods even at higher prices, British manufacturers can do much to counterbalance this disadvantage, such, for instance, as the maintenance of larger stocks of their goods in Canada, and a better appreciation of the conditions to be met there than appears to be the case generally at present. The report condemns the British custom of depending upon merchants and agents to get at the consumer, and also the absence of specialisation for the market. In but very rare cases, it is pointed out, does the British manufacturer adapt his goods to Canadian requirements, the very antithesis of the methods adopted by American and even German importers. In many smaller details, the report gives the impression that British firms have treated the Canadian market with a certain amount of indifference. Methods of packing need improvement, prices should be quoted c.i.f. and not f.o.b., and better terms of credit should be granted. Finally, there is the very important matter of currency and weights and measures. Over and over again it was impressed upon Mr. Grigg that British traders should adopt Canadian weights and measures, and quote in dollars and cents.

In his conclusions, the Commissioner admits that the geographical position of the United States makes it inevitable that a proportion of Canadian trade should fall to that country. Further, he points out that the Canadian home manufacturer is now becoming a serious competitor alike with the United Kingdom and the United States. Consequently, between Canada on the one hand and the United States on the other, it is self-evident that only the most strenuous and persistent efforts can maintain, to say nothing of extend, British trade with the Dominion. It is suggested that British manufacturers should consider the placing of branch factories there, a course which would not only gratify Canadians, but would give manufacturers a more intimate acquaintance with the market, and enable them to maintain stocks more easily. This suggestion is made to counteract the advantage which American firms have obtained by importing partly finished materials from home works and completing the work upon them in Canada. Quite apart from this method of procedure, however, Mr. Grigg is confident that there are many ways in which British traders should be able to strengthen their hold, and even increase it, upon the Canadian market. Efforts should be made to promote and encourage facilities of quick and cheap transportation and communication, and he quotes instances in which orders have gone to the United States for this reason alone. A cheapening of telegraphic communication is also desirable. He reiterates the opinion that the home producer should enter into direct communication with the Canadian buyer, and that attention must be turned to the problem of distribution under the new trade conditions which prevail to-day. Goods are now produced for the Canadian market which are *too good*, and, laudable as a high standard of workmanship may be, it does not always necessarily mean that the commodities sell. A point of importance in this connection is the question of standards, particularly in regard to iron and steel. Canada has adopted American standards, engineers and architects are familiar with them, and if British manufacturers wish to sell in the Canadian market, they must adopt, for goods destined for that market, the same standards also. Greater and more careful advertising is recommended, as well as a more complete and effectual system of distribution of trade literature, matters upon which it is recommended that Canadian advice be taken. National trade representation is the subject of the final conclusion of the report. At present Great Britain is totally without any such representation. The appointment of commercial correspondents such as is now contemplated by the Board of Trade is welcomed as an important step in the right direction, and likely to be ultimately of substantial advantage.

A New French Electrical Journal.—For some time the official organ of the "Syndicat Professionel des Usines d'Electricite" of Paris has been the *Bulletin des Usines Electriques*. It is now announced that from henceforth the place of this will be taken by a new publication, entitled *La Revue Electrique*. The new journal will be published twice a month, and will have forty pages of reading matter instead of the sixteen contained in the *Bulletin*.

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COST OF ELECTRICAL POWER FOR INDUSTRIAL PURPOSES

THE discussion on Mr. John F. C. Snell's Paper on the "Cost of Electrical Power for Industrial Purposes," before the Institution of Electrical Engineers, was concluded on Thursday. We gave an abstract of the Paper, and of the discussion in London and Dublin on January 9th, in our issue of January 16th.

Mr. C. P. SPARKS (Engineer-in-Chief, County of London Electric Supply Co., Ltd), referring first to Tables I. and II. of the Paper, dealing with the cost of independent supply, said that Mr. Snell put a new position before them. For some years past it had been almost recognised as an axiom that the most economical thing for everybody to do was to take power supply from some huge bulk station, but the figures Mr. Snell now brought forward, until they had been carefully examined and considered, appeared to show in the first instance, that small independent plants could produce electricity at very much lower rates than it was possible for a large bulk undertaking to do. Table XIV., column 2A, gave some suggested prices for the supply of alternating current to power consumers, and column 4 of the same table gave Mr. Snell's estimate of the prices at which the Newcastle Electric Supply Co. could supply, and on comparing these with Tables I. and II. it appeared that the company could only supply consumers up to 100 h.p. more cheaply when their load factor was above 30 per cent., and that they could not expect to supply consumers between 100 and 500 h.p., no matter

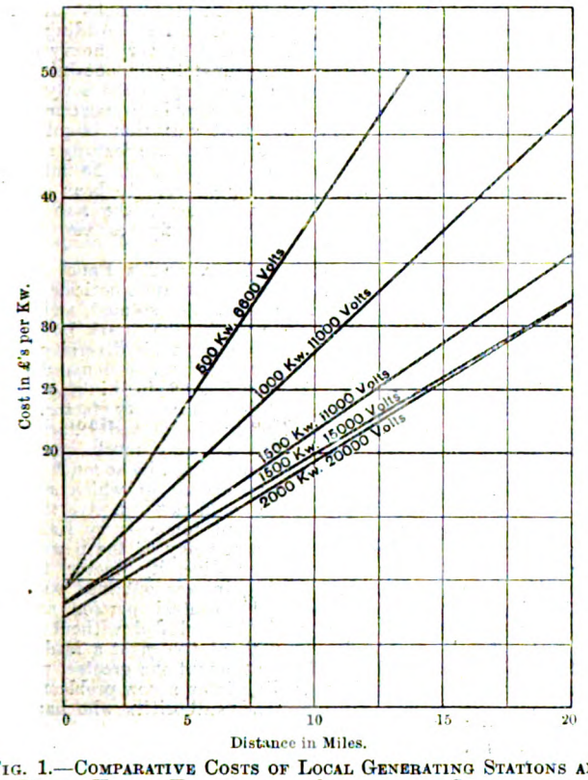


FIG. 1.—COMPARATIVE COSTS OF LOCAL GENERATING STATIONS AND POWER HOUSE, TRANSMISSION SYSTEM WITH SUB-STATIONS.

what their load factor. He thought that Mr. Snell's Tables I. and II. were inaccurate in this respect; they represented the kind of costs that were obtained when the independent plant was new and in perfect order, but the working costs given were too low for the average case. So far as the average user was concerned, the figures must be put on a much higher level. The second point he wanted to take was in connection with mill work. He agreed with Mr. Snell in his estimate of gearing losses in jute mills. In modern well-arranged mills, driven by steam engines, the figure of 30 per cent. given by the author was, if anything, on the high side. His own experience showed that it ranged from 25 per cent. to 30 per cent. The advantage of electrifying a mill with a gearing efficiency of this kind was small, for, as a general rule, it was not possible to put the motor on the actual textile machines to be driven. There were, however, other reasons for electrification, namely, the advantage of a smoother method of driving, and the fact that the power was delivered right up to the machines; which resulted in there being no slip. It was for these reasons that mill driving was growing, and would grow, without any regard to the cost of power. Mr. Snell had suggested that the price of electric energy should be about 0·48d. per unit. From his experience he thought that this figure was something near it as a kind of practical result that could be obtained from independently driven small mills. With regard to collieries and larger power users, Mr. Snell had extracted some details from the Paper which he (Mr. Sparks) read before the Institution of Electrical Engineers a short while ago, which showed how difficult it was for a power company to supply a really large power user, and it was on this point that he would like to refer to Fig. 1 in Mr. Snell's Paper, which dealt with the question of capital cost per kilowatt. At the side of the curve was the figure £20. Whilst £20 might be a fair figure for some undertakings, in the case of concerns having from 1,500 to 3,000 kilowatts of plant installed, the cost was from £11 to £13 per kilowatt. The consequence was that there was hardly any chance for a power company to supply under these conditions except at a very limited radius. In the case of a colliery, the question of coal, which was assumed for the curve to cost 11s. per ton, was again a difficulty in the way of a power company, and it showed that for a large colliery undertaking it was almost impossible for a power company to supply. With regard to Table III., he was surprised on reading this to find the very small number of units put down per horse-power. Mr. Snell had taken as his basis the units per head. This he thought was altogether erroneous. The basis of units per horse power was in every way preferable. In front of Table III. the author said, "In Sunderland at the time of the last census, for which the author was responsible, and omitting the large engine works and shipyards, there were 587 motors, representing a total horsepower of 1,634, or an equivalent to 1,220 kw. The maximum demand on the station plant was only about 500 kw. There was thus a diversity factor of 2·4, the total units for the year being 404,999 or 332 per kilowatt installed. This represented a consumption of 810 units per kilowatt demanded for this particular load, and was thus under an average load factor of 10 per cent." This was only 250 units per horse-power, and he thought there must be some reason for this. Possibly they were not all connected the whole of the year, but from figures from various parts of the country, he was sure that 250 units per horse-power was an exceptionally low figure. Before closing his remarks he would like to say a word with regard to the lighting business. Mr. Snell had said: "But a warning should be noted by station engineers that the future will bring, in all probability, a very large proportionate increase of low price power units, and with improvements in lamps and their reduced energy consumption, the proportionate lighting units may even fall below their present figure." He disagreed with this entirely. The use of metallic filament lamps, while causing a falling off of the actual demand of the lighting consumer, did not diminish the number of units consumed, which was the important factor.

Mr. ROBERT HAMMOND thought that the Paper would be remembered as the one that brought prominently before the Institution the very great effect of the diversity factor upon the cost of electrical energy when supplied from central stations. Electrical engineers agreed that the diversity factor had as much effect upon the station load factor as long hour use, since the station load factor was the product of the average consumer's load factor and the diversity factor. If, for instance, £7 per kilowatt of the station maximum demand was found to be the sum required to cover all the standing charges, then it was obvious that with a diversity factor of 1·66, the charge to the consumer to cover the standing charges would be reduced to £4 4s. per kilowatt on about a 20 per cent. load factor. That figure gave an allowance to the consumer of about 0·35d. per unit. This was the figure of which the consumer got the advantage by taking his supply from a central station. It must, however, be borne in mind in speaking of 0·35d., or any other figure with which the consumer might be credited, that to give each consumer the same allowance would be obviously unsound, because the consumer, for instance, whose maximum load coincided with the top of the peak did not help the diversity factor, but he injured it. Instead of having an allowance, he should absolutely be charged more than the figure which represented the standing charges of the station. However, the time would possibly come when a scientific scale would be thought out by means of which each consumer would receive that allowance which his effect upon the diversity factor warranted. From the marked effect that the diversity factor had upon the costs, one would suppose that it would be best for all consumers to obtain their supplies from big stations, especially when, in addition to the advantage of less capital expenditure upon big stations, there was the additional advantage that the plant was more efficient, and there were also savings in wages and in maintenance. In London there was also the advantage of being able to choose the site on the river, where there was ample water for condensing, and where steamers with sea-borne coal could come alongside. One was therefore somewhat staggered at the very low costs that were quoted in Mr. Snell's Paper as those obtainable by power users having their own plant. He was rather afraid that Mr. Snell, with his usual desire to be extremely fair to the other side, had looked on these figures far too leniently. In Table II., which dealt with loads from 100 h.p. to 500 h.p., the price which Mr. Snell set out as

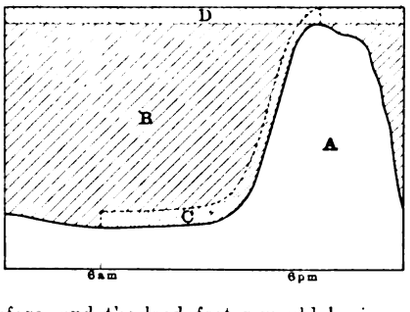
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the figure for a load factor of 25 per cent. 0·59d. per unit, but 0·95 appeared further on in the Paper as the actual cost to a particular consumer with a maximum load of 504 kw. Again, on a 35 per cent. load factor, the costs set out in Table II. were 0·494d., while at Vickers, Sons & Maxim's works Mr. Williamson, with a load factor of 37 per cent., had a cost of 0·716d. Again, in Tables VIII. and IX., Mr. Snell dealt with the actual cost of the big power undertakings in this country, which were supplying very large quantities ranging from 3,000 to 25,000 kw., which latter was now the power supply in Manchester, as well as in Glasgow. One would expect to find a very great improvement on the 0·59d. in regard to these undertakings. But in the case of Leeds the cost was set down at 1·37d. If a private consumer with a 200 kw. plant could produce at 0·59d. with a load factor of 25 per cent., could it be said that the mere moving of a plant into a central station at once doubled the cost of working? Even the strongest opponent of municipal trading would hardly say that. He was aware that the 1·37d. covered a proportion of the standing charges due to mains to the extent that the lighting mains were being used for power supply, but in Leeds mains cost about £24 per kw. upon the basis of 1·65 diversity factor. 10 per cent. on this was £2 8s., which on a 25 per cent. load factor was about 0·25 per unit, and this was included in the 1·37d., as represented by mains. If 1·37d. were the correct costs, how was it that where coal could be obtained so cheaply by the big manufacturers, the Leeds undertaking was supplying such a big firm as Kitson's? They had power people on the mains whose consumption ran into two million units. There must be an error in Mr. Snell's figures. He had doubtless faithfully transcribed what power users had given him as their costs, but a power user was never aware of what his costs were. The power user, in making up his costs, took coal and one man's wages, but he omitted the proportion of standing charges.

THE PRESIDENT (Colonel Crompton): It would rather help your remarks if you would say what you are charging Kitson at Leeds.

Mr. HAMMOND said that he was able to say, without mentioning any names, that there was no consumer in Leeds charged less than 1d. per unit, and at 1d. per unit they were supposed by Mr. Snell's hypothesis to be supplying people who could make a very much smaller quantity at 0·59d. He did hope that the reason was that to this 0·59d. must be added many charges which did not appear on the surface. In conclusion, he could only say that the Paper came at a most opportune time, and the discussion upon it would be renewed by him with equal vigour, possibly, in the House of Commons, where some of them trusted that this year would see a solution of a very important question, and the provision for London of a bulk supply that would do great things for the biggest industrial centre of the world.

Mr. E. W. COWAN (Cowans, Ltd.), sketched the load diagram below. The area A represents "active fixed capital," and the shaded area B "inert fixed capital." The area B, the speaker regarded as representing the bye-product of the works, which, he contended, it would pay to sell for whatever it would fetch. The supply of this bye-product, he added, was limited, and its sale at bye-product prices must be correspondingly limited. If an applicant for power supply came with a demand for a uniform load from 6 a.m. to 6 p.m., as shown by the area C, the "inert fixed capital area" must now be increased by the rectangle D. As the effect upon the works diversity factor of this customer would be nil, the total area of "inert fixed capital" would be greater than before, because the area D added was greater than the area C utilised or rendered active. The proportion of the area B+D to the area A+C would, however, be



less than before, and the load factor would be improved. Consequently, Mr. Cowan concluded, the principle of charging such a consumer according to the effect of his demand upon load factor and diversity factor was sound; but he was of opinion that it did not go far enough in that it ignored another factor, viz., "the intensity of demand," by which he meant the appraisement of the value of the supply by different classes of consumers. This might, he suggested, be called the "utility factor." The utility of a unit of electricity was greater to a lighting consumer than to a power consumer, and the difference in utility was expressed by the price each class of consumer was ready to pay. He contended that it would be rational to base all charges to consumers, as far as may be practicable, upon the basis of the intensity of their demand.

Mr. G. L. ADDENBROOKE said he could go a little further than Mr. Hammond on the question of the difference between the costs in Tables I. and II., and the actual costs obtained in particular instances. But English manufacturers were not so behindhand as some people would make out, and a very large proportion of plant throughout the area would be in engines which were fairly economical, and, at any rate, were in good working order. If a manufacturer were approached under such conditions upon such calculations as Mr. Snell put forward, he at once objected to the charges for interest and depreciation on his plant. If he scrapped his plant and put in electric driving he would get nothing but the removal price, which would be a very small sum. Therefore he took up this position: "I may as well write off this sum now. Some day or other my engine will break down, and then I will come to you. In the meantime, it will not pay me unless you can supply me at something less than my present working costs and actual repairs." This had accounted in a considerable measure for the slower progress of power companies than many people would have anticipated. It was not an argument against power companies in any way because sooner or later the plant would break down, and the manufacturer would come to the power company. With regard to collieries, in the discussion on Mr. Sparks' Paper, he had given a table of prices at which he considered a power company would have to supply within moderate distances, and on this basis power could very well be supplied even in face of the figures mentioned by Mr. Sparks. He thought the matter was fairly evident from the fact that even in Mr. Sparks' case there was a very considerable length of transmission. Adding a few miles on did not cost very much extra. The very heavy capital charges which were necessary, unfortunately, in obtaining Parliamentary powers, were always a handicap to the early stages of power supply as they formed a considerable proportion of the total capital. Another point was that a station ought to be about ten times the size of its largest consumer, speaking roughly. Of course, if a consumer happened to be near, he might be supplied much cheaper, but it was a good rule to bear in mind that if a consumer was more than one-tenth the size of the station then they should look into their figures very closely before they could supply him.

Mr. C. H. WORDINGHAM said that Mr. Snell's Paper bristled with figures, but his experience was that arithmetical figures, like other figures, were not always what they seemed, and it was usually futile to discuss them. He would like to ask how many central station engineers really knew what their diversity factor was. How many knew what was the maximum demand of all their individual consumers? He could not help thinking that a great deal too much was being made of diversity factor. The important thing was the load factor; the diversity factor did undoubtedly affect the result, but he very much questioned whether the diversity factor meant anything like as much as was made out in these power company stations, of which so much was heard and so little seen. He could not conceive that the tacking together a number of different towns—very similar as they were and must be in the areas of many of the power companies—could possibly improve the diversity factor to any material extent. Where the full gain was obtained was in a rather large town, where both the central portion and the suburban or residential part could be included without having to go too far for the load, and without too great a load at the outer circumference. In London he thought the greatest possible mistake was being made in regarding it as a new problem, when there were so many companies and authorities who had sunk their money in it.

Mr. W. H. BOOTH referred to the heating of cotton mills. They had to be heated day and night and on Sundays, practically the whole year round, except a few hours during summer in the daytime. The mill was heated not only by its own machinery, but also by special steam pipes. An Oldham cotton-mill spinning 28's to 30's with 70,000 spindles, and a horse-power of 1,000, would have three boilers 30ft. by 8ft. 6in. at work, which required one fireman. If heat must be supplied to the mill, the fireman was still needed. The coal required for heating was from 12 to 14 tons a week in winter, and the heat had to be supplied from somewhere. At the Acme Mill, Pendlebury, there were two mills close to one another. One was electrically-driven by power from the Radcliffe power station of the Lancashire Electric Power Co., and the other, which was driven in the ordinary way, supplied steam to the electrically-driven mill. It was a moot point with regard to Manchester cotton mills, who was losing on the contract, the supplier of electricity or the user. But it was claimed, at any rate, in favour of the electric drive that as much as 7½ per cent. greater work was obtained, which would mean something like £500 per annum extra profits. The coal used in Oldham mills was from 1¼lb. to 2lb. per horse-power-hour, and in winter from 1¾lb. to 3lb. The consumption in summer was 37¼ tons to 50 tons per week, and in winter from 43 to 75 tons per week. This came out at about 2,500 tons, which, at 10s. per ton, amounted to £1,250. This did not agree with Mr. Snell's figures. There was another mill in Manchester belonging to some fine-spinners, which took, he was told, about 2,000 h.p. from the Manchester Corporation Stuart Street

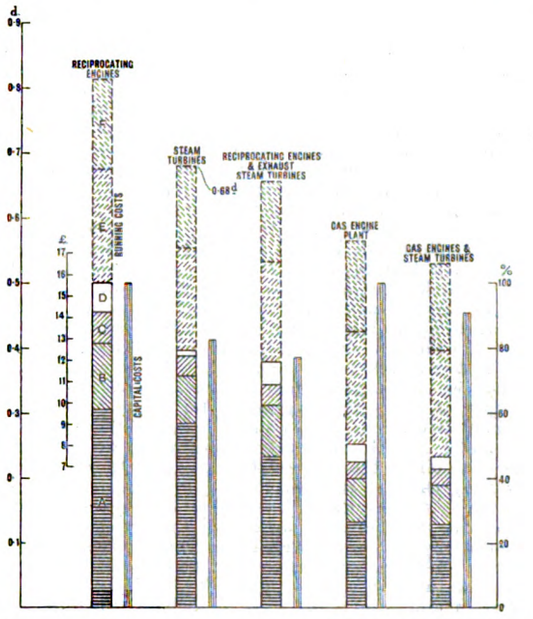
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station at considerably less than ½d. per h.p.-hour. This being so, Mr. Snell's figures must be wrong, because he showed very much higher figures for Manchester. In power supply tney were always apt to think a poor load factor meant that a consumer should be charged heavily. Mr. Snell referred to these limitations, and advised some people to spend twice as much time in docking a ship. He also referred to another method which would be fatal in Lancashire, and that was to change the dinner hour. When there were half-a-dozen people in a family living in one house and working in different mills, and having different dinner hours, he thought the old lady of the house would object.

Mr. G. W. PARTRIDGE (Engineer-in-Chief, London Electric Supply Corporation), said that after 20 years' experience of London, he did not believe there would be a diversity factor of 1·66. It would be much nearer 1·25. If this were the case it altered, as far as he could see, all Mr. Snell's calculations. Another point was that in London a great many of the factories had working hours practically the same. Table VI. gave the cost of the transmission system at £12 per kw., but this figure was very much too low. It must be remembered that in laying out a scheme such as Mr. Snell talked of, it would take a great number of years before there were very many consumers, and from his experience it was impossible to get anybody to take a supply until the main was absolutely outside his door. Even after mains were laid it sometimes took two or three years before the consumer would take a supply. Another point was that the cost of repairs and general road work in London was very much higher than in the country. Spare ducts must be allowed for in the first instance, and it would take a great number of years before Mr. Snell would get anywhere near the figure he gave. Instead of £12 for the first two or three years it would be nearer £30. The Newcastle Co. had, according to the Paper, a cost for mains and sub-stations of £26. As Mr. Snell allowed £3 for sub-stations, this left £23 for transmission system. If it cost £23 to lay mains in a district like Newcastle, he thought it would come to very much more to lay the same mains in London.

Mr. G. H. CORRINGHAM said that if the figure of 2d. per unit for lighting was correct with a lamp like the Osram, a consumer would be able to have 30 c.p. for 14 hours for one penny. This would be bound to stimulate the lighting branch. The usefulness of Table I., he thought, was considerably impaired by wages for attendance not being included. Taking the case of a 60 kw. plant out of Table I. and adding £75 per annum for wages (this was the most favourable case in the table) gave 0·17d. per unit. With regard to the Sunderland diversity factor, he would like to mention that on the Bermondsey station the diversity factor, reckoned on the same lines, came out at 2·7 against 2·4. In Table VII. the figure given for this station as the actual charge was 2d. per unit. He did not know how this had been obtained, but in the year ending March, 1906, the figure for power was 1·45, and in the last published figures it was 1·17. In Table IX. the mean rate which was given for a 20 per cent. load factor was evidently wrong, but this was apparently a clerical error, because it was neither the mean of the four preceding columns, nor was it the correct average by multiplying the prices by the number of units in the respective stations and dividing by the total. He did not think Fig. 1 was applicable, unless the annual load factor were taken into consideration. It seemed to him that if a station was at full load for 24 hours a day the fact that the loss of energy was constant was going to make a difference, as all the other curves were falling curves, both capital cost per unit and production cost per unit. Mr. Snell had assumed £12 per kw. on the basis that every 100 kw. would supply 166 kw. outside, with a diversity factor of 1·66. This assumption could hardly be credited, because they could not run without spare plant. In Bermondsey now there was room to put in 4,000 kw. The present size of the plant was 1,475 kw. The new plant could probably be installed for no greater cost than £10,000 for each 1,000 kw., and this being so he did not see where the advantage came in of having plant, say, at Barking Creek at £12 per kw. and adding transmission and transformation charges.

Mr. LEONARD ANDREWS (Key Engineering Co.) said he would confine himself to one point only, viz., to use the author's own words, "the present inability of most undertakings to meet a large demand for power at such rates as to hold their own with local plants." Other speakers had dealt with this question by attacking the author's figures as to the cost at which these local stations can produce their power, but no one appeared to have referred to the question from the other end, viz., was the figure which the author had given as low as they could hope to reach. The author himself said that he did not think there was much prospect of materially reducing this figure of 0·68d. for alternating current supply. Mr. Stott, the Chief Engineer to the Rapid Transit Co., in a Paper read before the American Institute of Electrical Engineers in 1906 on "Power Plant Economics," had pointed out that a very considerable economy could be effected by purchasing for a portion of the equipment plant that cost the minimum amount and using that for the peak of the curve and using the most economical plant possible, even though it cost more for the flat portion of the curve. Mr. Stott took five different methods of generating, viz., reciprocating engines, steam turbines, reciprocating engines combined with exhaust turbines such as were now being used at Edinburgh, gas engine plant, and gas engines combined with steam plant. The costs were plotted by Mr. Andrews on the diagram below from A to D in each case. Taking reciprocating engines at 100 per cent., with steam turbines, the estimated running costs were 80 per cent., reciprocating engines combined with exhaust turbines about 75 per cent., gas plant 55 per cent., and with combined gas and steam plant something below 50 per cent. He also gave capital cost in each case, and again taking reciprocating engines at 100 per cent., steam turbines were about 80 per cent., gas plant was very high again, and combined gas and steam plant slightly lower than gas plant alone. In order to bring these into line with Mr. Snell's estimates, Mr. Andrews had assumed that Mr. Snell had based his estimates



A. Coal.
B. Labour.
C. Repairs.
D. Oil, Waste, Water, and Stores.
E. Interest and Depreciation, 6¼ % on Capital.
F. Rent, Rates, Taxes, and Management Expenses, 5 % on Capital.

upon steam turbine plant. Taking £13 per kw., the diagram gave the capital costs of the other systems. In the case of running costs, he had also taken Mr. Snell's figure of 0·68d. per unit for turbine plant, and deducted from it 0·125d., corresponding to 5 per cent. upon the capital cost, for management, rent, rates, and taxes, and charges of that sort, and a further 0·157d. which was calculated upon the cost of the generators, mains, and transformers, assuming 20 per cent. load factor, 1·66 diversity factor, and 64 per cent. interest and depreciation. This brought the balance down to 0·4d., which he assumed to be the working charges. These had been divided according to Mr. Stott's figures into four items, A, B, C, and D, and the two sets could be compared. The result was a gain of about 22 per cent. over Mr. Snell's figure of 0·68, if combined gas engines and turbines were used instead of turbines alone. As a practical illustration of what had been done in this direction, Mr. Andrews said that he had seen a works in Germany a few weeks ago where gas engines and steam turbines were running in parallel in this way, and he was told that they were supplying power in bulk to a town about 30 miles distant by overhead mains, and were selling it there at an average price of 0·5d. per unit.

Mr. A. M. TAYLOR (Birmingham Corporation Electricity Supply Department) said that on the last occasion Mr. Snell and himself had rather misunderstood one another and as to what they each meant with regard to diversity factor. Since then he had had an opportunity of looking into the construction of Tables VIII., IX., and X., and he felt quite satisfied that he could show that these were constructed on the wrong basis. The only inference in comparing Table IX. with Table VIII. was that it referred to the station load factor, but he thought Mr. Snell must mean the consumers' load factor. On the other hand, if this meant consumers' load factor, Mr. Snell ought to have given a fifth column, showing the varying values of diversity factor with the increase in the consumers' load factor, because it must be evident that if the consumers' load factor increased, the diversity factor must go down in a station. He thought, as a matter of fact, that Mr. Snell had taken these as the station charges and the station load factor, because in Table XII., in comparing the Newcastle supply, Mr. Snell gave the columns side by side for the same load factor, and in that case it was perfectly evident that he had simply reduced the standing part of the charge per unit from the first to the second column by dividing by the diversity factor. This, Mr. Taylor

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maintained, was absolutely wrong. Further, if the left-hand column in Table XII. was constructed on the basis of 0·24d. per unit for the running charge and £7·6 per kw., whereas the right-hand column is upon 0·24d. and £4·5 per kw., then the result was obtained by dividing practically by the diversity factor. In Table VIII. Mr. Snell had not at all done justice to the municipal supply concerns. In connection with Manchester, for instance, he had constructed this result upon the basis of 0·39d. running costs and £8·48 per kw. standing charge. He ventured to say that at Manchester at the present time 0·2d. instead of 0·59d. would be nearer the mark. Therefore, while the figure for the 20 per cent. load factor would not be materially altered on 80 per cent. load factor, the result was that instead of 0·69d. per unit, as Mr. Snell had got, this should be 0·54d. If, again, this was compared with London County Council supply in bulk, where the distribution charges, as had already been pointed out, were of the order of £3 per kw., the result was that they got down to the figures on a 20 per cent. to 80 per cent. load factor of 1·15d. per unit and 0·44d. per unit respectively without dividing by the diversity factor at all, which, of course, he submitted was wrong. He thought it would be seen, therefore, that justice had hardly been done to the municipal stations as against the London concerns, and if Manchester could not do their 0·2d. per unit, Birmingham would do it in the course of another year.

The PRESIDENT (Col. Crompton), in summing up the discussion, said he wished to say that long before he knew he was going to be President he had intended to discuss this dear old subject which had filled their debates so much some 20 years ago. It was the opening words of the Paper which had tempted him to discuss it, namely, "that the fundamental elements of details of design in large power stations and transmission systems are now so generally accepted that there appears to be but little to add to the available information." If the author meant by this that we had approached finality, he was sorry for the Institution of Electrical Engineers, for a great interest would leave their discussions. He himself believed they were no more near finality in this matter than we were fifteen years ago. He did not believe that the great improvements which had taken place during the last eighteen months in metallic filament lamps was going to rest by themselves. There were great possibilities of improving the thermo-dynamic efficiency of generating plant; the enormously increased use of the internal combustion engine during the last two or three years, and the spur that it had given to steam design, left us on the verge of great steps in advance. Those who would have to debate this question 15 or 16 years hence would have to face antiquation costs just as they now had to be faced, and he did not see what was the use of begging that question either in Parliament or elsewhere. He did not believe that those who started with a gigantic scheme now, would in a few years, when they had got their scheme working, be in any better position than those who now had plant working. He did not believe in huge stations; he did not believe that the Lots Road, or "Lots of smoke Road" station, as it was sometimes called, was absolutely perfection. He himself had seen private installations on the scale of a million units a year running for many years at lower figures than had been put forward by Mr. Snell. He would support Mr. Snell to the utmost in Tables I. and II., which had been so much challenged. It was a well-known fact that there were plenty of travellers for modern manufacturing firms who could produce suction gas plant and modern steam plant, and put it down under guarantee for private firms at under a halfpenny per unit, which included all charges and 10 per cent. interest and depreciation. These circumstances were what large power distribution schemes had to contend with, and these were the plants which they were so fond of pointing out that they wished to supersede. He was now speaking from the point of view of a chairman of a lighting and power company. He knew that these private plants were the enemy that had lain in the path for years. He knew of cases where suction gas plant had been put down during the last year or two, and was working satisfactorily within a few yards of one of the largest power stations in the north of England, and this fact had been mentioned over and over again in evidence in London, as one of the reasons why it was so difficult to get manufacturers to take power from outside sources in London. All those who wished to reduce the total cost of electric supply by increasing the demand for it, and filling up the blank spaces on their load diagrams, must take a leaf out of the book of those great commercial undertakings, the drapery houses. The members present all had wives or daughters, or ought to have, and they all knew the fertile subject of remnant sales. By his remnant sales the draper succeeded in disposing of his remnants, and this enabled him to sell to the public the rest of his goods at a lower price than he would be able to do otherwise. Electric supply engineers had their remnants, namely, energy for power supply, and they sold it at a penny. Mr. Snell had put down his (Col. Crompton's) company at a figure which was most complimentary, namely, a little above that which Mr. Snell said it ought to have sold at; but Mr. Snell had made a mistake there, because they sold it at a penny like everybody else. But they did not sell it to make money, but in order that a plant already existing might, under existing conditions, yield a better return. There was something else; there was a fetish or a superstition that prices must never be raised once they had been lowered. But why should that be true to electrical energy, when it was not true to coals, bread, or any other life necessity? Why should not electrical engineers vary their prices according to conditions? If conditions were extremely favourable, if a certain number of manufacturers settling down in a town increased the output, why should they not then give everybody the benefit of it, and still maintain the dividend, or reduce the burden of rates as the case might be? On the other hand, if these good conditions disappeared, if the collieries increased prices, or the prices of labour rose; if the neighbourhood became more thinly populated and works migrated into the country on account of rates or other causes, why should they not then increase their prices? Electrical engineers had allowed themselves to be driven by a sort of popular clamour. The newspapers in London had led people to believe that they had an inalienable right to electricity at a farthing per unit, but the public had nothing of the kind. Electrical supply at the present prices had been an inestimable boon to the public, and they were extremely lucky to get it at present prices. The shareholders often had a poor return for their money, in spite of the fact that the electrical engineer had done yeoman service; better in this country and in London than in any town or country in the world. He had studied this question for twenty years; he had been everywhere, and had seen all the huge stations in America. He had seen what Americanised stations could do here, and he had seen the best stations on the Continent. But we had nothing to learn from them, and we had never had anything to learn from them. We held the record in England for the coal bill, and we ought to keep it as certainly as we had the record of the *Mauretania*. He was heartily with Mr. Snell, whose Paper was a very valuable contribution to the Institution proceedings. It would be a work of reference which he himself would dip into from time to time. He wished heartily to support his figures as to the small cost of modern private plants. He could assure them that all the improvements that had taken place of late years had been to the advantage of the small plant, and not so much to the advantage of big plant, and he felt confident that the overwhelming superiority of the 5,000 kw. turbine plant was no longer to be maintained. The same results had already been obtained by smaller plant, and it was quite clear that the private manufacturer could have figures put before him which would make him hesitate to go on to the public mains unless he could have figures quoted him very much lower than had been considered possible hitherto, and which had been rendered necessary by the great cost of transmission.

Mr. J. F. C. SNELL said that after such a prolonged discussion, it would be quite impossible for him to reply fully, in the short time available, to all the points raised by the various speakers. He wanted first to make a correction. The Newcastle Power Co. had asked him to point out that in his Table XII. he gave the figures for 1907; these really were for the year ending December 31st, 1906. In order to avoid any suggestion that the Paper was in any way an advertisement for himself, he wished to point out that it was begun to be written last year, and he had at present absolutely no connection with any of the present power Bills. It would, therefore, be seen that that part of the Paper which referred to London, was entirely the free criticism of a free lance. With regard to Tables I. and II., he should be sorry if his Paper gave the impression that the figures were such that all manufacturers could obtain from their local plant. He had been most careful to show that, in some cases, wages, and a proportion of the general establishment charges, were not included. Certain of the costs were omitted because they could not be obtained, and he had shown in the results of plants at various works, in many cases from figures taken by himself or his assistants, that higher results were obtained than were shown in Tables I. and II. In these, however, all the costs were included, *i.e.*, actual capital charges, and some proportion of the general establishment charges. The figure, 0·71d. referred to, was taken from a very well-known engine works, and he knew it was perfectly correct, and it was higher than the figures in Table II., because it included a proportion, and very properly so, of the general establishment charges, and a proportion of the rating of the whole works. He would be sorry if the Paper had the effect of frightening capitalists—they appeared to be frightened enough already—but he did think it was advisable when considering the question like this, to face the truth, whatever the truth might be. Mr. Taylor had covered a number of points, and it would be unwise of him to attempt to reply to his supplementary remarks until he wrote the reply for the Journal. Mr. Taylor, however, stated that the Paper only dealt with large power users. There he was quite mistaken, because the tables quoted in the first parts of the Paper not only included direct supply to a certain proportion of large users, but also included the actual distributing charges to a number of small users, and the distributing cost—he was speaking from memory—of £30 per kilowatt were taken for the local distribution to smaller users. He had already explained that Figure 1 was corrected for diversity factor; in fact, if Mr. Taylor carefully read the Paper he would see that this was stated. Mr. Taylor had also referred to storage in sub-stations, but he was sorry to say that the cost of storage batteries had not been sufficiently reduced to enable them to be used to the extent which he personally would like to see them used. He had said in the Paper that £12 per kilowatt was applicable to large

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stations, to the order of 20,000 kilowatts and upwards. They had heard that evening from Mr. Sparks that for plants of 3,000 kilowatts only he had built stations at from £11 to £15, and he was quite sure, in spite of what many critics had said, that stations of from 10,000 kilowatts upwards, could be installed for something of the order of from £12 to £14. Mr. Seabrook had referred to the Newcastle cost of £33, and compared it with £12, which was the estimate given in the Paper. But Mr. Seabrook must surely remember that the Newcastle figure included the old Pandon Dene station, and also included a further pioneer station of the power company. It was not the real cost of what the newer station of the power company would represent to-day. As to his estimate for sub-stations being too high, and that they should be reduced to one-half, all he could say was that this figure was based on practical work, and where no money was wasted. Moreover, the figures were confirmed by Mr. Rider from actual practice, and had been confirmed in the Glasgow discussion by Mr. Lackie and Mr. Robertson. Mr. Seabrook did not agree with centralisation for London, and had said that centralisation would be more applicable to the provinces. With this he could not at all agree, because in the provinces land was much cheaper than in London, and many other items were cheaper. Mr. Seabrook, in passing, had compared Tables VIII. and II., but he should not have done this, he should have compared Table IX. Table VIII. represented the actual cost of production from the works. Mr. Seabrook and others made a mistake if they thought they could lose a large number of their electric lighting units with impunity. The lighting units must always be a higher order of cost than the power units, because the much criticised diversity factor was a dominating factor in the division of costs between the power and lighting. By diversity factor he meant the sum of the maxima of different users from any station, and its ratio to the maximum demand at the station itself. This, he took, was the true diversity factor, and they would always find—at least he had always found—that the diversity factor of power users was much higher than that of lighting consumers. Naturally people all wanted their lighting nearly at the same time, and lighting consumers would have a diversity factor of one, were it not for the fact that they had theatres a little later in the evening, and that the residential and shop maxima were not simultaneous. In the case of Sunderland, the diversity amongst the smaller works supplied from the actual lighting mains amounted to 2·4; he had taken 1·66d. as the average diversity factor for industrial purposes. Personally, he believed this factor was too low, and he would be very glad indeed to find that it was, because it had such an effect upon the actual cost of production for power purposes.

Some members who had desired to speak were unable to do so owing to lack of time, and others were not able to be present. We append a *résumé* of some of the communications that have already been sent in:—

Alderman GEORGE PEARSON (Chairman of the Bristol Electricity Committee) feared that it would be many years before small towns would be able to command the services of large power companies in their immediate vicinity. Assuming, however, a power company to be in existence, and the charges to be as shadowed forth by Mr. Snell, he thought it would be an advantage to the small towns to accept the services of such companies rather than generate for themselves. But he thought that a power company was never likely to be of great service to the larger municipalities, nor did he think it possible that a power company could exist except in the midst of a thickly populated district. He was inclined to agree with Mr. Snell that the estimated distance over which power companies could economically supply had been somewhat overstated. The Bristol Corporation were arranging to supply eight miles from their station, but he would think twice before agreeing to supply at double that distance however high the voltage might be fixed.

MR. W. C. P. TAPPER (Chief Electrical Engineer, Stepney Borough Council) described the figures in Table VII. not only as incorrect, but as utterly meaningless, owing to the absence of any reference to the load factor and diversity factor assumed by the author in their calculation. They should have been given as so much per kw. per annum, and so much per unit, as this took full account of the load factor. The charges for Stepney would have been correctly stated as £4 per kw. per annum, plus 0·5d. per unit, with a maximum charge of 1d. By both reckoning the cost and charging the consumer on this basis, there could be a profit on both items, and thus there is no risk of the consumer obtaining his supply below cost price. At Stepney for a particular year, the total cost of production was £2·7 per kw. per annum, plus 0·495d. per unit, and the charge to the consumer of £4 and 0·5d. was therefore a safe one.

Mr. A. W. HEAVISIDE wrote of "those wonderful factors, the power factor, the load factor, the diversity factor, the intensity factor, the determinate factor, and the malefactor," which, he says, are described abroad as the outcome of the British savages' desire for a formula for every problem in life. Admitting that a number of uneconomical systems over small areas used for special, not general, application, was undesirable, he opposed on general public grounds, permission being given to any amalgamation scheme of existing undertakings. He would suggest as the best scheme the dividing up of existing undertakings into such groups as would secure cheap production and distribution, and leaving each group under one management. Then at stated intervals of five, seven, or ten years a balance sheet should be drawn up by an independent body of experts, comparing the results of that period. Should such an examination show marked advantages in the working the administration of one group as compared with another, it would become the duty of the less successful groups to fall into line, and gradually bring their systems up to a higher standard of efficiency. Provision, he thought, should also be made for an emergency service, by means of a ring main all round London, by which one group could assist another group when in need.

Mr. A. H. SHAW (Chief Electrical Engineer, Ilford Corporation) did not think it fair to compare the cost of power in the Newcastle and Sunderland district with the cost of power even from a large bulk station like that proposed to be erected in London, as the costs of the latter were bound to be higher. He thought he was right in stating that the large majority of the possible 400,000 h.p. in London was made up of a large number of comparatively small consumers instead of a comparatively small number of very large consumers, as on Tyneside. He thought also, that the costs of the Lots Road station had not been altogether as low as were anticipated. He also made the same point as we did in our editorial comment last week, viz., that if the charges in Table VII, referred to as being "correct," had been charged in the first instance, they would still be incorrect as the load upon which they are based would not have been obtained at this price; and by the same method of calculating it would have been necessary to fix the price at the highest charge possible, in which case no power load at all would have been obtained. Mr. Shaw's letter continued: It is also incorrect to compare these charges with the "probable" charge from a power supply company. The former charges include all distribution losses and establishment losses, and the average consumer is only a small one whereas the latter is the estimated average charge of the L.C.C. for a 20 per cent. load factor for a bulk supply. Mr. Snell recommends that transmission systems should be so arranged that works requiring over 100 kw. should be supplied from their own static sub-stations. When I raised this point with the officials of the L.C.C. in regard to their power Bill, I was informed that they would not be prepared to supply a local authority in bulk at more points than one in any district until such sub-stations had a load of between 2,000 and 3,000 kw. Referring next to capital expenditure, Mr. Shaw said that at Ilford, the cost was now about £46 per kw., and with the further extensions now in hand it would shortly be reduced to about £38 per kw., about 50 per cent. of which is expenditure on mains. He believed that the solution of this matter was not a large bulk supply company, but a scheme of linking up various stations, whether companies' or local authorities'. The larger and more economical stations could then be extended as required, supplying current at low ratio to the smaller stations, which would only be run on the peak load. All who were concerned should do their utmost to press the Board of Trade to push forward with their Electricity Supply Bill in the coming session.

Mr. G. H. COTTAM (Chief Electrical Engineer, Hampstead Borough Council) said it would not be fair to those who have borne the burden and heat of the day, and who had buildings and land capable of considerable extensions, if they were to be prevented from extending their plant. Nor would it be fair that promotors of new companies should be exempt from the County Council Building Acts while the local authorities were still to remain under them. In another scheme it had been asked that their bulk supply mains should be exempt from local rates and taxes. One company made a great show in advertising their price for power at 0·22d. per unit, which, said Mr. Cottam, when it "came to be looked into at our load factor, meant for converted energy at our switchboard one penny per unit, we having to supply, house, and maintain the converting machinery; and it was they who asked exemption from rates for their mains!" Mr. Cottam then referred to the ill-success of some of the power companies, mentioning particularly the Midland and South Wales companies. Within the last week he had been told that the Durham Collieries Electric Power Co. were selling at ¾d. per unit, yet their total costs were 2¼d. Referring next to the Lots Road station of the Underground Railways Co. of London he said that it is rumoured that the cost per unit of their energy for power in Hampstead is greater than the local authority charges them for lighting their station. He was also told that the Neasden power station of the Metropolitan Railway could easily beat Lots Road. In conclusion, he contended that the power schemes which had been put before Parliament in recent years had done considerable injury to the industry in general, making it difficult to obtain money for extensions, and preventing would-be consumers from coming on, because they thought that by waiting they would obtain energy so much cheaper.

Mr. F. B. WOODHOUSE (Engineer and Manager, Yorkshire Electric Power Co.) thought that Mr. Snell had generalised too freely in making his comparisons, but on the broad principle that the smaller and older stations cannot supply large power users at competitive prices, he was in full agreement with him. With regard to Mr. Snell's estimates, Mr. Woodhouse wrote: In Section 1 a large undertaking's supply may be divided into

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two classes, (1) Bulk supply, *i.e.*, for redistribution, for lighting and small power users; (2) supply to power users direct. The first class of customers must have electricity, and the competitive prices at which power may be bought are easily determined. In the second class, however, the problem for the power user to decide divides itself into two parts, the first whether electrical energy is preferable to mechanical transmission for his works; the second, which depends on the answer to the first, what is the competitive price? It is obvious that if mechanical transmission is preferable the supply would be utilised in one motor, but that if the reverse is the case then a number of motors would be used—that is to say, the competitive price would be higher. An analysis of the average costs of Table I. shows Mr. Snell's estimate as equivalent to a charge of about £3 6s. per kilowatt per annum, and 0·5d. per unit. It should be remembered that by far the greatest part of a power supply will be to consumers having load factors between 10 per cent. and 30 per cent. Between these limits the figures seem fair ones, but they cannot be considered as anything but a first approximation. One power user with a 25 per cent. load factor may require to run his plant day and night continuously; another may only require to run for definite hours daily, and will shut down completely the rest of the time; their costs may, therefore, differ considerably. Referring to the next part of the Paper, Mr. Woodhouse thought that the comparison of the pumping costs on a graving dock and pontoon were made on a false basis, that of a ship tonnage. It is obvious that in the dock a large ship will, in proportion to its draught, displace a larger quantity of water from a full dock than will a small one, and therefore leave less to be pumped. The comparison should be made on the basis of pump horse-power hours. He adds that the price given for the public supply would be an absurdly low one if capital charges were considered. The load factor of the pontoon pumps would in practice not exceed 1 per cent. per annum, but with this load factor it was not surprising that clashing with the peak rarely occurred. The average water horse-power in the electrical case was 168, in the gas 96, equivalent to, say, 160 i.h.p. How did two 40 h.p. engines do this? If there is an error here, then the capital charge would be considerably increased. Coming next to paper mills, Mr. Woodhouse says: Any calculations based on h.p.-hours of steam plant must be looked on with suspicion. I cannot accept Mr. Snell's ratio of costs per unit and per h.p.-hour. The ratio of kw. to e.h.p. is 1·41 : 1·05, whereas Mr. Snell assumes the ratio as 1·41 : 1, or the generator has an efficiency of 105 per cent. He could not agree with Mr. Snell's statement that a cable and distributing system sufficient for a large power scheme can be laid down at a cost per kw. equal to that of the generating station, but as I had endeavoured to show in my recent paper, the advantages of centralisation would allow a considerably greater proportion of the total costs to be expended outside the station.

Mr. L. H. HORDERN (Manager, Westminster Electric Supply Corporation, Ltd.) said that not a single one of the big power schemes had yet proved itself a financial success, and he hoped that this would be the last year in which it will be proposed to introduce into London such a peculiarly unsuitable method of supply. We must look for safe progress on evolutionary, not on revolutionary, lines. Turning next to the details in the Paper, he pointed out, as an example of the importance of diversity factor, the case of lifts. Individually, these have a very bad load factor, but give collectively a very good load factor to the supply station. Under any scale of charging which involves a high rate per kw., and a low rate per unit, the cost of working lifts electrically would be prohibitive, and he believed that in London a flat rate was the correct system of charging for power, and not the scale suggested by power companies. These scales might suit the scattered districts for which power companies are the only possible system of supply, but they seemed, said Mr. Hordern, to be as unsuited to a closely-populated district as are power companies themselves. Mr. Hordern, whose letter is highly critical throughout, returns to the general question in concluding, as follows:—"In conclusion, we are advised that by hook or by crook a large power station must be erected, but that it is essential it should not prejudice present capital: the omelette must be made without even cracking an eggshell. Even suppose this impossible feat achieved, we are not told why we should go to the new station for our supply. We are responsible for maintaining a supply each in a certain area; that we are purchasing our supply from another company at a fractionally lower rate than we could make it ourselves would not divest us of responsibility for failure. Who again is going to place the success or failure of their undertaking in the hands of another company, which, on its own showing, would have to cut everything very fine to make a profit, and whose plant or mains might consequently break down sufficiently frequently to interfere with business? Is it the apparently solid foundation provided by our London fogs which induces our visitors to build so many castles in the air? The generation and supply of electricity must be in the same hands if a company is to control its own destiny, and to achieve the best results the whole of the supply in any district should be given from one source. Small areas where this is the case are in a better position than large areas where generation and supply are separated, or where power and light are supplied by two different concerns. A power company operating at Westminster could not supply the large consumers cheaper than my company, and it could not supply the small consumers at all, while if it were merely supplying current in bulk we should require to be able to prevent it economising at the expense of reliability.

Letters have also been received from Mr. J. H. Bowden (Poplar Borough Council) and Mr. W. B. Esson, but we are compelled to hold them over, together with the report of the discussion at Glasgow, until next week.

ELECTRICAL SCIENCE

British and American

A Null Method of Measuring Ionisation.—The rate of leak method customarily used in the measurement of the ionisation produced in a gas by any agent has many disadvantages. For example, if the agent be a rapidly transforming radioactive substance the time taken to make a reading of a sensitive electrometer is much too great and the movements of the needle are much too sluggish to allow of accurate study of the rate of decay of activity. In the December *Philosophical Magazine* J. S. Allen explains a method of measuring wherein the task of the experimenter consists in keeping the electrometer needle at rest and in reading divisions on a ruler. It is in principle similar to a method, which was not a zero method, used by Bronson. Two ionisation chambers are provided. One consists of two parallel horizontal metal plates, on the lower of which the radioactive matter under test is spread. The other ionisation chamber is similar, but differs in that its lower member is a shallow brass box, covered with a lid that can be slid horizontally along the line of a diameter of the box. The floor of the box is covered with a uniform layer of uranium oxide, and by sliding the lid it is possible to vary at any desired rate the conductivity of the gas in the ionisation chamber. The lower plates of the two chambers are connected respectively to the end terminals of a battery of cells, whose middle point is earthed; the upper plates are connected to the same pair of quadrants of an electrometer, whose other pair is earthed. If at every moment the current from the positive end of the battery through the gas ionised by the test substance is balanced by the current allowed to flow through the uranium chamber from the negative end of the battery, then the electrometer needle will remain at zero. With a substance whose activity is varying the lid of the box must be moved continuously to maintain the balance, and the readings to be taken are those of the time and of the position of the lid on an arbitrary scale. This scale must, of course, be calibrated by the rate of loss method. The calibration curve for a circular box shows that the ionisation increases very rapidly at first as the lid is opened and then more slowly.

Continental

Flames as Rectifiers.—A. Cathiard points out in the *Comptes Rendus* for January 6th that a flame in which no solid conductor is suspended may be utilised for rectifying alternating currents. It is only necessary to use one electrode having a much smaller area than the other. The current then passes only from the larger to the smaller electrode. He uses by preference graphite electrodes in a coal-gas flame, the smaller electrode being a pointed pencil 5 mm. in diameter. From 2,000 to 10,000 alternating volts are applied at forty periods per second. The distance between the electrodes may vary from 5 mm. to 10 cm. without altering the phenomenon, and the electrodes may be at different levels. The continuous current obtained is feeble, never surpassing 30 milliamperes. But it produces distinct electrodeposition in a voltameter. When the current is made stronger, it becomes alternating. There is a bright arc within the flame, and a transport of solid carbon. Even when the current is continuous a feebly luminous arc is seen, whose end moves rapidly about on the larger electrode. When the voltage is reduced, the current also decreases, and finally the rectification is reversed, giving rise to Hanckel's phenomenon. The author has not yet obtained oscillograph curves from the flame current.

Positive Rays.—The Doppler effect in canal rays turns out a most valuable and suggestive phenomenon with regard to the mechanism of radiation. Its discoverer, J. Stark, makes some interesting deductions from it in the *Physikalische Zeitschrift* for December 15th. The displaced canal ray spectra are emitted by positively charged atoms. This is generally agreed. But the author, in spite of Wien's objections, also maintains that they are not emitted below a certain minimum speed. That is why there is a gap between the undisplaced line and

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the displaced fluting. The displaced series spectra are only emitted when a positive atom impinges upon a neutral atom. The impact must be in resonance with the natural period of the radiating electron. Radiant energy is then liberated at the expense of the perfect elasticity of the impact. The necessary speed is greater in diatomic than in monatomic gases. The author answers the question: Why is no light produced by the impact of the α-particles of radium? The reason is that they are too swift. They traverse an atom in 10^{-17} sec., which gives a wave-length 100 times too small to be discernible. Besides the displaced radiation, there is also a stationary radiation, due to the impact of electrons on positive atoms, and the ordinary thermal radiation, which produces a symmetrical broadening of the spectrum lines.

Artificial Emeralds.—F. Bordas has already shown that the colouring of corundum and aluminides generally by radium is not a chemical process, since it is unaffected by immersing in liquid nitrogen. It is certainly not an oxidation. In the *Comptes Rendus* for January 6th the same author studies the effect of prolonged heating upon sapphires and topazes coloured by radium. Temporary heating has no effect, but if the crystals are floated for three hours on a molten alloy of lead and tin and covered with asbestos tissue they begin to lose their colour, and after four hours they return to the state they were in before they were exposed to radium. Prolonged heating to several hundred degrees C., therefore, reverses the colouring action of radium. This observation enables us to control the tinting process with great nicety. The author believes that all Oriental emeralds were originally blue sapphires, which acquired their green colour by the admixture of yellow due to radium. Emeralds may be produced artificially from sapphires in this manner. But the resulting tint is not always of the right shade, and can be improved by heating. The α-rays are inactive in the colouring process, since they are intercepted by glass. The author proves that the β or cathode rays are equally inactive, and concludes that the γ-rays (*x-rays*) of radium produce the colouring.

Magnetism and Specific Heat.—Pierre Weiss has discovered an interesting relation between magnetic intensity and specific heat. He points out, in the *Comptes Rendus* for December 30th, that the discontinuity observed in the magnetisation of iron, nickel, and magnetite at certain high temperatures is exactly paralleled by similar discontinuties in the specific heat, and gives a qualitative and quantitative explanation of this fact. When a substance is magnetised, it possesses a certain internal volume energy of magnetisation, expressible as to product of the "molecular field" and the intensity of magnetisation. It equals, in fact, $\frac{1}{2}H_m I$ ergs per cc., or $\frac{1}{2}nI^2$, where H_m is the molecular field, I the intensity of magnetisation, and n a constant. Now I decreases on heating, and makes a sudden drop at the temperature at which demagnetisation sets in. There is, therefore, a supply of internal magnetic energy which becomes free, and reduces the specific heat. This energy of demagnetisation equals $\frac{1}{2J}\frac{d}{nd\mathrm{I}^2}$, where J is the mechanical equivalent of heat. It can be calculated from the curves of susceptibility, and comes out equal to the drop in the specific heat, as the author proves from the data supplied by Curie and Pionchon respectively. The energies and temperatures agree within about 10 per cent.

ELECTROCHEMISTRY AND ELECTROMETALLURGY

LAST Friday evening's lecture at the Royal Institution was given by Professor T. E. Thorpe, F.R.S., upon "The Centenary of Davy's Discovery of the Metals of the Alkalis." The lecturer commenced with an interesting historical introduction, in which he referred to the foundation of the Royal Institution in 1799. The Institute was founded with the intention of ameliorating the condition of the working classes and for the material benefit of mankind. However, although founded to help those who could not help themselves, in the first years of its existence it was in anything but a flourishing condition, and nearly came to a premature end from want of sustenance. But the appointment of an ungainly youth "with a small brown head" in 1801 resulted in an astonishing revival, and henceforth the Institution was destined to take a leading part in the scientific achievements of the country. It is interesting to note, as we have before pointed out, that Davy's first lecture dealt with galvanism, the galvanic pile of volta having only been discovered in the previous year. Davy was evidently fascinated by the electrical phenomena, but although he showed that the reason for Nicholson and Carlisle, when they electrolysed water, obtaining acid at the positive pole and alkali at the negative pole, was due to impurities, and although he enunciated his electric theory of chemical combination, he had had little time to work at the subject he had at heart. The first actual account of his discovery of the alkali metals is to be found in his laboratory note book, and is dated October 19th, 1807; a copy of this page was thrown on to the screen. The lecturer then gave in considerable detail the account of the discovery by lavish quotations from the original Paper of Davy. Finally a short account of the present-day process for manufacturing sodium from fused sodium hydroxide was given. Dr. Thorpe said that perhaps Davy's greatest discovery was his discovery of Faraday. Davy discovered the method of obtaining the alkali metals by electrolysis, but it is owing to Faraday's electrical discoveries that at last it has been found possible to manufacture sodium on an industrial scale by electrolysis. In 1890 the price of sodium was 8s. per lb.; to-day it is 8d. The present annual output is estimated at about 5,000 tons. The lecture was illustrated by a number of interesting photographic slides showing the works of the Castner Kellner Co. at Weston Point and at Walls End.

We learn that on January 7th the furnace house of the Notodden Works in Norway, where nitrates are manufactured from atmospheric nitrogen, was burnt down. The fire broke out at 3 o'clock in the morning in the electrical portion of the works, probably from a short-circuit. The fire brigade managed to save the buildings which were in the neighbourhood of the furnace house, and it is therefore hoped that it will not be long before the works can be restarted. The damage is estimated at 150,000 kronen (about £8,250). It is interesting to note that, owing to the great success of the process, the capital of the company stands at a considerably enhanced value.

In the *Zeitschrift für Elektrochemie* of January 17th, Bernh. Neumann writes upon electrometallurgy in aqueous solution. He commences with a study of the work done during the last half-year upon the electrolytic refining of copper. Incidentally it is mentioned that, in 1906, 368,137 tons of copper were electrolytically refined, and for the first eight months of 1907, 241,000 tons (the numbers probably refer to short tons of 2,000 lb. each). In America, 85·7 per cent. of the copper produced is refined by electrolysis.

In France, the Société de Cuivre in Eguilles have a refinery in which two tons per day of refined copper are produced. The manufactory in Givet produces seven tons, and the Elmore Works at Dives turn out 12 tons per day. In Australia, the Electrolytic Refining and Smelting Co. has been formed, with a capital of £150,000, to refine imported copper and also copper produced in Australia.

Interesting information as to the loss owing to the cathodes dissolving in the electrolyte is given. The solubility may vary from 0·2 to 1 per cent. This may in part be due to excess of iron salts being produced in the electrolyte as the anodes pass into solution. Owing to the circulation of the electrolyte, and also to electrolytic action, the ferrous iron becomes converted into the ferric condition, and the ferric sulphate then reacts with the deposited copper thus:—

$$Cu + Fe_2(SO_4)_3 = CuSO_4 + 2FeSO_4.$$

By careful insulation the loss of current through leakage may not be more than 1 per cent, but at least 5 per cent. is lost through shorts between the electrodes. The current efficiency is given as between 90 and 95 per cent.

The process of Cowper-Coles for obtaining seamless tubes by rapid rotation of the cathode, and that of Elmore, in which a burnisher is employed, are well known, also the method of Harrison, in which the electrolyte is injected against the cathode. All these processes aim at working with high current densities and obtaining a smooth and tough deposit. According to the German patent 175,479, the same results can be obtained by using a moderate speed of rotation and having a fine insoluble powder, such as kieselgur, in the electrolyte (20 kg. per 100 litres) (ELECTRICAL ENGINEERING, Vol. I., p. 1015).

One of the most difficult problems yet to be solved is the treatment of copper ores in such a manner that the copper may be directly obtained pure without it being in the first place necessary to smelt it. L. Anderson (American patent 862,871) suggests treating the ore directly with hydrofluosilicic acid and then electrolysing the copper fluosilicate so obtained. R. Lamp (American patent) hopes to solve the problem by treating the crushed ore in revolving drums with sulphurous acid, and L. Juman (German patent) treats the roasted ore with a solution of ammonium sulphate, ammonium sulphite, and ammonia. After driving off the excess of ammonia the mixture is treated with sulphurous acid, and the double salt, $CuSO_4$, Cu_2SO_3 so obtained is dissolved in sulphuric acid and electrolysed. We are afraid that none of the methods will turn out commercially successful, but it is as well to record them, because there is a wide field open for research in this direction.

In connection with the electrolyses of gold cyanide solutions, Douglas Lay finds that if the cyanide solution contains free alkali, that it is then only very slightly decomposed by the electric current. For example, in one case where no alkali was added, 30 per cent. of the cyanide was decomposed, but in another case, where free alkali was added, only 0·03 per cent. of the cyanide was decomposed. This, of course, is important, because if the decomposition is very slight the solution after the gold has been removed can again be used to leach out fresh quantities of tailings.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published Jan. 16th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from from abroad.

1906 Patents

20,928, THE BRITISH THOMSON-HOUSTON CO. (*General Electric Co. of New York*). This specification relates to the control of alternating-current motors of the commutator type, and its object is to provide suitable means for braking such motors. This consists of impressing on the field a voltage ninety degrees out of phase with the voltage of the supply. This produces a current in the field in phase with or in opposition to the source of supply, so that the induced armature voltage may practically be in opposition to the source, thus ideal conditions for no load may be obtained. The reactance of the armature circuit of the motor is very much greater than its resistance, so the current lags by a large angle behind the electro-motive force. The induced armature voltage must be varied in order to vary the braking effect, but if the resultant voltage is to be maintained at all times ninety degrees out of phase with the line voltage, the induced armature voltage must vary simultaneously in amount and phase, so that the line voltage, induced armature voltage, and resultant voltage will form a right angle triangle. The invention also supplies to the field of the motor a current of proper phase and magnitude to induce in the armature a voltage which with the voltage of the source, produces a voltage ninety degrees out of phase with the voltage of the source, and maintaining the phase of the resultant voltage fairly constant. Four claims, two figures.

29,174, H. LEITNER. This specification relates to improvements to electric motors, designed to be driven by a fluctuating source of direct current supply, as obtained in traction circuits, and the object is to make a motor the speed of which will remain practically constant whatever the fluctuations of the voltage may be. This is accomplished by making use of a constant or approximately equal E.M.F. in opposition, but inferior to the exciting voltage of the shunt field circuit of the motor. This E.M.F. may be obtained by a battery or dynamo, and by varying the opposing E.M.F., "over-compensation," that is, running faster at low voltages, or any degree of under compensation can be arranged for. One claim, one figure.

29,584, BRITISH THOMSON-HOUSTON CO. (*General Electric Co. of New York*). This relates to circuit controlling devices which automatically open an electric circuit in case of overload, and also to devices to prevent the closing of the switch when there is an overload on the circuit. The method employed consists of two automatic circuit breakers connected to the circuit and having a common operating means, so that either may be closed and the circuit completed on closing the other. In case of over-load upon the circuit, the circuit breaker which was first closed will be automatically tripped and open the circuit, so that it is impossible to keep the circuit closed if the overload remains. Four claims, seven figures.

1907 Patents

793, W. D. KILROY & EVERSHED & VIGNOLES. The specification relates to an automatic electric starting switch, consisting of an electro-magnet, having pole pieces adapted to co-act with an armature, movably arranged, relative to the poles, and also with a rotary Foucault brake device, adapted to be rotated by the armature, a series of contacts for resistances or other devices, and a movable contact arm is moved in opposition to a mechanical restoring force by the armature over the resistance contacts when the electro-magnet is energised. Three claims, four figures.

3,908, THE SUNDERLAND FORGE & ENGINEERING CO., LTD., & W. BLAIR. This relates to electric cranes, winches, &c., fitted with hand or foot power brakes, and provides an improved interlocking gear and controller returning means by suitable links connected at one end to the brake lever, and which engage at their other ends suitable guides, arranged at either side of the controller spindle, having projections which engage and disengage the controller lever. When the brake is in the "off" position the links are in such a position that the projections are clear of the controller lever, and the latter can be operated in either direction, but when in the "on" position and the brake is operated the projections cause the controller lever to return to its normal position. Two claims, three figures.

6134, THE BRITISH THOMSON-HOUSTON (*General Electric Co. of New York*). This is a block signal system for electric railways, in which the track rails are electrically continuous, and the signal circuits are supplied with current from a supply of alternating current entirely separate from that supplying the power circuit, having the power circuits permanently closed, but the supply circuits for the signal currents to each block normally open. An approaching train has the means of controlling and closing the signal supply circuit of a block ahead of the train, so the signal may be cleared and held clear until the train enters the block. In this system inductive windings cross connect the rails at both ends of each block, and form with the rails a permanently closed track circuit for each block. The connection between the circuits of adjacent blocks are adapted to form a return path for the power current, and means are provided by which a moving train produces an alternating current in a track circuit ahead of the train, and a signal controlling device for each track circuit responsive to the alternating current when supplied to it. Four claims, one figure.

8462, G. MARCONI & MARCONI'S WIRELESS TELEGRAPH CO., LTD. In this invention, instead of using a spark or arc in the oscillating circuit of a wireless telegraph transmitter, the current is caused to discharge across a small gap at the periphery or near to it of a suitable insulated disc or sphere which is caused to revolve at a high speed between two fixed balls, very close to its periphery. These balls are placed in a circuit containing a condenser and an inductance of suitable values. Each plate of the condenser is also connected to the poles of a continuous-current machine producing a sufficiently high E.M.F. to cause the current to bridge the small air-gap between the disc and the balls. In the connections between the condenser and the C.C. generator, resistances of suitable value are placed. A conductive connection is made between the circuit containing inductance and condenser and the transmitting antenna, whose period of oscillation must be brought into resonance with the period of the oscillating circuit. The receivers should contain a responsive oscillation circuit with as little damping as possible. Four claims, two figures.

10,259, LE TALL (HEWITT). This specification relates to improvements in wireless telegraphy apparatus, and particularly to a new form of radiating circuits. One of the purposes of this patent is to secure a field of force having primarily a direction, such that the direction and space distribution of the magnetic and electro-static lines of force with respect to the length of the generating conductor, or radiator, and tend to lie in the radial planes passing through the axis of the radiator and the electro-static lines tend to lie in planes at right angles to the axis of the radiator. Any suitable system of primary or exciting circuit is provided, with a radiating circuit comprising a series of two or more coils or solenoids having a common axis and disposed in a vertical direction. These can be connected in multiple, and so proportioned as to produce a resulting vertical straight line. A sufficient number of coils are employed, so that the electro-magnetic and electro-static lines will be sufficiently distributed in space, insuring an efficient radiation. By connecting the coils in the same manner as in auto-converters, and each having a capacity, and inductance equal to one-quarter of a wave-length, and having one end earthed, they will maintain a more intense field and consequent effect. One claim, one figure.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Names in brackets indicate communicators of inventions from abroad.

Summaries of the more important of these patents will appear in our next issue.

1906 Patents

24,448, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric motor control apparatus.

27,358, HAMLYN. Automatic electrical circuit breakers of the loose handle type.

1907 Patents

98, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric transmission systems.

155, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Incandescent electric lamps.

521, PEARCE & WALTON. Inclined carbon arc lamps.

1,278, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Operating mechanism for electric switches and other purposes.

1,301, CLIFT. Electrical ignition devices for internal-combustion engines.

4,363, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Processes of insulating electric conductors.

4,802, POULSEN. Signalling in wireless telegraphy.

8,286, BRITISH THOMSON-HOUSTON CO. & DAWSON. Rotating members of dynamo-electric machines.

22,634, HOMMEL.—Ignition devices for internal-combustion engines.

For LOCAL NOTES, &c., see pp. 141 to 146

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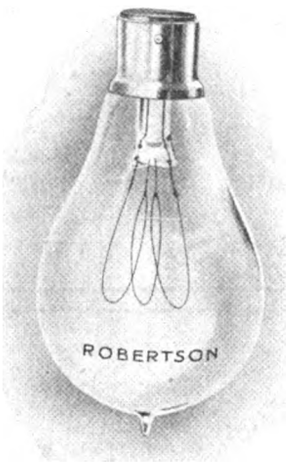
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For LOCAL NOTES, &c.—See pp. 141 to 146

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LOCAL NOTES

BARNES: *Tantalum Lamps for Public Lighting.*—The Electrical Engineer having reported that the tests of tantalum lamps for public lighting had proved highly satisfactory, the Council have resolved to renew all Nernst lamps where the lamp bodies give out during the next month, with tantalum lamps. A detailed report is to be prepared by the engineer of the costs per annum of the several types of lamps.

BOLTON: *Proposed Parliamentary Bill.*—Bolton Town Council at a special meeting, held on the 15th inst., decided to drop its proposed Parliamentary Bill, in view of opposition to the proposed construction of tramways in the Hulton district.

BRIGHTON: *Electricity Works Danger.*—The attention of the Brighton Corporation has again been called to the fact of the weakening of the east beach in front of the electricity works, which has become a source of danger. It is very important that the immediate attention of the Corporation should be given to this matter.

BUENOS AYRES: *Electric Supply Agreement.*—The *Review of the River Plate* states that the Compania Alemana Transatlantica de Electricidad have approved the ad referendum contract made with the Buenos Ayres Municipality. The contract, which will now be submitted to the Council, provides that the company has the right to work the industry until the end of 1957, at which time all the stations, machinery, plant, &c., will become the property of the Corporation.

CHISLEHURST: *The Council and the Electric Light.*—The Chairman of the Chislehurst Urban District Council, at a meeting of that body on the 15th inst., reported having interviewed the manager of the Chislehurst Electric Light Co., with regard to the cost and poor quality of the light provided. The manager is reported to have stated that owing to the scattered positions of the consumers it was impossible to reduce the prices, as they were only paying the shareholders 3 per cent. dividend on their investments. He recommended the use of the new metallic filament lamps. The chairman said he had tried the lamps, and found them satisfactory.

CLYDEBANK: *Transference of Electricity Order.*—The Finance Committee of the Town Council have had under consideration the question of the Clyde Valley Electrical Power Company transferring their Electricity Order to the Strathclyde Company. The clerk reported that the companies had agreed to all that the Council had asked. The Committee therefore agreed not to oppose the transfer.

DUNDEE: *Extension of Area.*—All the requirements in connection with the Electric Lighting Extension Order recently lodged by the Corporation with the Board of Trade have been complied with, intimation to this effect having been received. The purpose of the Order is to extend the area of supply so as to include the whole of the district annexed under the recent Local Government Provisional Order.

Brakes for the Electric Cars.—The Dundee Tramway Committee are taking every precaution in regard to the brake power on the cars, and on the 13th inst. they decided to equip six new cars now being built with pneumatic brakes at a cost of £65 for each car.

GLASGOW: *The Dalmuir-Dumbarton Tramway.*—Work on this tramway was commenced on the 20th inst., and it is expected that within a few months Glasgow people will be able to travel to Loch Lomond by car, a distance of 20 miles.

GRIMSBY: *The Electrical Undertaking.*—At a meeting of the Grimsby Corporation Electric Lighting Committee, held on the 20th inst., the Borough Electrical Engineer, Mr. W. A. Vignoles, reported that during the month, 215,951 units of current had been sold, an increase of 83,351 units upon the previous month's consumption. Mr. Vignoles suggested that the committee should adopt the standard wiring rules of the Institution of Electrical Engineers. Accidents had happened under the existing lighting rules, and they needed revision. The institute's standard rules precluded "shoddy" wiring. The committee decided to adopt the rules.

HANLEY: *Electricity Undertaking Costs.*—The working costs of this undertaking have varied little during the past four years, in spite of the greatly increased output. For 1903 it was £5,160; 1904, £5,685; 1905, £5,125; and for 1906, £5,131. The gross expenditure, including management, &c., was £74,024; added to this were interest payments of £25,528, and repayments of loans equalling £22,680, and the total receipts had equalled £125,000, in the twelve years the works had been in operation. The profits are roughly £8,600, and losses £3,600, leaving a surplus of £5,000.

HASLINGDEN: *Electric Lighting Order.*—It was reported at the Haslingden Council meeting on January 16th that in response to representations made to them by the Council, the Board of Trade were prepared to extend the Electric Lighting Order held by the Corporation for a further period of twelve months.

HOLYHEAD: *Electric Lighting Undertaking.*—The accounts of the Holyhead Electricity Committee for the past year show that there is a profit of £376. The number of consumers has increased from 30 to 292 in the three years during which the works have been in existence.

HOUGHTON-LE-SPRING: *Breach of Mining Regulations.*—At Houghton-le-Spring on the 16th inst., a miner employed on an electric coal-cutting machine at the Lambton Pit Colliery, was charged with a breach of the mining regulations. It was stated that owing to the defendant allowing the cable to get between the wall and the cutter some of the insulating material was rubbed off, the cable fused, and the machine fired. The defendant received a shock, and was fortunate in not being killed. He was fined 10s. and costs.

HUDDERSFIELD: *Electric Tramway Receipts.*—The report of the Tramways Committee showed that for the nine months ended December 31st, the total working expenses of the tramways amounted to £52,054, against £51,044 in the previous corresponding period. After allowing for interest on capital, redemption of debt, and depreciation, the net surplus was £5,536, against £2,900 in the preceding nine months.

HULL: *The Electricity Supply Breakdown.*—On January 14th a breakdown occurred at the Sculcoates Lane generating station, due to the failure and burn-out of the 2,200-volt armatures of three of the largest machines. This burn-out caused a cessation of the supply throughout the greater portion of the centre of the town from 4.20 p.m. to 4.50 p.m., but the district near the station was kept alight by the low-tension sets. One of the damaged armatures was totally destroyed, and will have to be rewound, and two others will in all probability require similar treatment. The Hull system is quite an uncommon one, being high-tension direct current, and is by far the largest undertaking of its kind at 2,200 volts in the United Kingdom, and the consequence has been that dynamos made for the Corporation have been largely experimental, and confined to a small number of manufacturers. The result of this is that the design of the machines at Sculcoates Lane embodies many features which preclude any likelihood of their continued successful running in the future. The Engineer regrets to have to say that he does not feel justified, either in the interests of the Corporation or himself, in accepting further responsibility in connection with them. He emphasises the fact that owing to the rapid way in which the undertaking is growing, the largely increased number of power users who are entirely dependent upon the Corporation system for a supply, and the very much greater usage which the plant now receives, the time has arrived when the Corporation must take into consideration the question of replacement of at any rate a portion of this defective part of the plant without delay. In dealing with the question of replacement, the Corporation is faced with the difficulty of finding any firms of repute who have had experience in the building of this class of machinery. The two latest machines in the station were built by the Lahmeyer Company, and have been running on full load for over 12 months and given every satisfaction. The Council has decided to purchase three more similar sets from that company, and these sets are to be installed before November next.

LARKHALL: *Fire at a Colliery.*—Early on the morning of January 15th a fire broke out in the power house of the Bitrkrigg Colliery, and the electric light plant, the engines for driving the coal-cutting machines and engine house, were entirely destroyed. The damage is estimated at £2,000.

LONDON: *London County Council.*—The L.C.C., on Tuesday, at the first meeting after the Christmas vacation, considered an application by Stepney Borough Council for sanction to borrow £42,150 for the equipment of a new generating station at Blyth's Wharf, Limehouse. The total estimated cost of providing the station, without allowing for extensions, is £66,565. The Finance Committee, reporting upon the application, stated that in the absence of a cheap supply in bulk, Stepney Borough Council could probably not do better than establish a generating station as proposed. Full particulars of the loan applied for had not been submitted, but sufficient information had been supplied to enable the committee to recommend that sanction be given to the borrowing of £22,000, on the understanding that the whole of the cost of new foundations, pipe, or cable connections, &c., be paid out of reserve fund and not out of the borrowed money.

Mr. McKINNON WOOD remarked that in consequence of the action of the County Council last year, the bulk supply scheme for London had not been carried through, and now, in this case, there was to be an expenditure of £66,000 on a generating station which no expert would say was an economical one.

Mr. HAYES FISHER said that so far as this particular case of Stepney was concerned, there was no evidence that if the County Council had acted otherwise than it did, the £66,000 would not have been expended.

Capt. HEMPHILL deplored the fact that the Council had done nothing towards securing a cheap supply of electricity for London. It was a pity they were allowing Borough Councils and private companies to fritter away money in dealing with this question in a piecemeal fashion.

Mr. GORDON, the representative of Stepney on the L.C.C., said they had come to the conclusion that they could not hope to obtain from outside sources a supply of electricity as cheaply as they could generate it for themselves, and so they

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proposed to build a generating station which, he believed, would compare favourably with others in regard to equipment and up-to-date-ness.

The Finance Committee's recommendation was then agreed to.

Applications for loans for electricity purposes were also granted as follows:—Battersea, £2,154; Woolwich, £3,000.

The Highways Committee reported that as Greenwich Borough Council had refused their consent to the construction of a junction line of tramways between the electric conduit tramways in Deptford High Street and the tramways in South Street, Greenwich, the scheme, estimated to cost £87,100, must be abandoned.

The two chimneys at the second portion of the Greenwich generating station, which have only been built to a height of 204 ft. owing to questions raised as to the effect upon the Royal Observatory, are to be completed, but not heightened, at a cost of £2,275.

The Council decided to fix draught screens to 423 roof-covered cars, at a cost of £10 per car. Fifty cars will be dealt with during the current financial year, and the remainder during 1908-9.

The Highways Committee reported as to negotiations which had taken place between the Metropolitan Electric Tramways, Limited, the Board of Trade, and the Committee, with reference to the proposed purchase by the L.C.C. of the Harrow Road tramways. Representations were made by the company to the effect that inconvenience would arise from the dual ownership of the tramway, and the Board of Trade intimated that before approving the purchase they would require to be satisfied that public interests would not suffer. In reply, the assurance was given that the Council would be prepared to come to any reasonable agreement for dealing with the matter, either by the Council working the tramways itself with mutual running powers, or by leasing the lines to the outside authority. The Board of Trade eventually approved the service of notice of purchase. It was decided to enter into negotiations and take all necessary steps in connection with the arbitration (if any) with reference to the purchase.

Battersea: Electricity Station Accident, &c.—The Lighting Committee of the Borough Council report the receipt of a writ of summons on behalf of Messrs. Mather & Platt, Ltd., with reference to the spare armature supplied by them in connection with the steam generating plant at the central station, payment of which had been deferred owing to alleged non-compliance with the provisions of the contract. The Committee has given directions for the matter to be brought before the Law and Parliamentary Committee. It appears from the report made by the Board of Trade upon the preliminary inquiry with reference to the explosion from a stop valve at the central station on November 1st, during the time of inspection by the engineer of the National Boiler & General Insurance Co., Ltd., that the explosion was caused by water hammer action, brought about by opening the drain and stop valve when the horizontal steam pipe between No. 1 engine and the main range of pipes contained water subject to the steam pressure of the boilers. No person was injured as a result of the accident.

Reconstruction of the Tramways.—With reference to the coming electrification of the Lavender Hill tramline, the Finance Committee of the Battersea Borough Council reported that the London County Council would sanction street widenings, "subject to the Borough Council agreeing (1) to contribute one-third of the net cost of such widenings, (2) to exercise any compulsory powers it may possess for acquiring the necessary property, and (3), to appoint the County Council's officers to act in the matter on behalf of the Borough Council. The committee decided "That the three conditions mentioned in the letter be agreed to; all details as to the material to be used in paving the roadways and as to levels, cost of altering same, and setting back kerbs, &c., to be a matter for subsequent arrangement with the London County Council."

Islington: The Exchange of Lighting Areas.—The sum paid to the County of London Electricity Supply Co., in respect of the exchange of electric lighting areas between Finsbury and Islington, for goodwill of consumers transferred, viz., £1,076, is to be charged to the electricity reserve fund.

Poplar: Public Lighting.—At a meeting of the Borough Council it was decided to substitute metallic filament lamps, for the existing carbon lamps for the lighting in the side streets. The cost of the lamps will be £416 13s. 4d. per annum, but they will save £228 10s. in current, and give 40 c.p. more per lamp column.

Southwark: Electricity Undertaking.—At the next meeting of the Southwark Borough Council, a report of the district auditor on the municipal electric light undertaking will be submitted, according to which the undertaking, which in the past has been a loss to the ratepayers, last year showed a profit of £473. Now the council is "free wiring" consumers' premises, and thereby anticipates a great increase in the supply.

The London Electric Supply Co.'s Offer.—The Electricity Committee reported on Tuesday having considered a letter from the London Electric Supply Corporation, Ltd., offering to supply energy in bulk, and urging that the principal advantage of such an arrangement would be to relieve the Council of the necessity of raising further capital in respect of the electric supply undertaking, while the price at which the supply would be given by the company would enable the Council to distribute it at a profit. The company's letter further stated that should the Council not see their way to take a bulk supply, the company would be willing to take over the lighting of those streets in the borough which are at present lighted by electricity and also to light such other streets as are at present lighted by other means, and offering to quote terms in respect of either or both proposals. The Electrical Engineer was directed by the Committee to report upon the desirability or feasibility of linking the undertaking up with some other company or undertaking (assuming the Council to have the power to do so, and the company to have power to make the supply) with a view to making provision to meet emergencies or breakdowns. From the report presented to the committee on the matter it appears that the expense of carrying out such a scheme would necessitate the expenditure of a considerable sum which would far out-weigh any advantage likely to accrue by adopting the proposal. The assumption that by accepting the company's proposals the Council would be relieved of the necessity of raising further capital in working the undertaking was not borne out by the Engineer's report, which states that the process of linking up with another supply authority would cost in transforming apparatus—including transformers, motors, generators, switchgear, &c.—not less than £3,000, and might exceed that sum by £500—neither would it enable the Council to evade further capital expenditure if they propose to continue the development of the undertaking. Under all the circumstances the Committee failed to see that any advantage would accrue to the undertaking by taking a supply of current in bulk or otherwise from an outside source, and they had, therefore, decided that no action be taken on the letter.

MACCLESFIELD: *The Provisional Order.*—The Council are applying to the Board of Trade for a Provisional Order under the Lighting Acts of 1882 and 1888, for the following purposes: (1) To amend Section 6 of the Macclesfield Electric Lighting Order, 1901, and the provisions of the Electric Lighting (Clauses) Act, 1899, referred to in that section by extending the times within which distributing mains are to be laid down. (2) To authorise the Corporation to transfer and assign all or any of the powers, &c., of the Corporation, under the Order of 1901, to the Macclesfield Electric Lighting and Power Company, Ltd., or any company or person to be named in the intended Order. (3) To divest the Corporation of any legal powers imposed upon them by the Order of 1901.

MANCHESTER: *Tramways Parcel Delivery.*—At a meeting of the Manchester Tramways Committee, held on the 14th inst., it was stated that the result of the working of the parcels delivery system showed a profit of £1,084. The receipts were £3,670, and the expenditure was £2,586.

MANITOBA: *Government Telephones.*—The Manitoba Government took over the Bell system of telephones on the 15th inst. A reduction in the rates under the public ownership is promised in six months' time.

NORWICH: *The Great Eastern Railway Bill.*—The Law and Parliamentary Committee are raising a petition against the Great Eastern Railway (General Powers) Bill. It is proposed in the Bill that the company shall supply electricity to Parkeston, and to tenants of the company, and occupiers of premises connected by sidings with the railway undertakings of the company, or to any local or sanitary authority, or company authorised to supply electrical energy. The Corporation are taking this step to protect their own interests.

PERTH: *The Jeanfield Tramway Extension.*—At a meeting of the Perth Town Council held on Monday the 13th inst., it was decided, after a long discussion, to extend their tramway system to the Jeanfield district.

PONTYPRIDD: *Electricity Undertaking Progress.*—At a meeting of the Pontypridd District Council Electricity Committee, it was reported that the receipts for December amounted to £719 18s., as compared with £561 in the corresponding month of last year, while the tramway receipts totalled £845, as against £671 for the corresponding month last year. The Christmas traffic on the tramways for the week showed an increase of £71 10s. over the same week of the previous year.

READING: *Tramways Receipts.*—At a meeting of the Tramways Committee, held on January 2nd, the tramways manager reported that the receipts during the fourteen days from Monday, December 16th, to Sunday, December 29th, inclusive, constituted a record, amounting to £1,355. The previous highest takings for the same period were £1,309 in 1904. The traffic returns for the nine months ending December 25th from April 1st, 1907, were £24,368, against £25,149 17s. in 1906.

UXBRIDGE: *Transfer of Lighting Orders.*—The Uxbridge and District Electric Supply Co., Ltd., are applying to the Board of Trade for approval to transfer a portion of their supply area to the Metropolitan Electric Supply Co., Ltd., situated in the Urban District of Greenford. A plan of the area has been deposited at the Board of Trade offices. A copy of the proposed deed of transfer and plan have been deposited at the office of Messrs. H. C. Cleaver, Ltd., Tudor Works, Park Royal, Willesden, where copies can be obtained. Objections to the proposed transfer are to be made to the Assistant Secretary, Harbour Department, Board of Trade, 7 Whitehall Gardens, before the 17th day of February, 1908.

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TENDERS INVITED AND PROSPECTIVE BUSINESS

AUSTRIA-HUNGARY.—Tenders are invited for the supply of electric lighting materials for the railway works at Pilsen. Tenders should be sent to the K. K. Staatsbahndirektion at Pilsen before January 30th.

AUSTRALIAN COMMONWEALTH.—The representative of the Commonwealth in London (Captain R. Muirhead Collins, C.M.G.), notifies that he has received tender forms, specifications, &c., in connection with the supply and delivery of thirty-three switchboards for private branch exchanges for common battery working, for which tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 2.00 p.m. on March 4th. Specifications, tender forms, &c., may be obtained at the Commonwealth Offices in London, 72 Victoria Street, S.W., where also preliminary deposits on tenders may be paid. Copies of the specification and conditions may be inspected at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, London, E.C.

BANGOR.—A Local Government Board inquiry has been held into the application by the Corporation for sanction to borrow £1,000 for electric lighting purposes.

BEXHILL.—In connection with the application of the Urban District Council to the Local Government Board for sanction to borrow £5,800 for extensions to the electrical plant, the following amended estimate has been prepared:—Dynamo and engine: Contract, £2,899; foundation, &c., £120. Boiler: Contract, £1,560; foundations, &c., £336; pipe work, £450; switchboard, £250. Store: Contract, £215; fixtures, &c., £ 5. Total, £5,855. The application is therefore to be made for the increased sum.

BRISTOL.—The Docks Committee invite tenders for the supply, delivery and erection, and maintenance for 12 months after they have been in use, of electric cables for the supply to Avonmouth Docks. The tenders are also to include the construction, delivery, erecting in place, fitting, completion, and testing and the maintenance for 12 months after they shall have been taken into use of the electric lighting installations, complete in all details, for the various buildings, railway yard, wharves, &c., at the Royal Edward Dock, now in course of construction at Avonmouth. Specifications, &c., from the Secretary of the Docks Committee (fee £5, returnable), and tenders to 19 Queen Square, Bristol, by February 17th.

CHELTENHAM.—Tenders are invited for the supply of electric light fittings, among other stores, for the year ending March 31st, 1909. Particulars from the Borough Surveyor, to whom tenders by January 31st.

CHISLEHURST.—The Chislehurst Electricity Supply Co. is to erect a new sub-station at Lower Camden at a cost of £3,000.

CROYDON.—The Corporation has decided to install coal-conveying plant in the generating station at an estimated cost of £2,525, made up as follows:—Coal bunkers, £980; conveyer, £850; automatic measures, £195; building, £500.

EDINBURGH.—Tenders are invited for an extension switchboard panel. Specifications, &c. (fee, two guineas, returnable), from Sir Alex. B. W. Kennedy, the consulting engineer to the Corporation, 17 Victoria Street, London, S.W., and tenders to the Town Clerk by February 10th. (See an advertisement this week.)

ESSEX COUNTY COUNCIL.—A Local Government Board inquiry was commenced last week at Colchester into an application by the Essex County Council to borrow £289,276 for the purposes of a new county asylum. Of this amount £4,300 is required for electrical generating plant.

ILFORD.—The Electricity and Lighting Committee brought up at the last meeting of the District Council a report recommending the extension of the plant at the generating station at a total cost (including buildings) of £27,000. There was also a recommendation that current be supplied for power purposes at the rate of 1d. per unit to consumers of over 20,000 units per quarter. The chairman of the Committee explained that the business was extending, and it would be necessary to have the extension ready by next autumn. During December 20 new accounts were opened, and in the previous month 35. Up to date they had 3,000 consumers in Ilford. The time was coming, he hoped, when they would be able to make a universal charge of 1d. per unit for power and heating. The chairman of the committee pointed out that although the generation cost was 0·99d. per unit, the output included current for both power and lighting: for the latter they got 3½d. per unit. They could, therefore, afford to take a lower charge for power supplied as a day load. In reply to further remarks the chairman said that the proposed extension was not intended to meet the case of any prospective new consumer, but to satisfy the demands of their present lighting consumers. The committee's recommendations were adopted.

ITALY.—The December *Bulletin* of the French Chamber of Commerce reports that the committee elected for the construction of railways across the Dolomite Alps have finished the preliminary work, and applications for authorising these lines have already been made to the Government. A company is being formed for the construction and working of the new system. The lines to be constructed are three: the first, from Bribano to Agordo; the second, connecting the Cadore line with Cortina di Ampezzo, with a branch line to Auronzo; the third, from Feltre to Primolano. The three lines will have a total length of more than 100 kilometres, and will be of narrow gauge. It is proposed to instal hydraulic works to provide the power for electric traction. It is stated further that the Italian Government have assigned a credit of 70 million lire for electric traction on various lines having steep gradients and long tunnels, and that a concession has been granted to a company composed of French, Belgian, and Italian capitalists for the exploitation of an electric railway between Rome and Naples.

The *Bollettino delle Finanze* announces that "Il Consiglio d'amministrazione delle Ferrovie has authorised the sum of 1,137,000 lire (about £45,480), to be expended on the conversion to electric traction of the branch railway line from Savona to S. Giuseppe, and also for the installation of a steam power station for the production of the electric current.

LEEDS.—Tenders are invited by the Electric Lighting Committee for steam, exhaust, overflow, and other pipes, valves, &c., in connection with a steam turbo-generator of 3,000 kw. capacity. Particulars from H. Dickinson, manager, the Whitehall Road, Leeds (fee, two guineas, returnable), and tenders to the Town Clerk by February 10th.

LONDON: *London County Council.*—Tenders are invited for the road-work and platelaying in connection with reconstruction for electric traction on the underground conduit system of the horse tramways in Caledonian Road and Seven Sisters Road. The total length is 5¼ miles single track. Contractors will be required to use the track rails and their fastenings, the slot rails and the conduit rails, and the special work for the various junctions and cross-overs, which will be supplied by the Council under other contracts, but all the remaining metal work and other material are to be included in the tender. Full particulars from the Chief Engineer at the County Hall, Spring Gardens (fee £5, returnable). Tenders to the Clerk by January 28th.

The Council also invites tenders for (*a*) the manufacture, delivery, and laying of about five miles of low-tension, lead-covered electric cable, and about two miles of telephone cables, &c.; and (*b*) the laying of stoneware cable ducts, building manholes, repaving, &c., for the reconstruction for electric traction of the Council's tramways in Caledonian Road and Seven Sisters Road. Tenders to the Clerk by February 4th (See an advertisement this week.)

NEWPORT.—The sanction of the Local Government Board has been received to the borrowing of £28,000 by the Corporation for the purposes of the Electricity Works.

NORTH EASTERN RAILWAY CO.—The directors of the North Eastern Railway Co. invite tenders for the erection of an electrical sub-station at West Hartlepool. Plans and specification may be seen, and quantities and further information obtained upon application to Mr. William Bell, the Company's architect, at York. Tenders to the Secretary at York not later than Monday, January 27th.

NORWAY.—It is stated that an underground electric tramway is to be constructed at a cost of £75,000.

RUSSIA.—The "Moniteur des Intérêts Matériels" (Brussels) reports that an agreement has been concluded between the tramway company and the Municipality of Odessa, by which the tramway system is to be extended from 80 to 140 kilometres, the company to be allowed three years (from the date when Government authorisation is received), to complete the system and to instal electric traction.

STRETFORD.—A Local Government Board enquiry was held last week into the application by the Urban District Council for sanction to borrow £42,718 for the purpose of the electrical undertaking. It was stated in evidence that the original scheme in 1903 was based upon an estimated demand of 400,000 units per annum, but that the demand of the first year was more than double this, and already extra plant has had to be put down, the cost of which is included in the sum for which sanction is now being sought. Of the amount for which sanction is being sought a sum of £36,990 is needed for structural alterations and new plant, the remainder being required to meet the excess expenditure over loans already sanctioned.

TAUNTON.—Application is to be made to the Local Government Board for sanction to borrow £2,000, which, it is estimated, will cover the next three years' estimate for the supply of meters and cables.

WEST HAM.—Tenders are invited for the supply of engine-room stores, rubber-cored cable electric wiring materials and accessories, and chemicals. Particulars from the Borough Electrical Engineer's office, 84 Romford Road, Stratford, E. Tenders by February 6th.

WIMBLEDON.—The Corporation invite tenders for the supply and erection of the undermentioned plant at their electricity works, and are prepared to accept tenders subject to the sanction of the Local Government Board being obtained for the necessary loan:—(*a*) A 1,000 kw. turbo-alternator, with condensing plant; (*b*) two water-tube boilers, economisers, pipe-work, and feed pump; (*c*) high-tension main switchboard

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and switchboard gallery. Forms of specification and tender, with the general conditions, may be obtained from Mr. H. Tomlinson-Lee, the Borough Electrical Engineer, Electricity Works, Durnsford Road, Wimbledon (fee £1 each specification, returnable), and tenders to the Town Clerk by February 18th.

WOOLACOMBE.—The Council is considering whether it shall instal an electric lighting plant.

YARMOUTH.—Tenders are invited for the supply, delivery, and erection of a 400 kw. continuous-current traction generator. Particulars and forms of tender from the Borough Electrical Engineer, 20 King Street, Great Yarmouth (fee £1 1s., returnable), to whom tenders by February 1st.

TENDERS RECEIVED AND ACCEPTED

ADMIRALTY.—Messrs. Cowans, Ltd., have received an order for switchboards for H.M. battleships *Minotaur* and *Shannon*, and also for the Gibraltar Dockyard.

CROYDON.—The Corporation has placed an order with the British Electric Transformer Co., at £211, for two 100-kw. transformers.

BELFAST.—At the bi-monthly meeting of the Belfast Harbour Commissioners, on Tuesday, it was stated that nine tenders had been received for the construction of the new harbour tramway, and the engineer and electrical engineer of the Trust had recommended the tender of Messrs. Dick, Kerr & Co., Ltd., subject to certain modifications

FRANCO-BRITISH EXHIBITION.—Seven switchboards are being supplied by Messrs. Cowans, Ltd., in connection with the lighting of the Franco-British Exhibition, including Andrews' patent discriminating devices.

HULL.—The Corporation have confirmed a recommendation of the Electric Lighting Committee to purchase three Lahmeyer continuous current generators.

INDIA.—Messrs. James Gordon and Co. are supplying three of their patent Samson balanced gate turbines in connection with the Mulakand water power scheme in India.

LLANDUDNO.—The Urban District Council has accepted the tender of the Tudor Accumulator Co., at £1,741 for additional plant in connection with the light railway.

LONDON: *London County Council.*—The L.C.C. has accepted the following tenders for the supply of requisites in the tramway department:—Bullers, Ltd., 2,000 track insulators, at 3s. 5½d. each; Callender's Cable and Construction Co., Ltd., two miles of jumper cable, £800. The following tenders have been received for the supply, delivery, and erection of a car-traverser for the central repair depot:—Appleby's, Ltd. (accepted), £513 10s.; Heenan & Froude, Ltd., Worcester, £580. Permission to sublet portions of the work has been given as under—Supply of steel castings, Wm. Beardmore & Co., Ltd.; supply of steel plates, bars, angles, &c., Frodingham Iron and Steel Co., Ltd.; axles, wheel centres, and tyres, Hadfield's Steel Foundry Co., Ltd.

Battersea.—The Borough Council has accepted the tender of Callender's Cable and Construction Co., Ltd., for the supply of cables, &c. (based upon 25 tons of copper at the rate of £63 per ton) for one year, the company undertaking to maintain the whole of the cables supplied by them for a further period of twelve months.

Hammersmith.—A repeat order has been placed with Messrs. Cowans by the Borough Council, for sub-station switchgear, including Andrews' reverse current relays.

Islington.—The Borough Council has accepted the tender, at £548, of Daniel Adamson & Co. for repairs to an engine, steam pipes, and foundations at the generating station.

Westminster.—The City Council has accepted the tender of Messrs. Speedy, Eynon & Co. to maintain the electric light installation at Caxton Hall for three years at £35 for the first year and £30 per annum for the two succeeding years. The reason for the larger sum for the first twelve months is that the existing lamps have been in use for practically two seasons and now require replacing throughout, needing 400 lamps at once. It is almost certain that in addition at least another 100 lamps will be required before next Christmas if the lamps are to be run to the best advantage as regards current consumption.

LOWESTOFT.—The Corporation have accepted the tender of Messrs. Siemens Bros. and Co., Ltd., for the supply of a 45-h.p. electric locomotive at £472 for use on the proposed new coal siding. The tender of the Electrical Co. has also been accepted for the supply of meters during the coming year.

METROPOLITAN ASYLUMS BOARD. The following tenders were received for the installation of electric lighting at the Mead Ambulance Station: T. Potter & Sons, Ltd., £139 (accepted); Speedy, Eynon & Co., £143; C. Pullan, £145; A. V. Gifkins & Co., £149; Smeeton & Page, £178 2s. 6d.; The Electrical Co., Ltd., £180; Dargue, Griffiths & Co., Ltd., £183; H. J. Cash & Co., Ltd., £185; Edmundson's Electricity Corporation, Ltd., £186 10s.; G. Weston & Sons, £189; A. Plocknell, £192; J. Wilson, £192; C. Cooper & Co., £210 10s.; Jenkins & Cawte, £229 15s.; Fulham Electric Supply Co., £253; W. G. Cannon & Sons, Ltd., £266 16s. 11d.; The Kevan Electric Co., Ltd., £335.

SWINDON.—The Electricity and Tramways Committee recommend that the tender of Messrs. Thomas Parker, Ltd., of Wolverhampton, for a variable speed motor and regulator for the boiler-house, be accepted at £45 10s., and that the tender of Messrs. W. and T. Avery, of Birmingham, for a weighing machine with automatic tape register at £30, also be accepted.

THE MIRRLEES WATSON CO.—The Mirrlees Watson Co., Ltd., Glasgow, have recently received orders for a number of condensing plants, amongst which are the following:—John H. Wilson & Co., Birkenhead; National Electric Construction Co. for Rhondda Trams; Huddersfield Corporation, elevated counter current jet plant, dealing with 120,000 lb. steam per hour, 28⅝ in. vacuum, with cooling tower water; John Brown & Co., Ltd., Sheffield, elevated jet condensing plant. Repeat orders have also been received from the British Thomson-Houston Co., for Rangoon, and the City Road station of the County of London Electric Supply Co., and from the Trafford Park Electric Supply Co.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Son, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars net c.i.f. port of arrival quoted on Tuesday night was £65 to £65 10s. This is no change in the price last week.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—The first meeting of the creditors in the bankruptcy of G. K. Spivey, electrical engineer, 54 Pinderfields Road, Wakefield, was held last week at the Official Receiver's office, 6 Bond Terrace, Wakefield, Mr. J. Eickersteth Ottley presiding. No creditors were present or represented, therefore no resolutions were passed, and the estate remains in the hands of the Official Receiver.

A meeting of Messrs. Witting, Eborall & Co. will be held at 49 Cannon Street, London, E.C., on February 15th at 12 noon, to hear the liquidator's account of the winding-up. This firm, it may be remembered, went into voluntary liquidation when Mr. A. C. Eborall became the representative here of Messrs. Brown, Boveri & Co.

A petition for the winding-up of Messrs. D. Santoni & Co. (1905), Ltd., will be heard on Tuesday, January 28th, at the Royal Courts of Justice, Strand, London.

Reason Electrolytic Meter.—The Board of Trade has approved a pattern of electrolytic meter made by the Reason Manufacturing Co., Ltd., and known as Wright's electrolytic meter, Hadfield's solution, and also the method of fixing same.

The Lots Road Smoke Nuisance Prosecution.—In connection with the unsuccessful summonses taken out by the Chelsea Borough Council against the Underground Electric Railways Co., of London, Ltd., for permitting the emission of black smoke from their generating station at Chelsea (ELECTRICAL ENGINEERING, Vol. II., pp. 711 and 770), a suggestion was made that the London County Council should contribute to the costs. This was in consequence of the pressure brought to bear by the London County Council upon the Borough Council to prosecute, the latter being threatened with treatment as a defaulting authority under the Public Health Act unless proceedings against the company were taken. The London County Council now state that they have no authority to make any contribution towards the costs in question.

Electrical Exhibition at Acton.—An Electrical Exhibition promoted by the Urban District Council of Acton in the interests of their supply undertaking, was opened last Monday. Councillor R. Dunsmore, in introducing the Mayor of Hammersmith, who kindly consented to formally open the exhibition in the absence of Mr. Herbert Nield, M.P., explained the various uses to which electricity could be put in the home and the workshop, and recommended those present to inspect carefully the various appliances for lighting, heating, and power, which would be found on the stalls. The Mayor briefly replied, and mentioned that the success of the undertaking depended largely on the number of patrons, and he trusted that this large gathering would mean a considerable number of new consumers. Councillor F. A. Baldwin passed a vote of thanks to the Mayor, which was seconded by Councillor R. Poulton, and gave a short outline of the history of the undertaking. The principal exhibitors are given below:—Mr. G. C. Berry, of Acton, Edison lamps and B.T.H. cooking appliances; Messrs. Robert King & Co., Victoria Street, S.W., numerous specialities for which they are agents; Messrs. Pooley & Austin, Victoria Street, S.W., "Spagnoletti" instruments and switches, "Mawdsley" motors, and two Engineering Instruments Co.'s switchboards, which had just been manufactured for the Acton District Council; Siemens Bros.' Dynamo Works, Ltd., tantalum lamps and motors; Dowsing Radiant Heat Co., Ltd., their well-known heating appliances and electro-medical apparatus, also samples of the new 60 c.p. zirconium metallic-filament lamps being used direct on a 230-volt circuit; Messrs. J. Poore & Son, various specialities of the General Electric Co., and demonstrations of the processes of the manufacture of the Robertson lamp; Messrs. Waygood & Co., Ltd., model of their well-known automatic electric lift; the Sunbeam Lamp Co., Ltd., had on view a case of samples of their numerous styles of incandescent lamps. The exhibition will be open every day until the 25th inst., and various entertainments are to be given during the course of the week

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MISCELLANEOUS CITY NOTES

BRITISH ALUMINIUM CO.—An extraordinary general meeting will be held to-day at Winchester House, Old Broad Street, London, to consider a resolution for dividing the £10 conversion shares created in 1906, into two shares of £5 each, viz., a 7 per cent. preference share and an ordinary share ranking *pari passu* with the existing shares.

DIRECT UNITED STATES CABLE CO.—The revenue for the half-year to December 31st was £58,268, compared with £60,379 for the corresponding period of the previous year. Working and other expenses were £25,103, leaving a balance of £33,165, exclusive of £2,515 brought in. Two interim dividends of 4s. each absorb £24,284, and, after setting aside £5,000 to the reserve fund a balance of £6,396 is carried forward.

HARPER ELECTRIC PIANO CO.—A dividend of 10 per cent. on the preference shares for the half-year ended December 31st, 1907, has been declared.

MACCLESFIELD AND DISTRICT TRAMWAYS CO.—A special general meeting will be held at the offices of Messrs. Kidsons, Taylor, and Everatt, 1 Booth Street, Manchester, on February 3rd, at 4 p.m., for the approval of the company's Bill deposited in Parliament. This proposes the abandonment of the tramways already authorised.

METROPOLITAN RAILWAY CO.—A dividend of ½ per cent. per annum has been declared upon the ordinary stock for the half-year ended December 31st, 1907, and the sum of £5,500 is carried forward. The dividend on the surplus lands stock is at the rate of 2¾ per cent. per annum, carrying forward £900.

MONTREAL LIGHT, HEAT AND POWER.—A dividend of 1½ per cent., or at the rate of 6 per cent. per annum, for the quarter ending January 31st, has been declared.

P.P.K. CEYLON RUBBER ESTATES.—The directors have announced a dividend at the rate of 2½ per cent. per annum for the year ended December 31st, 1907.

THE UNDERGROUND ELECTRIC RAILWAYS COMPANY OF LONDON.—According to the *Financial Times*, a meeting of the Dutch holders of profit sharing notes in the Underground Electric Railways Company of London was held at Amsterdam on the 14th inst. The report of the meeting, sent by the Amsterdam correspondent of the *Frankfurter Zeitung*, states that the meeting, which was convened by the Committee of the Stock Exchange, appointed a committee to examine any proposals for reorganisation. It was announced that out of the total of £7,000,000 in outstanding notes £1,500,000 is in the hands of Dutch holders. These comprise £600,000 in administration certificates, and £900,000 in original notes. During the discussion attention was drawn to the declaration that the amount which had been expended by Messrs. Speyer and Co. for the payment of the December coupons forms a debt of the company.

PERSONAL.—Mr. F. M. Saxelby, head of mathematics at the Technical College, Belfast, has been appointed to a similar position at the Battersea Polytechnic. Previous to his appointment at Belfast, Mr. Saxelby was head of the Mathematics Department at the Royal Technical Institute, Salford.

Moscow Tramways.—In connection with the contract which has been given to a British syndicate for the conversion of the Moscow tramways to electric traction, a Reuter telegram from Moscow on Monday states that the guarantee of £10,000 has been deposited.

Telegraph Traffic.—The Trinidad-Demerara Cable noted in our last issue as being broken, was restored to working order on the 17th instant. At last the cable between Brest and Dakar has also been repaired. This cable has been inoperative since July 22nd, 1907, but traffic was resumed on the 17th instant. The Singaradja-Amperan cable and the Fao route were restored on the same day. It has become necessary to undertake repairs on the cable between Teneriffe and St. Louis, Senegal, and traffic has in consequence to be sent *viâ* Madeira. The Lagos-Kotonon cable, which was down on December 4th, was repaired on the 18th inst. An earthquake at Gonaives is reported to have been the cause of the cutting off of this town from communication with the outside world. Official advices from the Haitien Government state that all offices of the land line system are at present closed as far as international traffic is concerned. The interruption, however, may possibly be due to a revolution. Telegrams may still be accepted for stations at which submarine cables land, viz., Cape Haitien, Mole St. Nicholas, and Port-au-Prince, and from these towns they will be sent by post to places in the interior, but only at sender's risk. Owing to the break of the Teneriffe-St. Louis cable, messages for West Africa and South America cannot be accepted for transmission *via* Teneriffe, but should be sent *via* France and Dakar. Telegraph offices have been opened at Greatham, Hants, and at Melsonby, Yorks. According to information the proposal to establish a wireless system between British Guiana and Trinidad, which was passed by the former colony, has been rejected by the latter.

THE UNION ELECTRIC CO.'S NEW WORKS

The Union Electric Company held a conference of all their agents at the new works on Thursday last, and afterwards held a reception, at which, by their invitation, we were able to be present. This company recently moved from their old premises in Queen Victoria Street to Park Street, Southwark, and after only a few months' tenure there, the business has increased to such an extent that they have again been compelled to take additional works. At these new works a complete installation of machinery has been put down for the manufacture of switchboards, arc lamps, &c., which are manufactured on the premises. The company had on view some of their more recent manufactures, which made a very interesting display. Among these their well-known "Excello" arc lamp, in all its latest improvements, was exhibited, the most recent being the improved sleeve, which by means of its construction allows all gases from the interior of the globe to be led directly to the atmosphere, and at the same time it does not allow cold air to gain access to the burning area. This entirely prevents the deposit which used to accumulate on the globes. Another new lamp is the Snowball type of lamp, which has a full-moon-like effect, which renders them useful for picture galleries, &c. One of the special features of this lamp is the elimination of practically all the violet rays, thus giving a silvery white illumination over the whole surface of the globe. The Koh-i-noor lamp is one of their latest productions, and is a remarkable miniature arc lamp, which has great economy in current, maintenance, and carbon consumption, coupled with long burning hours. The lamp gives a mean candle-power of 700, and takes 6 mm. carbon, with a consumption of ½ unit per hour, and 30 hours' burning capacity; the general design of the lamp is extremely artistic, and suitable for decorative schemes. The size of the lamp is only 21½ in. long, with a 7-in. globe. The firm also make a speciality of inverted arc lighting, and reflection from the ceiling, and in most of their offices and works this method has been employed. In some cases, where it is necessary that the source of light shall be concealed, a metallic reflector is placed beneath the arc, but in other cases opal or translucent glass is employed, which allows some of the rays from the arc to pass through. This method of lighting gives an even distribution of light, resembling daylight. The company have installed a testing department, where every lamp is tested, and its certificate of the test is attached, and the lamp is then placed in a packing case and sealed, and is then placed in the stores ready for sale, and the case is not opened again on the works. The company has vast stores on the ground and basement floors of the building, and separate departments for switchboard stores. The company also exhibited several types of their various switchgear, traction type overload cut-outs, reverse current cut-outs, and all kinds of alternating current breakers, and a quick-break main switch for currents up to 300 amperes. Several specimens of the company's volt and ampere meters were shown, and also several testing sets, and the Hanby watt hour meter for single and polyphase currents. The company are now manufacturing, on the premises, high-tension switchgear of all kinds, and oil brake switches, which are either double or triple pole. There are also remote control H.T. oil break switches, which are controlled by H.T. relays, time relays, or similar devices by means of direct current at low voltages. On Thursday evening the company gave a dinner at the Café Royal, Regent Street, W., to all their provincial agents and many guests; about 140 people assembled. After an excellent repast a smoking concert was held, which was thoroughly enjoyed by everyone.

NEW PUBLICATIONS

"Proceedings of the American Institute of Electrical Engineers, January." (New York: The Institute). 50 cents.

"Electric Arc Lamps." By J. Zeidler and J. Lustgarten. (London: Harper & Bros.) 5s.

"Modern Electrical Theory." By Norman Robert Campbell. (Cambridge: The University Press.) 7s. 6d.

"The Local Government Annual and Official Directory, 1908." by S. Edgecumbe Rogers. (London: The Local Government Journal Office.) 1s. 6d.

The Board of Trade and the Electric Lighting Acts.—The Board of Trade recently received a letter from the Town Council of Hastings urging the desirability of municipal authorities being empowered to wire premises for consumers, and to supply fittings. The Town Council stated that they were adverse to incurring the large expense involved in promoting a private Bill with the express object of obtaining the powers referred to, and they asked whether the Board contemplated introducing a measure for extending the Electric Lighting Acts so as to confer, *inter alia*, upon all local authorities who own electricity undertakings the powers in question. The Board of Trade has now replied to the effect that they hope to introduce a Bill next session to amend the Electric Lighting Acts, and in the event of their doing so the matter to which attention had been drawn by the Hastings Town Council would receive consideration.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ltd.	10	7	5/-*	10—11	+¼
Do. 4½% Cum. Pref.	10	4½	4½%*	10—11	+¼
Do. 6% Cum. Second Pref.	10	6	6%	10—10½	
Do. 4½% Debenture, Red.	Stock	4½	4½%	99—102	
Bromley (Kent) E.L.& Power Co.,Ltd.	5	5½	2/-*	4⅜—5¼	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	95—98	
Brompton & Kensington E. S. Co.,Ltd.	5	10	4½%*	7—8	
Do. 7% Cum. Pref.	5	7	7%*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	97—100	
Ch. Cross. W. E. & City E. S. Co.	5	5	5%*	4⅛—5	+⅛
Do. 4½% Cum. Pref.	5	4½	2½%*	4⅛—5	
Do. 4% Deb. Red	Stock	4	4%	97—100	+1
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	4½—4⅝	−⅛
Chelsea Electric Supply Co., Ltd.	5	4½	2/-*	3⅜—4⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
City of London Elec. Lt. Co., Ltd.	10	6	5%	10—11	
Do. 6% Cum. Pref.	10	6	6%*	10½—11½	−1
Do. 5% Deb. Red	Stock	5	5%	120—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	97—100	+1
Cty of Durham E. P. Dis. Co.	5	4	2/1%	3½—4¼	
Do. 5% Pref.	5	5	5%	4⅜—4⅝	
County of London Elect. Sup. Co. Ltd.	10	5	4%*	6½—7⅛	
Do. 6% Cum. Pref	10	6	6%*	10⅝—11⅛	+⅛
Do. 4½% Deb. Red	Stock	4½	4½%	103—106	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	95—98	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅜—⅝	
Do. 6% Cum. Pref.	5	3½	—	¾—1⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	70—80 xd	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4½—5	
Do. 5% Cum. Pref.	5	5	2/6*	5—5⅛	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97 xd	−2
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6⅜—6⅞	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N't'ng Hill E.L. Cos. Db.Rd.	Stock	4	4%	99—103	
London Electric Supply Corporation	3	4	2/4½d*	1⅛—1⅜	
Do. 6% Pref.	5	6	6%*	4⅛—4½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—94	+2
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	5⅞—6⅜	+⅛
Do. 4½% Cum. Pref.	5	4½	4½%	4⅞—5⅛	+⅛
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	101—105	+1
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D	100 & 500	4½	4½%	95—98	
Newcastle & Dist. E. L. Co., £9 paid	10	5	3/7½d.*	9½—10½	+1
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply	5	8	5%	6½—6⅞	
Do. £2 Pm.	5	8	1/4½d*	6½—6⅞	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5⅛	
Do. 10/- Pm	5	5	1/4½d	5—5⅛	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	6%*	11¾—12¼	+¼
Oxford Electric Co., Ltd.	5	7	2/6*	5¾—6	
Do. 4% Deb. Red.	Stock	4	4%	93—95 xd	−2
St. James and Pall Mall E. L. Co. Ltd	5	10	5/-*	7¾—8¾	+¼
Do. 7% Non-Cum. Pref.	5	7	3/6*	6½—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	¾—1⅛	
Do. 4% Deb. Red	Stock	4	4/-*	71—75	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2⅞—3	
South Metropolitan E. L. & P. Co.	1	2½	6d*	⅝—¾	
Do. 7% Cum. Pref.	1	7	8½d.*	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	101—104	+1
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1⅞—2⅛	
Do. 5% Cum. Pref.	5	5	2/6*	2—2⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	5%*	8½—9⅛	
Do. 4½% Cum. Pref.	5	4½	4½%	5—5⅛	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	87—90 xd	−2
Central London	Stock	4	3%	65—68	
Do. 4% Preferred.	Stock	4	4%*	84—86	
Do. Deferred.	Stock	4	—	43—46	−1
Do. 4% Debentures.	Stock	4	4%	100—103 xd	−1
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	73—76	
City and South London Cons.	Stock	2½	2½%	44—46	
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	116—119	
Do. 5% Perp. Pref. 1896	Stock	5	5%*	114—117	+1
Do. 5% Perp. Pref. 1901	Stock	5	5%	113—116	
Great Northern & City Pref. "A"	10	4	11½d.	1¼—1⅜	−¼
Gt. Northern, Piccadilly & Brompton	10	4	4/-*	4—5	
Do. 4% Perp. Deb.	Stock	4	4%	82—85	+2
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1%*	39½—40½	−2
Do. 3½% Preference	Stock	3½	3½%*	87—90	
Do. 3½% "A" Pref.	Stock	3½	3½%*	77—80	
Do. 3½% Convertible Pref.	Stock	3½	3½%	74—77	
Metropolitan District	Stock	nil	—	10—11	
Do. 6% Perp. Deb.	Stock	6	6%	107—110	+3
Do. 4% Pref. Deb.	Stock	4	4%	70—75	
Do. Extension Pref. (5%)	Stock	nil	—	18—23	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	—	47—52	
Underground Elec. Railways Co of London 5% Profit Sha. Sec. Notes	Various	5	5%	36—40	+1
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—106	+1
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	1¼—1⅜	
Do. 5% Cum. Pref.	1	5	5%	1⅜—1½	
Do. 4½% Deb. Red.	Stock	4½	4½%	90—95	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1⅜—1⅝	+⅛
Do. 6% Cum. Pref.	10	6	6%*	4⅛—5⅛	−⅛
Do. 5% Perp. Deb.	Stock	5	5%	92—95	+2
Do. 4½% 2nd Deb.	Stock	4½	4½%	69—74	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4¼—4¾	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	96—99	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%			
Dublin United Trams Co.	10	6	6%*	13—14	
Do. 6% Pref.	10	6	6%*	12⅜—13⅜	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅛—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	92—95	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7⅛—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—84	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	95—98	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—⅛	
Do. 5% Cum. Pref.	1	5	6d*	1⅛—1⅛	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	91—94	
National Elec. Construction Co. Ltd.	1	10	2/-	1⅛—1⅛	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	¾—1¼	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9½d*	⅞—⅞	
Do. 5% Cum. Pref.	1	5	5%*	⅜—¾	
Do. 4½% Deb. Red	Stock	4½	4½%	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4½—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10⅛	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6⅞d.*	¾—1⅛	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	60—70	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1⅛	
Do. 6% Cum. Pref.	5	nil	—	3½—3¾	+⅛
Do. 4½% 1st Deb. Red	Stock	4½	4½%	83—86	+2
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅜	30/-	57—60	
Do. 6% Pref. Ord.	Stock	6	3%	101—103	+1
Do. Def. Ord.	Stock	1¼	—	15½—16	−¾
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	80—84	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3½	
Do. 10% Cum. Pref.	5	10	5/-*	8½—8¾	
Do. 4½% Debs.	50	4½	4½%	97—100	
Direct United States Cable Co. Ltd.	20	4¼	4⅜%	13¾—14¼ xd	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99—101	
Eastern & S. African Tel. Co., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12⅜—12⅝ xd	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	100—103	+⅛
Eastern Telegraph Co.	Stock	5½	5%	131—136 xd	+1
Do. 3½% Pref.	Stock	3½	1¾%	82—85 xd	−1
Do. 4% Mort. Deb.	Stock	4	4%	99—102	
G. N. Tel. Co. (Copenhagen)	10	20	5%	30—32	
Indo-European Telegraph Co. Ltd.	25	13	65/-	52—56	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅝—¾	+⅛
National Telephone Co., Ltd., Pref.	Stock	6	6%*	110½—112½	+½
Do. Deferred	Stock	5½	6%*	107½—109½	
Do. 6% Cum. 1st Pref.	10	6	6%*	11—13	
Do. 6% Cum. 2nd Pref.	10	6	6%*	10—12	
Do. 5% 3rd Pref.	5	5	5%*	5¼—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	96—98	
Do. 4% Deb. Red.	Stock	4	4%	99—101	
West African Telegraph Co. Ltd.	10	4	4/-	10—10½	
Western Telegraph Co., Ltd.	10	7	6%	12⅝—13⅜	
Do. 4% Deb.	Stock	4	4%	97—100	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅛—⅜	
Do. 6% Cum. Pref.	1	6	7½d	⅝—1⅛	
Babcock & Wilcox, Ord.	1	20	1/7½*	3½—3⅝	
Do. 6% Pref.	1	6	7½d	1⅛—1⅜	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6½—6⅝	
Do. 6% Cum. Pref.	5	6	3/-*	5⅝—6⅛	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	100—103	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%*	85—89	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅝—1	
Do. 4% Mo t. Deb. Red.	Stock	4	4%	40—45	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅜	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	83—86	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ltd.	5	15	15/-	9½—10½	
Do. 5% Cum. Pref.	5	5	5%	5¼—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	104—106	
Consolidated Electrical Co., Ltd.	1	3	8¾d*	⅞—1⅛	
Crompton & Co., Ltd.	3	5	5%	1⅝—1⅞	+⅛
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	94—97	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1⅛—1⅜	
Do. 6% Cum. Pref.	1	6	7½d	1—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	99—102	
Edison & Swan United "A." £3 paid	5	4½	2/6	⅞—1⅛	
Do. do. (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	⅛—⅜	
Do. 7% Cum. Pref.	2	7	—	1½—1⅝	+¼
Do. 4% 1st Mort. Deb.	Stock	4	4%	62—66 xd	+2
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	10½—11⅜	
Do. 4½% Cum. Pref.	5	4½	2/-*	4⅜—5⅝	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	101½—106½	
I. R. & G. P. Co., Ltd.	10	10	10%	14½—15½	
Do. 4% Deb. Red.	100	4	4%*	97—99	+1
Tel. Const. & Maintenance Co.	12	15	5%*	28½—30½	
Do. 4% Deb. Bds. Red	100	4	4%	99—102	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3½—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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ELECTRICAL ENGINEERING

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SUMMARY

A SERIOUS mains explosion occurred on Sunday night on the Westminster network, the result of which was two broken windows in Mr. Leopold de Rothschild's house in Hamilton Place. A short circuit occurred in a bitumen main crossing the road, and an explosive mixture of bitumen gas and air penetrated through a service box to a cellar in the area of the house. (Page 150.)

AN article by Mr. E. L. HILL reviews the advantages of electrical driving for textile mills, and deals with the question whether preference should be given to group drive or individual drive in different cases. (Page 151.)

AMONG the further local authorities in London and Greater London who will oppose the Electric Power Supply Bills are Woolwich, Paddington, Hendon, Richmond, Stepney, Lewisham, and the Middlesex County Council. The Bills will start in the House of Lords. (Page 152.)

THE commissioners of the Board of Trade appointed to inquire into the boiler explosion at the Greenwich station of the South Metropolitan Electric Light & Power Co. in December, 1906, have given judgment to the effect that no blame attaches to the firm who supplied the boilerplate, while considerable responsibility rests with the boiler-makers. The chief and resident engineers to the station are also held responsible in a minor degree. The commissioners do not in any way attribute the explosion to conditions attendant upon the use of thermal storage. (Page 153.)

AN action was commenced on Tuesday last week in the King's Bench Division, by two Italian electrical engineers against the executors of the late Sir John Pender, Bart., for breach of contract made in December, 1889, in connection with certain water-power rights and concessions for the purpose of supplying electrical energy to the City of Rome. The hearing lasted until Monday, when it was stated that terms had been arranged between the parties. (Page 154.)

THE action by the Rev. EDWARD HEATH, Vicar of St. Mary and St. Mary Magdalene Church, Brighton, brought against the Corporation for alleged nuisance from vibration caused by the electrical machinery at the North Road sub-station, was continued in the Chancery Division this week. Evidence has been given on behalf of the Corporation by Mr. JAMES SWINBURNE, F.R.S., Prof. C. V. BOYS, F.R.S., and Mr. ARTHUR WRIGHT. The hearing has been adjourned until to-day, when it is expected that judgment will be delivered. (Page 154.)

DR. R. GOLDSCHMIDT read a Paper last Thursday at the Institution of Electrical Engineers, the object of which was to provide in a convenient form data of what

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may be regarded as the standard performance of electrical machinery. Continuous-current machines, rotary converters, alternators, induction motors, and single-phase commutator motors were dealt with, and numerous curves of efficiencies and other properties of such machines over a large range of sizes were given. The discussion was opened by Prof. SILVANUS THOMPSON, who drew some distinctions between the constants in the formulæ based on first principles and empirical results, and discussed the constancy of the value of the ratio between the armature load and the flux in machines. Mr. MACFARLANE considered such a fixed ratio inadmissible, and quoted examples to show that the author's flux curve did not represent the most economical conditions, and Mr. V. A. FYNN complained that the section on single-phase machines was not sufficiently specific. Mr. H. BURGE also spoke, and Col. CROMPTON questioned the possibility of standardisation of such matters. Dr. GOLDSCHMIDT, in his reply, pointed out that his results represented general averages, and were not based on particular designs. (Page 155.)

THE electrical winding plant, which the Priestman Collieries, Ltd., have installed in their Axwell Park Colliery, although of small size as compared with most main shaft winding engines, is a complete example of the Ilgner system with flywheel converter. (Page 163.)

DR. R. POHL'S Paper on recent developments in turbo-generators, read before the Institution of Electrical Engineers in London last November, was further discussed by the Leeds Local Section last week. One or two points which the author had not touched upon were suggested, and various means of minimising commutation troubles were discussed. Agreement was expressed with the author as to the impracticability of homopolar designs. (Page 166.)

IN the discussion in Glasgow on Mr. J. F. C. SNELL'S Paper on the cost of electrical power for industrial purposes, Mr. ROBERT ROBERTSON showed graphically the difference between the tabulated and actual figures quoted by Mr. Snell for independent plants, and thus brought out the difference very clearly. Mr. C. P. SPARKS criticised the estimated figure of £12 for transmission as far too low. Mr. LACKIE emphatically stated that Glasgow was not supplying power below cost price. He expressed surprise that Mr. Snell's costs for independent suction gas plant were higher than for steam plant, and gave some interesting figures for the diversity factors of various classes of load. Finally, he entirely disagreed with Mr. Snell in his view that the smaller towns should have been prevented from erecting their own generating stations, and said that even now Mr. Snell's suggested remedy would not prove beneficial, as the small towns would only call on the power company to supply their peak load in winter. Mr. J. ROBERTSON stated that the load factor of a shipyard was a bad one, but confirmed the figures quoted by Mr. Snell for such loads. The conclusions in the Paper, however, he regarded as too pessimistic; his own capital expenditure at Greenock was £43 per kw. Moreover, in his figures the author had not taken account of the capital already paid back. Mr. J. H. BOWDEN, in a communication received in London, says that his actual charge for power at Poplar in 1907 was 1·156d. per unit, whereas Mr. Snell actually credits him with charging the sum of 1·43d. per unit for something which ought to be charged at 1·686d., but which might be obtained elsewhere for 0·83d. Mr. W. B. ESSON expresses himself generally in agreement with Mr. Snell's figures as to the costs in private generating stations, and as to some of the present power charges in London being too low. (Page 167.)

PROF. KAPP, in his second lecture at the Royal Institution last Saturday on the "Electrification of Railways," considered briefly the chief characteristics of the forms of the continuous-current three-phase and single-phase systems now in use. (Page 169.)

A SHORT discussion followed the reading of Mr. BARLOW'S Paper on "The Heat Conductivity of Iron Stampings" before the Birmingham Local Section of the Institute of Electrical Engineers. The Paper was given at some length in our last issue. Some criticism of the mathematics was made by Dr. SUMPNER and others. But the importance of the experimental results was generally agreed upon. In the absence of the author, Prof. KAPP, at whose suggestion the experiments have been made, replied. (Page 170.)

AN original communication by Mr. P. H. POWELL, selected for publication in the Journal of the Institution of Electrical Engineers, describes some determinations of the air-gap correction coefficient for partly-closed slots of various proportions by the stream line method. (Page 171.)

THE manufacture of fine classes of iron and steel by electro-thermic methods is continually developing. For the actual refining of steel and iron, the electrical induction will probably be the furnace of the future. Under ELECTROCHEMISTRY AND ELECTROMETALLURGY we describe the new 5-ton Roechling-Rodenhauser furnace, which is being operated at the Roechling Iron Works at Voelklingen in Germany. Another very important development in the employment of electrical energy is in the manufacture of nitrogenous products from atmospheric nitrogen. We draw attention to a number of new works where the manufacture of calcium nitrate and cyanamide is or will be manufactured. (Page 172.)

A PAPER by D. F. COMSTOCK in the "Philosophical Magazine," of which an abstract is given under "ELECTRICAL SCIENCE," contains a mathematical investigation of the motion of a system of electric charges having an important bearing on the disintegration theory. In the Papers abstracted in the Continental section, CORBINO describes how to obtain undamped oscillations without a condenser, BECQUEREL develops some new aspects of his magneto-optic effect, RUNGE assigns a place to the new infra-red series of lines of the alkaline elements, and THULLIE confirms and develops Langevin's electron theory of magnetism. (Page 173.)

AMONG the specifications published to-day is one by W. P. HAMLYN describing an automatic circuit-breaker of the loose-handle type, which is actuated independently of the toggle catch. In the 1907 specifications the BRITISH THOMSON-HOUSTON CO. have one relating to direct-current transmission systems of the high-tension type, in which unipolar generators are connected in series for producing the voltage required, and a special means is provided for keeping the voltage steady. A new method of sealing the leading-in conductors of metallic filament lamps is patented by the same firm, who have also patented a new method of insulating composition for electric conductors. A specification by E. PEARCE and S. WALTON is for an improved method of regulation for inclined carbon lamps, designed to prevent over-feeding and sticking of the carbons. POULSEN has improved the method of periodically damping the oscillations in wireless signalling, and can regulate the vibrations of the circuits connected to the antenna. There are no patents of electrical interest expiring during the present week. (Page 173.)

THE Brentford Council are not opposing the L.C.C. Tramways Bill for the tramway across Kew Bridge. The Brighouse Town Council has decided to purchase electricity from the Yorkshire Power Company, and are building a sub-station. The Cardiff tramway track repairs ordered by the Board of Trade will cost £100,000. Sir Alex. Kennedy has advised the Dunfermline Town Council to sell its Provisional Order to the Fife Power Company. The North Metropolitan Electric Supply Co. are considering a scheme for the supply of power in bulk to the Finchley Council.

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MESSRS. CROMPTON & Co. are seeking a provisional order to transfer the Hendon Electric Lighting Order to a company called the Hendon Electric Supply Co. The Stoke Newington Council propose to erect a generation station in connection with their destructor at an estimated cost of £3,700. The West Ham Corporation electricity accounts show some interesting figures, as also do those of Plymouth and Sheffield. The Stourbridge Electric Lighting order has been transferred to the Shropshire and Worcester Electric Power Co., Ltd. Greystones is to have an electric generating station, and a company is being formed to exploit the undertaking. (Pages 175-176.)

SPECIFICATIONS in connection with several Australian telephone tenders may now be seen at the Board of Trade Commercial Intelligence Department, 73 Basinghall Street, London. Burnley Corporation invites tenders for a booster; at Edinburgh an extension switchboard panel is required, and tenders for stores are invited by Leeds, Islington, West Ham, and Sheffield. The Rawtenstall Corporation and the Islington Borough Council also require a large quantity of electrical machinery. New tramcars are required at Southampton, cables at Tunbridge Wells, and substation plant at Fulham. (Page 176.)

THE report of the Central London Railway shows considerable losses both in revenue and passengers carried for the past half-year. Dividends are declared, however. The Metropolitan Railway Co. reports an increase in revenue of nearly £4,000, and a decrease in expenses of nearly £6,000. To meet the expenses arising from the West Hampstead and Farringdon Street accidents, a sum of £4,500 has been taken from the reserve fund. At the meeting of the East London Railway Co. reference was made to the increasing difficulties of carrying on the undertaking in the absence of some arrangement for through working with the lessee companies, all of whose lines are now worked electrically. Statements have been issued by both the British Electric Traction Co. and Marconi's Wireless Telegraph Co. The former states that the question of paying the half-yearly dividend on the 6 per cent. cumulative shares due on February 15th will be left for decision until the annual meeting, owing to difference of opinion on the Board. The Marconi Co. states that a new audit of the accounts has been rendered, but it is expected that the annual meeting will take place early in March. (Page 178.)

THE three Bills relating to electric power supply in London will commence in the House of Lords. These Bills are now ready for first reading. We give particulars of several oppositions to private bills. (Page 181.)

DR. RUDOLPH GOLDSCHMIDT, in undertaking the compilation of the Paper presented last Thursday to the Institution of Electrical Engineers, set himself a difficult and laborious task. He has given in a compact form a series of generalised data relating to the performance of dynamos and motors, averaging the results of what has almost automatically become standard practice. Although there may be no absolutely new facts in the Paper, old facts are certainly presented in a new form, which will be of use to a large class of engineers. The aim of the author was not to standardise in the ordinary sense of the term, and he in no way sought to impose limits or otherwise to cramp the freedom of designers of dynamo-electric machinery. The series of curves of losses, efficiencies, and so on, are not intended as ideals to be worked up to in the production of standard apparatus, but represent what are the results that may be expected in average practice. No engineer, be he dynamo designer or only slightly versed in the ways of flux and ampere-turns, can keep in his head quantitative data of a long range, different sizes of machines of all types. There are numerous cases in which, although it is not necessary to work out detailed designs, approximate figures are required in planning out schemes, of the efficiency, inherent regulation, or some other property, which machines for certain purposes may be expected to have, and here, we think, Dr. Goldschmidt's curves will be found serviceable. Some of the speakers in the discussion lost sight of the fact that the results represented general averages, not referring to any special line of machines, and went out of their way to find designs which did not agree in every respect with the data in the Paper; but, as was pointed out by Prof. SILVANUS THOMPSON, it would be easy for designers to utilise the framework the author had provided, and plot upon it the corresponding particulars of machines with which they were acquainted.

THE fact that a considerable proportion of the Brighton consumers live over their shops has been handed down to us from a classical Paper of Mr. ARTHUR WRIGHT, and has now become almost proverbial; but it appears now that the Brighton resident is also not above availing himself of an excuse for not going to church on Sundays. An action for an injunction for nuisance against the Brighton Corporation in respect of their substation in North Road has been proceeding during the past fortnight, and it may be anticipated that judgment will be delivered to-day. The alleged nuisance is caused by the humming of the motor-generators in the station in North Road, which has been converted to a substation, and is supplied from the Corporation's large generating station at Southwick. Both sides admit that a humming noise can be heard in a church close to the substation, and the only question at issue is whether the noise is sufficient to interfere with the service, and distract the thought of the worshippers. In a case like this, in which the real question at issue could be settled at once by the judge going down to the spot and deciding the matter by his own observation, it is remarkable that it should be necessary to need expert evidence on both sides, and that no less than three experts, including two F.R.S.'s, should have to go down to Brighton to investigate the matter. The dispute is one that was certainly well adapted to being settled by arbitration, but, on the other hand, supply-station engineers and managers will doubtless be grateful to the Brighton Corporation and the Church party for allowing the action to come to Court, for it is, we believe, the first case in which an endeavour has been made to obtain an injunction in respect of a substation, and the case will be a useful precedent.

Mr. J. F. C. SNELL's Paper on the cost of electrical power for industrial purposes has been discussed at greater length at the Institution of Electrical Engineers than any other Paper we have had there for some time. It is on a question of vital interest to the electrical industry, and those who are interested in electric power distribution will be glad to hear that the adverse effect which the more pessimistic parts of the Paper might have had, has been more than counterbalanced by the

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confident optimism of many of the supply station engineers. We have already pointed out that Mr. Snell's "correct" prices for power supply which he thinks should be charged by the existing electricity works are based on the premise that a trader is acting wrongly to offer a commodity below its present cost price, even if in doing so he can produce such a demand that the cost price with the more favourable output will be greatly less than the selling price. With this assumption we cannot agree. Many suppliers, moreover, have adduced figures to prove that they are by no means selling below cost price, as Mr. Snell imagines. His tables of figures for the costs of production in independent electrical plants were also criticised, and while he himself admits that they may be taken as minimum figures, and do not include the proper proportion of establishment charges, yet there is no doubt that the assumption cannot be made from first principles, as some are inclined to do, that works with their own generating plant are necessarily run less economically than if they buy their electrical energy. In the case of this Paper, the experiment of having simultaneous discussions in London and some of the Local Sections has proved a success. The discussion in Glasgow, which we report in this issue, was well up to the level of the debates on technical Papers there, and so many speakers desired to have a hearing that the Paper is to be taken again at the next meeting of the section. In London also it is evident from the written communications received, many of which are of even greater value than some of the spoken remarks, that the two evenings' debate did not exhaust the subject. For this reason, we owe a debt of gratitude to the Institution for giving us access to the written communications, so that we have been able to publish the pith of them while the Paper is still fresh in our readers' minds.

ARRANGEMENTS FOR THE WEEK

(TO-DAY), THURSDAY, JANUARY 30TH.

Royal Society.

4.30 p.m. Meeting at Burlington House, Piccadilly. Among the Papers down for reading is the following :—"On the Generation of a Luminous Glow in an Exhausted Receiver Moving Near an Electrostatic Field, and the Action of a Magnetic Field on the Glow so Produced," by the Rev. F. J. Jervis-Smith, F.R.S.

FRIDAY, JANUARY 31ST.

Royal Institution.

9 p.m. Evening Discourse by Prof. Ernest Rutherford, F.R.S., on "Recent Researches on Radio-activity."

MONDAY, FEBRUARY 3RD.

Institution of Electrical Engineers: Newcastle Local Section.

8 p.m. Meeting at the Armstrong College, when a Paper will be read by Messrs. T. F. Wall and S. P. Smith on "Experimental Determination of the Losses on Pole Shoes due to Armature Teeth."

Dick Kerr Engineering Society.

8 p.m. Meeting at Preston. Paper to be read :—"Notes on Commutation," by G. A. Juhlin.

TUESDAY, FEBRUARY 4TH.

Institution of Electrical Engineers: Manchester Local Section.

7.30 p.m. Ordinary Meeting at the University. Paper to be read :—"Protective Devices for High-tension Transmission Lines," by J. S. Peck.

WEDNESDAY, FEBRUARY 5TH .

Dynamicables.

7 for 7.30 p.m. Dinner at the Trocadero Restaurant.

THURSDAY, FEBRUARY 6TH.

Institution of Civil Engineers.

8 p.m. Ordinary General Meeting at the Institution of Civil Engineers, Great George Street, Westminster. Paper to be read :—"Protective Devices for High-tension Transmission Circuits," by J. S. Peck.

Institution of Electrical Engineers: Leeds Local Section.

8 p.m. Smoking Concert at the Hotel Metropole, Leeds.

Röntgen Society.

8.15 p.m. Meeting at 20 Hanover Square, London. Paper to be read :—"The Present Position of X-Ray Measurements," with demonstration of apparatus, by Dr. Deane Butcher.

FRIDAY, FEBRUARY 7TH.

Institution of Civil Engineers: Students' Section.

8 p.m. Meeting at 25 Great George Street, Westminster. Paper to be read :—"Electric Hardening and Annealing Furnaces," by P. T. Steinthal. Mr. James Swinburne, F.R.S., will take the chair.

SATURDAY, FEBRUARY 8TH.

Junior Institution of Engineers.

6.30 for 7 p.m. Anniversary Dinner at the Hotel Cecil, London.

SERIOUS MAINS EXPLOSION ON THE WESTMINSTER NETWORK

A SERIOUS explosion occurred at six o'clock on Sunday evening on the Westminster Co.'s mains in Hamilton Place, which leads from Piccadilly into Park Lane. It appears that a fairly old vulcanised bitumen cable in bitumen casing crosses Hamilton Place at the point in question, and a short circuit occurred across all three conductors of this cable. The heat generated at the short, boiled the bitumen in the usual way, and the gas generated passed through the conductor into a service box in the pavement, and then through the pipe containing the service cables to a cellar in an area of Mr. Leopold de Rothschild's house (No. 5 Hamilton Place). Here an explosion occurred, and two windows of the house were broken, one of which was blown in from the force of the explosion. Alarm was immediately given, and the Fire Brigade was soon on the spot, as well as the officials of the Westminster Electric Supply Corporation, but the services of the firemen were hardly needed. Unfortunately, a second explosion occurred in the street on lifting a pavement cover a short distance away. The explosive mixture, of bituminous vapour and air, which, of course, penetrated here, was again the cause, but it is not quite clear how this was ignited. The occurrence is greatly to be regretted, as it is well known that on the Westminster mains a very complete system of examination and testing is in force. We believe we are right in our assumption that the lead covering and armouring of the cables is not bonded through, and an indication of faults is obtained by feeling the sheathing for shock when the boxes are lifted for inspection. The cable under the roadway has been abandoned, as it would be a considerable expense and disturbance to traffic to lift it.

Telegraph Traffic.—Cable communication with Beira was opened on the 25rd inst. This cable connects at Mozambique with the system of the eastern group of companies. The French Telegraph Co. repaired the break in their Paramaribo-Cayenne cable on the 24th inst., but their Cayenne Salinas cable gave out on the 25th inst. The Trinidad-Demerara cable, repaired on Jan. 16th, was again interrupted from Saturday until yesterday. Communication between Rome and Constantinople stopped on the 25th of this month, but was restored on the 26th, and on the 28th the cable between Alexandria and Larnaca ceased to operate. The "El Arich" and other landline routes have also suffered derangement. Telegraphic connection has again been restored with the Orkney, Shetland, and Faroe Islands and Iceland. Caister now appears in the list of stations from which Marconigrams may be despatched to ships at sea.

The Eastern Telegraph Co. was yesterday refusing all traffic to Australia and the East in consequence of the Egyptian land lines being down.

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ELECTRICITY IN THE TEXTILE TRADE

By E. L. Hill

ALMOST the first requirement of the textile manufacturer is steadiness of drive, for this affects both the quality and output of his yarn; but uniformity of speed was unattainable until the application of electricity, and more particularly of three-phase electricity generated by turbo-alternators. The modern mill engine is a very fine machine of its kind, but it has all the disadvantages of low-speed reciprocating motion, viz., dead centres, want of balance, and varying angular velocity. These defects are inherent to its kind, and as long as such engines are used in textile mills, so long will the machines that they drive suffer from irregularities of speed. Gas engines at the present time need hardly be considered, since every defect of the slow-speed reciprocating steam engine is present in the gas engine in a markedly greater degree.

The modern mill engine is prodigal of space. By reason of its slow speed it is necessarily large, and, since its power is transmitted mechanically, much space is taken up by rope-races, pulleys, shafting, bevel, and other gearings. Moreover, the transmission losses are high, and increase rapidly as the plant is loaded up. The friction in the bearings and between gear wheels, and also the slip and creeps-in ropes and belts, become very serious items. The presence of slip caused by irregularity of drive can often be detected by the highly-polished surface of the pulleys.

The variation in angular velocity in the reciprocating engine is chiefly caused by the fewness of the impulses that its pistons receive per minute, only a few hundred at the most. The turbine, with its large number of blades, its many series of expansion, its purely rotary motion and its perfect balance, is necessarily a smoothly-running machine, and the impulses that its blades receive must be measured by hundreds of thousands per minute; it runs, in fact, at a constant speed. The alternator which the turbine drives is directly coupled to it, and runs at the same speed, and this, as will be seen later, has an all-important effect upon the steadiness of running.

Another great advantage of the turbo-generator is that it can be made capable of withstanding continuous over-loads for long periods without damage. The best modern practice divides the load in the textile mill between two machines, each of which is capable of withstanding whenever required an over-load of 100 per cent. for ten hours with a slightly higher steam consumption. Under normal conditions, both turbines share the work between them, but should one be stopped for examination or repair, the other can supply the whole of the power and lighting requirements of the mill at a small additional cost in coal. The extra capital outlay for two such turbines over one capable of driving the mill singly is surprisingly small, and is a very moderate premium to pay for insurance against possible loss caused by shut-down.

Compared with the size of a slow-speed reciprocating engine, pulleys, and rope-race, a turbo-alternator of equal power occupies about one-tenth of the room, and if the power is divided between two turbines they will not take up more than one-seventh of the room that the reciprocating engine would require

In the mill, power is transmitted to the various motors by means of suitable cables, which can be run and fixed anywhere. The losses in the mains at full load when a reasonable pressure is used need never exceed 2¼ per cent. Four hundred volts is the best pressure to adopt in most cases, as it is high enough to be economical in copper, yet not so high as to be dangerous or difficult to manipulate. With three-phase energy, which is far and away the best for textile mills, such a pressure has the further advantage of being suitable for lighting. With star-wound transformers, the lighting system can be wired between each of the three phases and the neutral point, the effective pressure on the lamps then being 230 volts. If a higher pressure than 400 volts is required, transformers become necessary for the lighting.

In the mechanically-driven mill, extensions of the premises often involve either excessive losses in transmission of power or the putting down of an independent plant. By the use of electricity, extensions only entail the running of cables and the fixing of motors. The extensions, moreover, need not follow rigid lines as in the case of mechanical drive, and the buildings can be placed anywhere convenient, and odd corners profitably employed.

With alternating current, the constancy of the frequency has an all-important effect on the steadiness of running. The speed of the motors depends almost entirely on the frequency of the supply, and is only affected to a small extent by variations in the voltage of the supply and the load on the motors. If, therefore, the frequency remains constant, the speed of the motors will not vary. It follows from this that motor-driven machinery can always run at the maximum speed that the fabric will permit. With uniform speed, fewer ends are broken, and no allowance need be made for sudden variations. With mechanical drive it is impossible to run at the maximum speed that the material can stand, because, owing to the irregularities of drive, that maximum would sometimes be exceeded. It is, therefore, necessary to fix on a lower speed, which entails a reduction in output. But with electrical driving the flyers, rings, and mules can always be run at the highest speed that the rovings can stand. This regularity of speed not only increases output, but also improves the quality of the yarn, so in both ways a better return is earned on the capital. The smoothness of running has, moreover, the effect of reducing the repairs bill.

Electrical energy can be easily and accurately measured, and, in consequence, when motors are employed a careful check can be kept on the different processes of manufacture. A machine that needs repair or a shaft out of alignment can be quickly detected and put right.

Another incidental advantage of the use of electrical power is that cheap lighting can be obtained for the mill, and from this it follows that the employees work under clean and healthy conditions.

Enough has been said to prove the advantages of electrical driving, and it may be of interest to examine roughly the methods by which the energy may best be made to do its work. The three ways to be considered are driving by a single motor, which takes the place of the steam engine, "group drive," and "individual drive." The group drive is far the most common, and is usually the most economical. In this system, one motor is used to drive one or sometimes two or three lengths of shafting, which, in turn, drive a number of machines through belting. The great advantage of such a drive is its low first cost, while its efficiency is high. Individual drive, in which each machine is worked by its own motor, entails a somewhat heavy initial outlay, but in certain cases it has advantages. As every machine is self-contained, any number of machines can be run with the maximum of economy,

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as all losses in belts, shafting, and the like are avoided. The individual drive is specially suitable for weaving-sheds, where the horse-power of the shafting compared with that of the looms is high, and where a large percentage of the looms are constantly at rest. The looms in a weaving-shed are a more or less fortuitous collection of individual machines. One, ten, or a hundred of them can be stopped without interfering with the rest, and independent driving is often a great advantage. In a new shed it will mean a great saving in the building, as no provision need be made for long lines of heavy shafting. The shed, moreover, will gain materially in light through the absence of pulleys, and the looms can be placed in any position, and much valuable space can be utilised that with mechanical driving would be unavailable. Three-phase motors for driving looms of from $\frac{1}{3}$ to $2\frac{1}{2}$ h.p. can now be obtained that will attain full speed from rest within one to five seconds; they drive the looms either by belts or gearing. When belts are used, a device is employed to maintain an even tension. In the case of gear driving, friction or centrifugal clutches are employed, which save the motors from sudden shocks caused by the stopping of the loom, and prevent damage to the reeds, which would otherwise be caused should the shuttle stop short in its travel.

Group driving is usually the best in spinning mills because the process of spinning is a continuous one. From the breakers to the mules or rings, the material travels—or should travel—evenly onwards, and the raw cotton forming the bale reappears, less wastage, as yarn in the spinning room. A stoppage in any part of the process would affect the output of the whole.

Mules should always be driven on the group system, because their frequent reversals call for an amount of power installed far in excess of the average required, and in mule spinning the drive should always be arranged so that one motor works several mules. Ring and doubling frames, on the other hand, can often be advantageously driven by separate motors, although the capital cost will be higher. The power they absorb is regular, and does not vary continually as in mule spinning.

Rapid progress in the electrical driving of textile mills is being made, and by midsummer of this year almost 6 per cent. of the total spindles in Lancashire will be electrically driven.

THE LONDON ELECTRIC POWER BILLS

THE London Power Bills will come up for consideration first in the House of Lords. A number of further reports have been made to local authorities affected by these Bills:

The Parliamentary Committee of the London County Council recommend that petitions be lodged against the London and District Electricity Supply, London Electric Supply, and the London (Westminster and Kensington) Electric Supply Bills.

The Town Clerk to the Woolwich Borough Council, reporting upon the London Electric Supply Bill, states that the Bill would enable the Joint Committee in any event to supply energy within the Council's area for haulage and traction purposes without the Council's consent, and, failing agreement, would compel a reduction of existing prices generally. In regard to the London and District Electric Supply Bill, the company propose to compete with the Council throughout their area of supply for all power purposes and for light to the extent of 20 per cent. of the power load. With regard to the London (Westminster and Kensington) Supply Co.'s Bill, the effect of clause 8 would be to empower the company to supply the South-Eastern Railway Company with energy to be used on any part of their system, including that portion in the Borough of Woolwich. The Council having considered the Town Clerk's report and the observations of the Law and Parliamentary Committee thereon, resolved to present a petition against the London Electric Supply Bill and the London and District Electric Supply Bill. The Council's interests, it was held, were not sufficiently prejudiced to warrant any opposition to the London (Westminster and Kensington) Electric Supply Co.'s Bill.

The Paddington Borough Council, at its last meeting, considered the views of the Legal and Parliamentary Committee regarding the London (Westminster and Kensington) Electric Supply Co.'s Bill, the London Electric Supply Bill, and the London and District Electricity Supply Bill. The only proposals of the first-named measure which appeared to the Committee to affect Paddington were contained in the clauses relating to the laying of high-tension mains. The Committee expressed the opinion that if high-tension mains were laid through Paddington for the benefit of other boroughs, the Borough Council should choose the route of such mains. The Committee object to the purchase clause in the London Electric Supply Bill, inasmuch as the Paddington Council at present possesses special powers for purchasing the undertakings of one of the parties to the Bill, *i.e.*, the Metropolitan Electric Supply Co., Limited. The Committee, however, regard it as improbable that either of the Bills will become law in their present form, and do not consider that they endanger the interests of the Borough sufficiently to warrant the very considerable expenditure which would be necessary to effectually support the Council's opposition to the schemes. It is further suggested that the attention of Parliament and the L.C.C. should be drawn to the Council's objections to the proposals in the Bills for the nullification of the powers possessed by Paddington for the purchase of the Metropolitan Electric Supply Company's undertaking in the Borough, and also to the other points mentioned.—It was decided to communicate with the L.C.C., the Borough's representative on that body, and the Parliamentary representatives informing them of the Council's objections to the proposals, and requesting the influence of the representatives in securing the rejection of the Bills.

At the last meeting of the Middlesex County Council the Parliamentary Committee recommend opposition to the London Electric Supply Bill and the London and District Electric Supply Bill on general grounds.

The Hendon Corporation has decided to deposit petitions against the London and District Electricity Supply Bill and the London Electric Supply Bill, Hendon being included in the areas scheduled.

The Richmond Town Council will also petition against both Bills.

The Parliamentary Committee of the Stepney Borough Council, in a report issued on Monday, states that the London and District Electricity Supply Bill would seem, from the Stepney point of view, the most dangerous proposal made to Parliament in regard to the supply of electrical energy. In addition to claiming the power to give supplies to such undertakings as railways, tramways, and canals, without first obtaining the consent of authorised distributors, the company proposed to give supplies without obtaining consent to power users whose maximum demand exceeded 250 kw. It proposed also to give supplies to other consumers when able to quote a lower price than the authorised distributor. The committee also object that the Bill does not indicate definitely the prices proposed to be charged to consumers, leaving the Borough Council, as undertakers competing with the company, in the dark as to the rates against which they were called upon to compete. The committee consider the clause empowering the company to acquire the undertakings of other authorities by agreement as most objectionable, and express the opinion that the company should be compelled, at the option of an authorised distributor, to purchase the latter's existing undertaking on fair terms. With regard to the London Electric Supply Bill, the committee point out that the prices, not exceeding £5 per kw. per annum and 0·35d. per unit, at which the Joint Committee is obliged to give supplies to authorised distributors, are actually higher than the maximum prices at which the authorised distributors would be bound to supply to consumers if the Bill became law. The Bill was, however, far more satisfactory to the Council than the London and District Bill, as it was not proposed to invade the Council's area except as regards docks which it was desired to supply with energy for haulage traction. The committee has decided in favour of opposition being offered to both Bills.

Acting upon a recommendation by the General Purposes Committee, the Lewisham Borough Council will oppose both the London Electric Supply Bill and the London and District Bill.

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THE GREENWICH BOILER EXPLOSION

THE Board of Trade inquiry into the boiler explosion which occurred at the Greenwich Works of the South Metropolitan Electric Light and Power Co., on December 20th, 1906, under circumstances already reported in ELECTRICAL ENGINEERING (Vol. I., page 24; see also Vol. II., page 1006), was concluded on Wednesday of last week at the Town Hall, Greenwich, when Messrs. A. A. Hudson and W. H. Hallett, the Commissioners appointed by the Board of Trade, delivered judgment.

The judgment commenced as follows :—This inquiry in many respects is remarkable. Though the inquiry has lasted a long time, the facts are comparatively simple, and the cause of the explosion not far to seek. A steel drum working at a pressure of 160 lb. per square inch was found to have developed a crack in the end-plate near the riveting for a length of 2 $\frac{7}{8}$ in., and a small jet of steam was issuing from it, yet no one in charge of the boiler, from the highest to the lowest, thought there was any danger, and no one took any step to shut down the boiler or reduce the pressure of steam. It has been urged that the drum was only four months old, had been supplied by a well-known firm, and had been thoroughly tested; but the fact pointed to something exceptional, and should have been taken as a warning that there must be something seriously wrong. The primary cause of the explosion was the supply of a badly constructed drum by the makers, the immediate cause being the neglect to reduce steam when a crack appeared.

The drum which exploded was a "thermal storage-drum," and was one of two connected with a Babcock & Wilcox boiler. It was constructed of mild steel plates, was cylindrical in form, with elliptical ends, and was connected with, and formed part of, the boiler.

The tests to which the boiler had been subjected were then described. The drum was first put into use at the company's works on August 18th, 1906, so that it had only been in use about four months when it exploded. During this short period of its existence it appears to have worked satisfactorily. A leak occurred in October, 1906, and another one later in the seams, to which no importance was attached, except that when the leak subsequently occurred (which led to discovering the crack in the end-plate which afterwards gave way), it was at first thought that the leak was due to a similar cause.

The appearance of this further leak, noticed first on December 17th, is then referred to, and it is recorded how no efforts were made to ascertain its cause until the following Wednesday, when a little of the lagging was removed, and it was discovered that there was a crack in the end plate of the drum 2 $\frac{7}{8}$ in. long, running in a line with the circumference and near the riveting. From this crack a jet of steam about 1 ft. long and $\frac{3}{4}$ in. in diameter was issuing. Upon this, Mr. Constable, the resident engineer, discussed the matter with Mr. Covell (of Messrs. Babcock & Wilcox), who subsequently telephoned to his firm, but neither considered that there was any danger. Mr. Constable then gave a written order to the shift engineers that the boiler was not to be let down, in order, as he said, not to increase the crack by changing the temperature of the drum; but he did not then report the discovery of the crack to his chief, Mr. Bowden. The reason, no doubt, that Mr. Constable sent for Mr. Covell was that he considered, as did also his chief, Mr. Bowden, that they had not yet taken over the drum from Messrs. Babcock & Wilcox, the terms of Messrs. Babcock & Wilcox's contract with the South Metropolitan Electric Lighting and Power Company being that the final payment was to be after six months' satisfactory working, and this period had not expired.

The visit of Mr. Shermer on the Thursday morning is then alluded to, after which Mr. Constable reported on the state of the boiler to Mr. Bowden. Mr. Shaw, engineering inspector of the National and General Boiler Insurance Co., was then sent for, and Mr. Bowden telephoned to Mr. Kolle, assistant manager of Messrs. Babcock & Wilcox, who appears also not to have anticipated immediate danger. Mr. Bowden's concluding words on the telephone to Mr. Kolle were, "We will see what Shaw says"; this was about twenty minutes to four. Mr. Bowden then sent Mr. Shaw to inspect the boiler, and in about fifteen or twenty minutes the explosion occurred, killing Mr. Shaw, who was in the act of examining the drum, and Mr. Coombes, the boiler-house foreman, who was then, or about then, removing some of the lagging. It was then twilight, and the heaviest load on the engines was just coming on; but it does not appear that the pressure in the boiler was beyond 160 lb. per square inch—its proper working pressure.

The nature and causes of the explosion are dealt with in a joint report of Mr. Carlton and Mr. Vose, who made the preliminary examination after the explosion. Shortly, the nature of the explosion was that the back end of the thermal storage-drum blew out, having fractured round the edge close to the rivets, while the drum, with the front end attached, was projected almost horizontally a distance of 95 yards into a neighbouring gas-works, penetrating in its course three stout brick walls before it came to rest, the third wall being 2 ft. thick.

After the explosion it was found upon an examination of the drum that a crack had, at the time of the explosion, existed two-thirds round the circumference of the end-plate, with a series of small cracks besides, leaving only $\frac{1}{32}$ in. to $\frac{1}{8}$ in. of sound metal, and that in one place this crack had penetrated entirely through the plate for a length of 2 $\frac{7}{8}$ in. This was the crack which had appeared on the outside. Other defects also appeared. All these defects were found to run round the knuckle, along the edge of a chain of deep indentations, which had been caused in fitting the end-plate into the shell of the drum at the works of Messrs. Babcock & Wilcox.

The process of manufacture of the end-plates of these thermal storage-drums was first to press the metal of the end-plate while hot in a die to the required shape, and, after they had cooled, to fit each end-plate into the shell by placing the flange of the end-plate into the last plate of the shell. By means of an hydraulic riveter, which could exert a pressure of 60 tons, the flange of the end-plate and the plate of the shell were then forced together, the metal of the shell and the end-plate in this last process being cold. The steel used in the drums was supplied by Messrs. Beardmore, and was made on the acid open-hearth process. During this fitting of the end-plate into the shell indentations to the depth of $\frac{1}{8}$ in. had been caused to the inside of the knuckle of the end-plate where the cracks before referred to were afterwards found. These indentations were caused by the snap-head of the riveter, which, instead of having been entirely directed against the flange of the end-plate, had partly come in contact with the inside radius of the end-plate at the knuckle. This, as Mr. McLaren reported to his firm after the explosion, was because the end-plate had been brought down too low into the shell-plate during the process before referred to. The effect of these indentations was to punish the metal very severely, and to cause distortions as well.

The Commissioners continue :—Though the work in the other part of the drum was described by Mr. Carlton as being of the highest class, we have no doubt that the indentations we have described showed bad workmanship, and this bad workmanship was the primary cause of the explosion. These indentations were not, according to the evidence of different persons in the employ of Messrs. Babcock & Wilcox, regarded as of any importance.

Messrs. Babcock & Wilcox contended that such indentations did not show bad work, and stated that numerous drums were sent out of their works with indentations, and several with as deep indentations as in the exploded plate. They also sought to shirk the responsibility for the defect in the end-plate by saying that the plates which Messrs. Beardmore had supplied them with were defective, and we have in consequence listened to exhaustive evidence as to the quality of the plates supplied by that firm to Messrs. Babcock & Wilcox, of which the plate used in the manufacture of the end-plate which exploded was one.

We have had, however, the benefit of very careful bending tests, made under the supervision of Mr. Carlton, and in the presence of representatives of Messrs. Babcock & Wilcox, and these tests, speaking generally, dispose of the suggestions of Messrs. Babcock & Wilcox of brittleness.

There was one test, however, which might have left some doubt in our minds had not exhaustive tests been made by Dr. Stanton, superintendent of the Engineering Department at the National Physical Laboratory at Teddington, and by Mr. Rosenhain, superintendent of the Department of Metallurgy and Metallurgical Chemistry in the same laboratory. These tests entirely disposed of the suggestion of inferior metal.

These tests, besides showing the good quality of the metal supplied by Messrs. Beardmore, demonstrated the injurious effect of the rough handling which the plate received at the works of Messrs. Babcock & Wilcox. We have no hesitation, therefore, in finding that the plate supplied by Messrs. Beardmore was of good normal quality, and that the fracture in the end-plate was in no way due to bad material. We also come to the conclusion that the cracks in the end-plate which caused the explosion probably existed to some extent at the time the boiler was tested by hydraulic pressure up to 240 lb., though probably not observable under ordinary internal examinations of the drum. The hydraulic test was a dead load, but when the live load—namely, 160 lb. of steam pressure—was applied; the cracks, in our opinion, increased, and this increase was partly due to the panting movement in the drum, caused by variations in the temperature of the drum, and the pressure in the drum arising from various causes.

The judgment then deals with the responsibility of the different persons concerned. It is stated that Messrs. Beardmore are in no way responsible, but the responsibility of the makers of the boiler is referred to as follows :—

Messrs. Babcock & Wilcox, on the other hand, supplied a drum with a defectively-constructed end-plate—that is to say, an end-plate injured by rough handling, due to bad workmanship. They are, therefore, primarily responsible for the explosion, and they have wasted some days in endeavouring to show that the defect in the end-plate was due to bad material. Mr. R. A. McLaren, their works manager, is responsible for sending out a bad end-plate from the works.

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Mr. H. W. Bowden and Mr. Constable are both held partly responsible; and with regard to the responsibility of the former, the Commissioners remark :—"In the management of electrical power stations, when the chief engineer is an electrical specialist, as he should be, it seems to us desirable that some arrangement of the staff should be made so that the engineer's responsibility for the safe working of the boilers should be lessened, or transferred to an engineer having a thorough knowledge of the working of boilers :—

The judgment concludes :—

The sums which we order to be paid to the Board of Trade are as follow :—

	£
Messrs. Babcock & Wilcox	400
Mr. Richard Andrew McLaren	50
Mr. Bowden	50
Mr. Constable	30

In conclusion, we think it will remove any false impressions caused by this explosion if we place on record the fact that nothing has occurred at this inquiry to throw any doubt as to the safety of thermal storage-drums; but if they are badly constructed or are not worked under safe conditions, explosions, of course, will occur, just the same as in the case of any other boiler.

ITALIAN WATER POWER SCHEME LITIGATION

ON Tuesday, January 21st, in the King's Bench Division of the High Court, Mr. Justice Grantham and a special jury had before them the case of Girolame Taddei and Paoli Bellami, against John D. Pender, Lord Hay and Richard Enfield, executors of the late Sir John Pender, for breach of contract made in December, 1889, between the plaintiffs and Sir John Pender on the one part, and Mr. Jabez S. Balfour on the other part, whereby it was agreed to purchase from the plaintiffs certain water rights and concessions in Italy for the purpose of manufacturing electricity for the lighting of the City of Rome and other uses. The defendants denied liability, and counter-claimed for £12,000 unrecovered on a previous judgment against plaintiffs. Mr. Horridge, K.C., M.P., and Mr. C. C. Scott appeared for the plaintiffs, and Sir Edward Carson, K.C., M.P., Mr. Rufus Isaacs, K.C., M.P., and Mr. Spencer Bower, K.C., were for the defendants. The plaintiffs are two Italian engineers, and the transactions of which the case forms the subject took place in 1889, and has reference to property some 17 miles from the City of Rome. In 1889 it occurred to the plaintiffs that the water power at a Villa near Rome, known as Villa D'Este, could be utilised for the purpose of supplying electrical power to the City of Rome. Accordingly they came to England, and saw the late Sir John Pender, then chairman of the Eastern Extension Telegraph Co., who was favourably impressed with regard to the scheme, and said he was anxious to form a company to be called the Italian General Works Electrical Enterprise Co., with the object of applying for concessions from the Rome municipality. Plaintiffs were instructed to go back to Italy to see if they could arrange the matter, the result being that they entered into an agreement, by which they agreed to purchase the right to use the water power in question for 600,000 lire (£24,000). They also arranged for the sale of the National Educational College, in the villa of D'Este, for 450,000 francs (£18,000), and both those agreements were entered into and completed. Plaintiffs paid a deposit of £2,000 for the water rights, and they guaranteed payment of another £2,000 as against the completion by the purchasers of the educational college on the site. Eventually, however, the negotiations fell through, and the concessions for the supply of electricity were never obtained.

On Wednesday, January 22nd, Mr. Horridge, K.C., M.P., continuing his opening statement, said plaintiffs had spent large sums of money in obtaining concessions for the water power in question. Sir John Pender and those associated with him got so far as the preparation of the prospectus of the Italian General Works Electrical Enterprise Co. The plaintiffs said they were entitled to £50,000 as soon as they satisfied the promoters of the company that they could get the concessions. Plaintiffs got conveyances of the property drafted at the Tivoli, and went to very great expense. This was a great and magnificent scheme for lighting Rome by electricity, but unfortunately it was ruined by the scarcity of money at the time, caused by the Argentine revolution and the Baring crisis.

Mr. Girolame Taddei, one of the plaintiffs, said he had many meetings and consultations in London with Sir John Pender and others. He gave them all the explanations they required as to the scheme, and everybody was satisfied. He and his partner had spent about £20,000 over the scheme altogether. On Thursday witness was cross-examined by Sir Edward Carson. He considered that he ought to have been paid £50,000 by Sir John Pender before he obtained any concessions at all, and before he obtained from the municipality of Rome the right to break up the streets and lay down wires, &c., for the supply of electricity. If they had obtained the municipal concessions they could have used the electricity for industrial purposes in the neighbourhood, and on their own ground. It was necessary to have the £50,000 in order to carry through the scheme and get the water rights. He said he believed it was a fact that there were petitions against the scheme from Tivoli and from Rome and from various users of the water. He knew of the petitions, but he did not inspect them. If they had got the £50,000 they would have obtained the water rights and all difficulties would have disappeared. Once he had got the concessions anyone would have been glad to enter into the matter, as it would have been a very profitable affair. Even if they had not been able to introduce electricity into Rome there would have been a field of operations outside the city.

On Friday, January 25th, Mr. Robert Powell Mackenzie, an engineer, was examined. He said the scheme was a splendid one, and there was no doubt that if the money had been paid there would have been no difficulty in obtaining the concessions, neither would there have been any difficulty in obtaining powers to get an order of public utility and break up the streets of Rome.

On Monday Mr. Horridge, for the plaintiffs, said Sir Edward Carson and he had arrived at terms which were satisfactory to his clients. The case was then accordingly withdrawn from the jury.

NUISANCE FROM BRIGHTON CORPORATION MOTOR-GENERATOR STATION

THE hearing of this case, previously reported on p. 116 of our last issue, was continued on Wednesday last week. His Lordship said it appeared from Mr. Wilson's evidence that the nuisance only commenced when two particular machines were working, and he suggested that it would be advisable for the experts to take special observation of these. Arrangements were accordingly made that after Wednesday's evidence the case should be adjourned till the following Friday, for the inspection on Thursday of the engines while in motion. The Rev. Mr. Roberts, lately curate of St. Mary's Church, stated that the noise from the electrical works interrupted the performance of his clerical duties. Mr. Astbury then opened the case for the defence, stating that the Corporation had exercised their statutory powers in a most reasonable manner, and had done everything possible to meet the plaintiffs. It was utterly impossible to detect any noise unless one knew that it existed and especially listened for it. Counsel maintained that if they could get the judge to go down to Brighton for ten minutes there would be an end to the case. Mr. James Swinburne, F.R.S., said he inspected the sub-station on April 10th, 1907, when it was working at its maximum load for such a time of the year. The station contained four rotary transformers, and three of these were working at the time of his inspection. Machines of that description were practically silent when moving, but most electrical machines made some humming noise. Witness was of opinion that the rotary transformers were well designed and well made, and on proper foundations, and he could find no fault with the station in any way. He had visited the church at Brighton; he went over the entire building and listened carefully at different places, especially those indicated by the Rev. Mr. Heath. He agreed there was certainly audible a slight noise in various places in the church when everything was quiet. From place to place it varied, but in no part of the church was the noise such as to constitute a nuisance. It was a low musical note, a little higher than the lowest G on the manuals of the organ. The noise was completely drowned by anyone speaking and by anyone passing in the street outside the church building.

When the hearing was resumed on Friday, Mr. Swinburne told the judge that he had gone down to Brighton with Professor Boys and Mr. Christie the previous day. Mr. Christie remained at the works, and various combination machines were run. Witness and Prof. Boys went to different parts of the church, and the experiment proved that machines three and five did not create a noise. Mr. Arthur Wright, the Corporation consulting engineer, stated that the noise could only be heard if extreme attention was paid to it. Professor Boys said in his evidence that the noise was so slight that no word in the English language could properly describe it. He did not think that the elastic support to machines would stop the noise, but he would recommend this being tried if an order to stop the noise was made.

Several other witnesses living in the neighbourhood stated that the works did not annoy them, since the steam plant was superseded by the present machinery.

On Saturday, the Town Clerk of Brighton gave evidence, and Professor Boys, recalled, said he believed the noise was a ground sound. He suggested that they should place the church columns on elastic supports, and this might afford a remedy, but he could not guarantee it as an absolute cure. The case was adjourned until to-day (Thursday).

Faraday House Old Students' Association.—The fourth annual dinner will be held at the Queen's Hotel, Leicester Square, on Friday, February 21st at 7.30 p.m., with the President, Mr. G. W. Partridge, in the chair. Tickets may be obtained from the honorary secretary, Faraday House, Southampton Row, W.C.

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STANDARD PERFORMANCES OF ELECTRICAL MACHINERY

DR. R. GOLDSCHMIDT, in his Paper read last Thursday before the Institution of Electrical Engineers, remarked that comparatively little information of a definite nature as to standard performances of motors and dynamos is generally available. For instance, a purchaser of a 10 h.p. motor will look in vain for information as to what the efficiency of such a machine ought to be. If there were any standard rule prescribing that the efficiency should be 85 per cent., manufacturers would probably endeavour to obtain 85½ per cent., and it might become a point of honour to exceed the conditions of the rules. Suggestions for standard performances, standard power-factors, standard efficiencies, &c., from a private quarter may, however, be acceptable, and, after criticism and discussion, may become useful as a private standard.

Although they might not be quite indisputable, he continued, such normal figures would be of assistance in many respects. The mechanical engineer cannot be expected to know what will happen if, say, in a machine tool or crane a gear is arranged to be cut out and the motor speed reduced. I will mention one case. A 5-h.p. 2-phase induction motor for a crane had been fixed at as low a speed as 500 revs. per minute, the overload capacity had been specified as 150 per cent., and the frequency was 50 ~. It does not appear at first sight that the current consumption of such a motor is about double that of a machine running 250 revolutions faster, or that a somewhat smaller overload capacity would have improved matters. The mechanical parts of the crane had been finished, and the motor had to be built contrary to the better judgment of "all who knew." In such a case a timely warning would have been of value. In compiling the Paper I have avoided as far as possible dealing with such generalities as are to be found in text-books, and have endeavoured to demonstrate the results by means of curves, restricting myself to comments on these only.

All electric motors and dynamos work through the interaction of the magnetic flux and the ampere-turns. Whatever machine one may select, whether it be an induction motor, an alternator, a synchronous motor, or a direct-current machine, one always finds a cylinder carrying ampere-turns on its circumference and a magnetic flux entering this cylinder in a radial direction. The torque is the product of both, and calling "power" the kilowatts reduced to 1,000 revs. per minute, then "Power" = KW at 1,000 revs. = const. × ampere-wires × flux = const. × AW × F.

With direct-current machines, polyphase alternators, and polyphase induction motors, the constant averages $0{\cdot}165 \times 10^{-9}$; with single-phase machines it averages $0{\cdot}145 \times 10^{-9}$. By "ampere-wires" is understood the total number of conductors which are cut by a plane in the middle of the armature at right angles to the shaft, multiplied by the number of amperes per conductor. With induction motors the ampere-wires are those of the rotor only. The flux is the sum of all fluxes entering the armature from all poles together. It is naturally possible to obtain a certain "power" with an infinite number of combinations of ampere-wires and fluxes. In actual practice the figure for both will be of the same order if we express AW in 10^3 (kiloamperes) as unit, F in 10^6 (megalines; 1 megaline = 167 kapplines).

The conditions fixing AW and F vary for every class of machine, and are not always those of economy of design. With direct-current machines the commutation, with alternating motors the pull-out, with alternators the voltage drop, come into consideration. Of the two factors, AW and F, working together to produce the output, one, F, is constant, while AW increases with the load. AW tends to destroy F, and causes sparking or voltage drop. Therefore, in order to produce a good machine F must not be too weak. It is due to these well-known conditions that F and AW do not actually vary so very much. The effect on the efficiency, which is the chief item about to be considered, is very small indeed, even if F varies by quite a considerable amount.

There are certain sections required for F and AW, as the density must not exceed a certain figure, limited by heating or saturation (teeth). Further, the length of path which the flux and AW have to flow in is also very nearly fixed, as both are interlinked, and have to surround one another. Therefore, if the AW and the size are given, the copper losses due to AW are pretty well fixed, as well as the core loss, provided the speed at which the flux revolves is known.

DIRECT-CURRENT MACHINES.

Fig. 1 shows F and AW for different KW at 1,000 revs., for machines having no commutating poles. In most cases these fluxes are identical with the most economical flux, especially with moderate speeds. With commutating poles the flux may be 25 per cent. or even 35 per cent. less.

The core loss caused by a certain flux F, is proportional to the speed. Taking 1,000 revs. per minute as the unit of speed, Fig. 2 shows the core loss at different fluxes. It must be understood that there are eddy-current losses, which increase as the square of the speed, the hysteresis only being proportional to it. But in our case the machine with more flux is a different machine, more iron section being provided. This is the reason why we are entitled to make the core loss practically proportional to the speed.

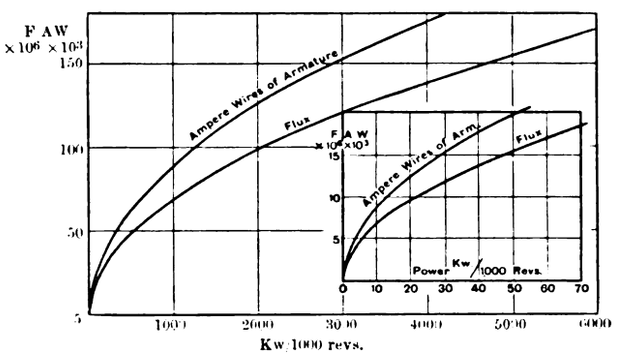


FIG. 1.—DIRECT CURRENT. STANDARD FLUXES AND AMPERE-WIRES OF ARMATURE.

The armature copper loss is dependent on AW only, as shown by Fig. 3.

In Fig. 4 the AW, copper, core, and total losses have been drawn up for 100-kw. 500-rev. machines designed with different fluxes, and it will be noticed that the total losses are practically unchanged (that is, only between 4,550 and 5,000 watts) if the flux is altered from 21 to 37 megalines. The losses with well-designed machines cannot be far from this minimum, as it is very expensive to provide surface for extra losses.

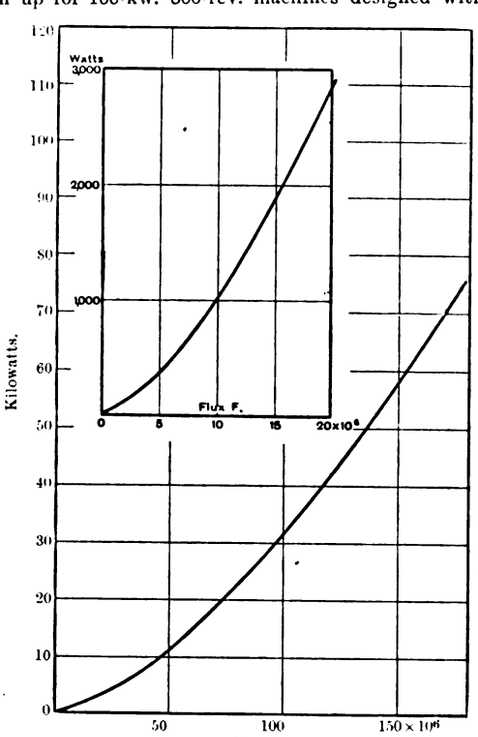


FIG. 2.—DIRECT CURRENT. CORE LOSS AT 1,000 REVS. PER MINUTE WITH DIFFERENT FLUXES.

For convenience sake I have combined Figs. 1, 2, 3 to form Fig. 5, where the losses are expressed in percentages of the output, and as a function of the "power" KW at 1,000 revs. By expressing them as a percentage, the core loss is now independent of the speed, whilst the copper loss is inversely proportional to it. As unit of speed we take again 1,000 revs. per minute. The ampere-turns of the field magnets are a function

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of armature ampere-turns and flux, the former demagnetising and the latter requiring to be driven through the air-gap. These ampere-turns have to surround the flux coming from the armature, which fixes their mean path, so that there exists a law which connects the power of a machine with the losses in the field.

I will define the expression "field ampere wires" as the field ampere-turns per pole multiplied by the number of poles

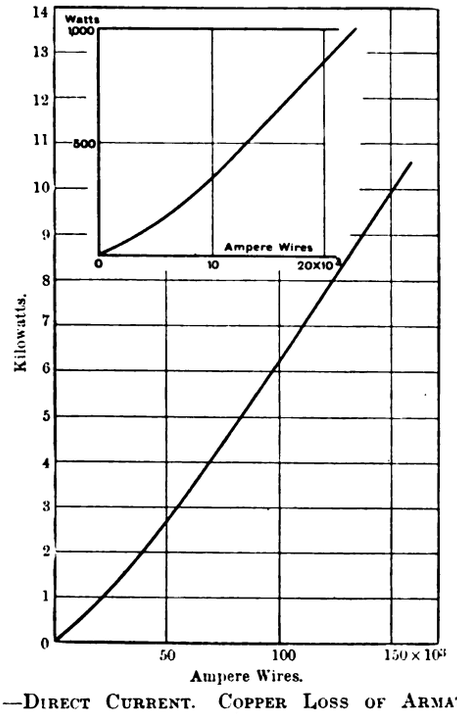


FIG. 3.—DIRECT CURRENT. COPPER LOSS OF ARMATURE WITH DIFFERENT AMPERE-WIRES.

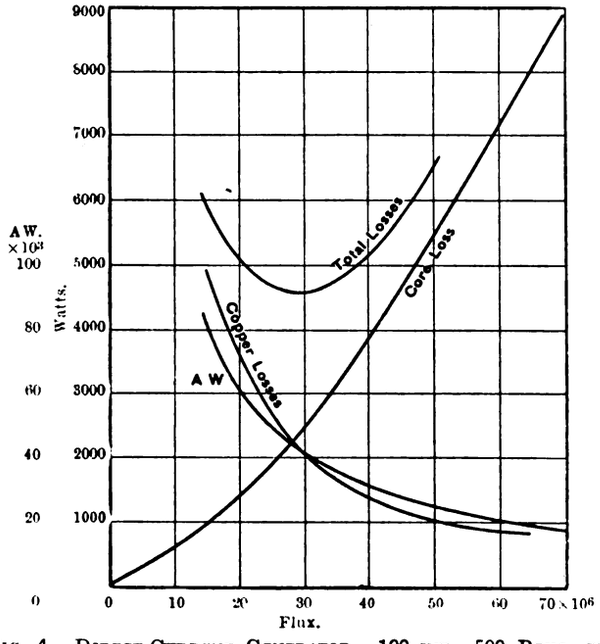


FIG. 4.—DIRECT-CURRENT GENERATOR. 100 KW., 500 REVS. PER MINUTE, LOSSES IN ARMATURE, WITH DIFFERENT FLUXES AND AW.

and multiplied by 2. The field AW and the losses as a function of the power are shown in Fig. 6. The losses are again expressed in percentages of the output, and, for correction, require to be varied in inverse ratio to the speed, 1,000 revs. per minute being again taken as normal. It may be noted that with large machines the field AW is about 25 per cent. more than the armature AW, and that 1,000 AW is about the lowest figure found with very small bi-polar machines. In machines with commutating poles the losses in the main poles are reduced, but this reduction is made up for by the losses in the commutating poles.

It remains to consider the friction losses. The most difficult question is that of the brush friction, but here also there exists a definite relation between current, current density in the brushes, and voltage drop, coefficient of friction, and friction losses. Also the commutator diameter can be approximately determined from the output; so that, choosing 200 volts and 1,000 revs. as normal, a curve can be plotted (Fig. 7) giving the percentage brush-friction as a function of KW at 1,000. These figures vary inversely as the voltage and directly as the speed. The bearing friction and windage are practically independent

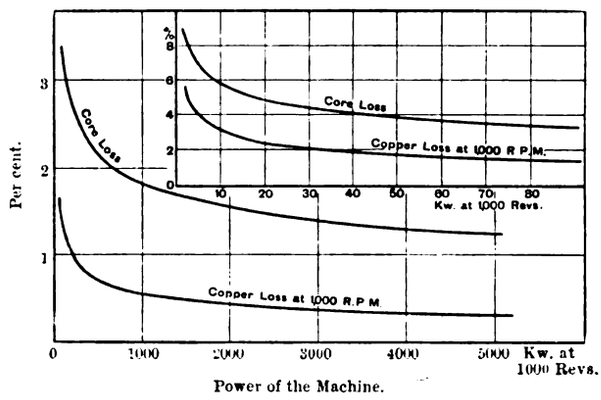


FIG. 5.—DIRECT CURRENT. ARMATURE CORE AND COPPER LOSSES IN PER CENT. OF OUTPUT.

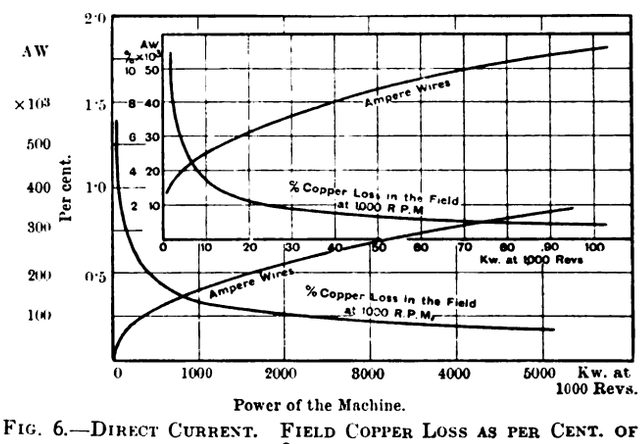


FIG. 6.—DIRECT CURRENT. FIELD COPPER LOSS AS PER CENT. OF OUTPUT.

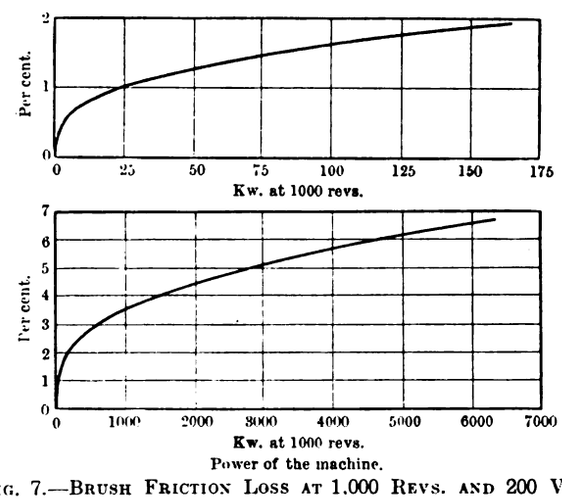


FIG. 7.—BRUSH FRICTION LOSS AT 1,000 REVS. AND 200 VOLTS.

of the "power," and depend almost solely on the angular velocity—that is the revs. per minute. Fig. 8 gives practical average figures for this class of friction.

The voltage drop in the brushes expressed as a percentage may be taken as $\frac{200}{\text{volts}}$. It is somewhat less with high-current and somewhat more with high-voltage machines. With copper brushes it may drop to about $\frac{100}{\text{volts}}$, but ought not to be assumed to be lower.

The total efficiency has been plotted in Figs. 9 and 10 for different speeds and as a function of the actual output (not

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"power" in this case) of the machine, Fig. 9 giving the efficiencies of dynamos up to 5,000 kw. In Fig. 10 the abscissæ represent brake horse-power, but naturally motor and dynamo efficiencies are practically identical, so that Fig. 10 can also be used for dynamos. The voltage has been assumed to be 500 volts. If the voltage is different, a correction may be carried out in the brush friction and brush drop. The comparatively low efficiencies at very high speeds are due chiefly to friction and core loss. Figs. 9 and 10 give only the full load efficiency. An idea of the performance with smaller loads can be gained by referring to the curves giving the losses in detail.

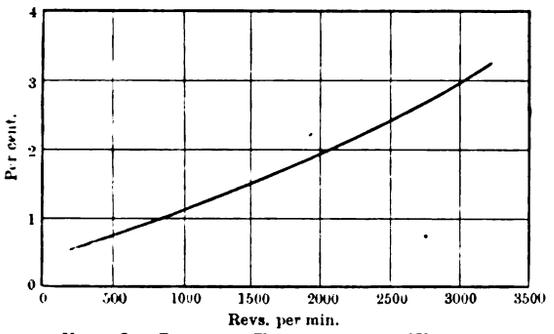


FIG. 8.—BEARING FRICTION AND WINDAGE.

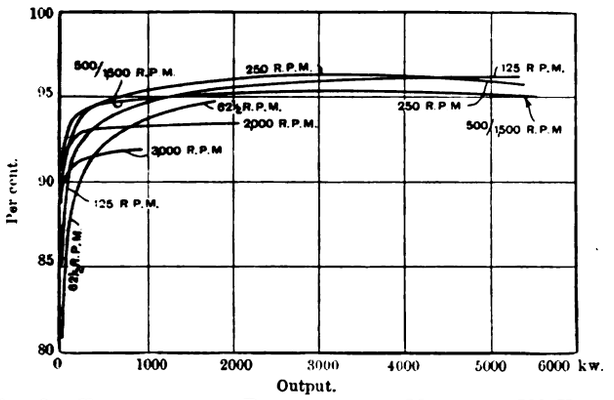


FIG. 9.—EFFICIENCIES OF DIRECT-CURRENT MACHINES, 500 VOLTS.

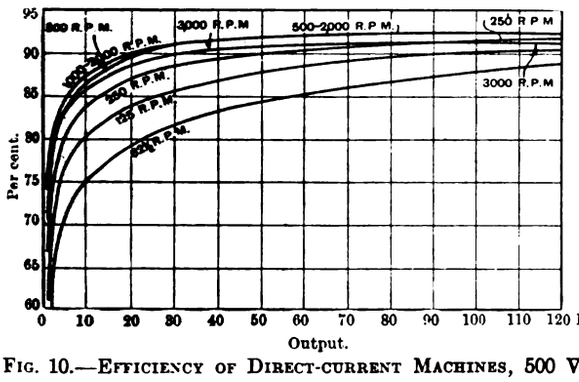


FIG. 10.—EFFICIENCY OF DIRECT-CURRENT MACHINES, 500 VOLTS.

ROTARY CONVERTERS.

The efficiency of a rotary converter may be obtained from the efficiency of the corresponding direct-current machine, making allowance for the losses on the alternating-current slip rings. For this purpose the curves in Fig. 7 may be used, reducing the friction found in this way to about one-half. This is naturally only very approximate. The output of a direct-current machine can be increased by a certain percentage, if used as a rotary, with 3-phase current by 33 per cent., and with 6-phase by 90 per cent. As the power-factor is not always unity, and a slight deviation from this reduces the output again. it cannot be assumed that the latter is increased by the full amount, but only, say, by 20 and 40 per cent. respectively. For approximate estimates the following formulæ may be used :—

$g_r = \frac{g}{0{\cdot}93 + 0{\cdot}07 \times g}$ for 3-phase, and $g_r = \frac{g}{0{\cdot}81 + 0{\cdot}19 \times g}$ for 6-phase, where g_r is the rotary efficiency and g the efficiency of a direct-current machine which is $\left(\frac{1}{1{\cdot}20} - 1\right) = 17$ per cent. and 28 per cent. smaller; g is to be taken from Figs. 9 and 10. Thus a 500-kw. direct-current machine at 250 revs. would as a 3-phase rotary have an efficiency of $\frac{94{\cdot}7}{0{\cdot}93 + 0{\cdot}07 \times 0{\cdot}947} = 95$ per cent.

ALTERNATORS.

The task of developing standard efficiencies for alternators is a very difficult one, as the law fixing the size of the machine is very complicated if the number of poles and the diameter are small. We can speak of the "output" of the field and the "output" of the armature separately. Our output formula KW at $1{,}000 = 0{\cdot}165 \times AW \times F$ refers to the armature only. Now, if we wish to make a good machine with not too much

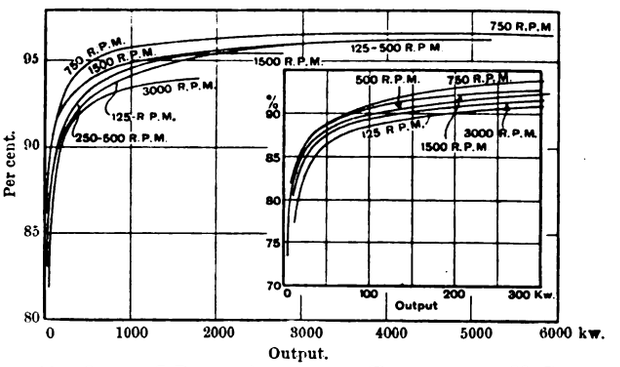


FIG. 11.—2- AND 3-PHASE ALTERNATOR EFFICIENCIES, 50 CYCLES.

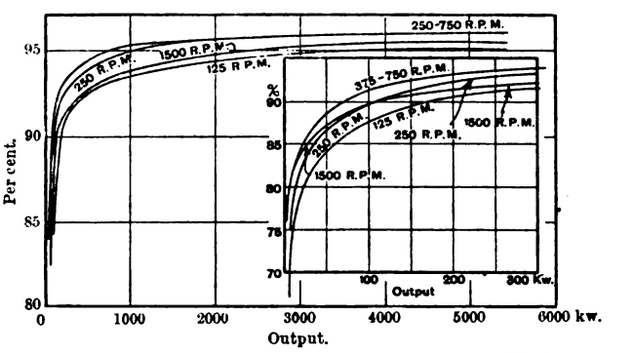


FIG. 12.—2- AND 3-PHASE ALTERNATOR EFFICIENCIES, 25 CYCLES.

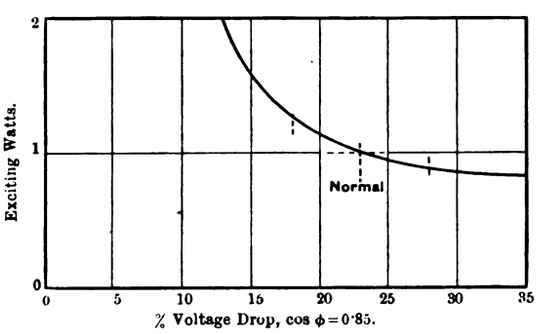


FIG. 13.—VOLTAGE DROP OF ALTERNATORS.

voltage drop, the AW of the field must be a multiple of the AW of the armature, say, three or four times as much. The flux in the field exceeds that in the armature by the amount of the leakage flux. Consequently the "output" of the field must be considerably more than that of the armature. As the field in the case of modern alternators is generally inside the armature, its mean diameter is smaller than that of the latter. Consequently it is often a difficult matter to provide room for sufficient AW and F, and the output of the whole machine has to be reduced. With machines below 5—6 ft. in diameter and a moderate number of poles this difficulty is always experienced. In such cases the output of a certain size of machine may be considerably increased by the admission of a higher voltage drop or by compounding.

On account of these difficulties I decided not to reproduce here the curves for the detail losses of alternators, as they would have been too numerous, but to give the results only. Figs. 11 and 12 show the efficiencies of medium-volt polyphase alternators for 50 and 25 ~ respectively, the power factor being unity. The falling off of the efficiency with very high speeds due to the friction and core loss will also be noticed here. In comparing alternating-current with direct-current machines,

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large alternators are found to be slightly more efficient than large direct-current machines, on account of the commutator losses of the latter, but the reverse is the case with small machines where only small currents have to be dealt with on the commutators and where the alternators require considerable excitation.

To find the efficiency of single-phase alternators it must be remembered that the output of a certain machine as a polyphase alternator is about 50 per cent. more than for single-phase. The losses of the latter may therefore be taken as those of a 50 per cent. larger polyphase machine.

Generally speaking, if g is the efficiency of the 50 per

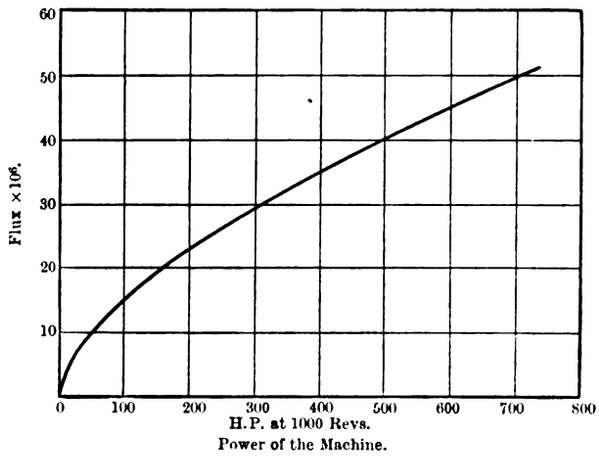


FIG. 14.—INDUCTION MOTORS. FLUXES.

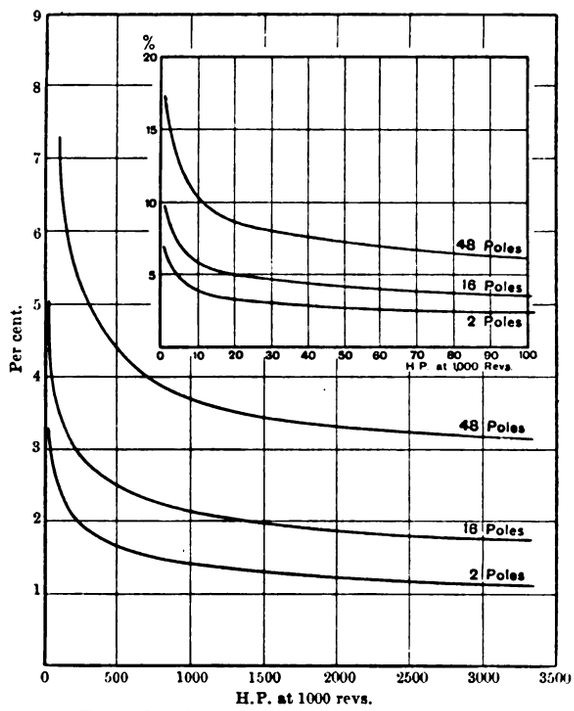


FIG. 15.—CORE LOSS OF INDUCTION MOTORS.

cent. larger polyphase alternator, the efficiency of the single-phase machine is—

$$g_1 = \frac{g}{1{\cdot}5 - \frac{g}{2}}.$$

If the power-factor is 0·85, the output of a certain machine is reduced 15 per cent. (actually the output of the armature only), while the excitation losses rise. It may therefore be stated approximately as—

$$g_{0\cdot85} = \frac{g}{1{\cdot}3 - 0{\cdot}3 \times g}.$$

I have pointed out what great influence on the size of machine the permissible voltage drop has. Therefore it is advisable not to specify it higher than can be helped. As a rule, one finds about 7½ per cent. drop specified with a power-factor of 1, and 23 per cent. with a power-factor of 0·85. Calling the excitation watts with this drop (23 per cent.) 1, and plotting a curve "exciting watts as function of the drop," the curve Fig. 13 is obtained.

INDUCTION MOTORS.

Efficiency.—The design of induction motors is far more definite than that of alternators, so that I may venture to reproduce a curve for the normal flux as a function of the "power" h.p. at 1,000 in Fig. 14. The overload capacity is the chief determining factor for these fluxes. In our case they refer to machines for

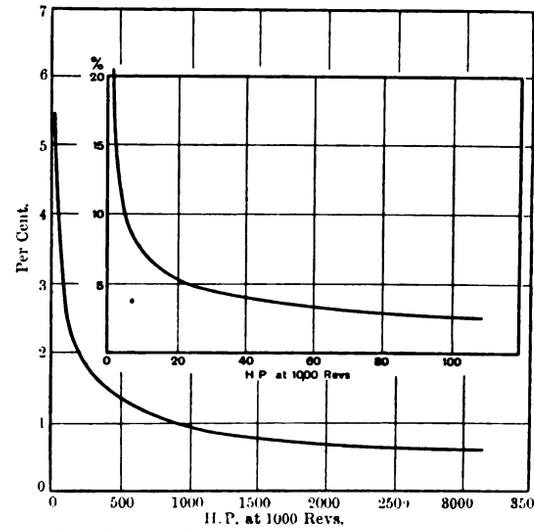


FIG. 16.—COPPER LOSS OF 4-POLE INDUCTION MOTORS.

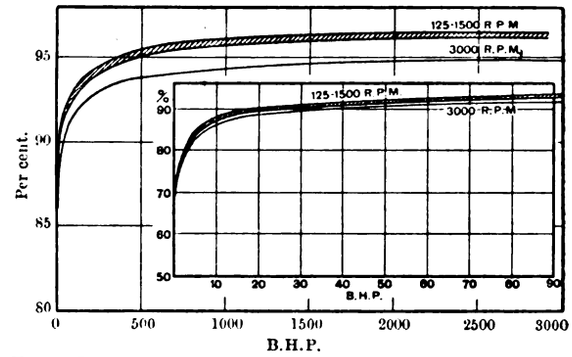


FIG. 17.—EFFICIENCY OF 50 CYCLES INDUCTION MOTORS, POLYPHASE.

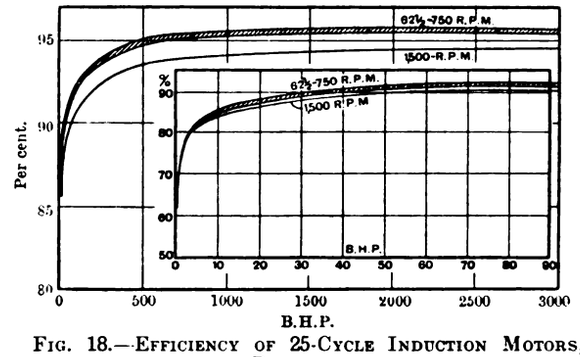


FIG. 18.—EFFICIENCY OF 25-CYCLE INDUCTION MOTORS, POLYPHASE.

about 125 per cent. overload capacity. With large and high-speed machines this figure is somewhat higher, owing to the fact that considerations of economy become important when AW and F are chosen. The percentage core loss and copper loss for different powers are shown in Figs. 15 and 16. In induction motors the percentage core loss is also independent of the speed, and of the periodicity, if plotted separately for different numbers of poles.

The copper losses have been plotted for 4 poles and 50 ~ only. Here it has to be borne in mind that the percentage copper loss increases as the square root of the number of poles, and in proportion to the periodicity. The reason for this is that with an increasing number of poles the output falls proportionately, but the mean length of turn is reduced as the length of the end connections decreases. With different frequencies the copper losses remain constant, whilst the output falls with the periods.

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Figs. 17 and 18 show the complete efficiency curves for 50 and 25 ~ for polyphase machines. Fig. 19 gives the efficiency of single-phase induction motors for 50 and 100 ~ . In these curves the most striking feature is the fact that the efficiency is almost independent of the speed. It has been possible to show a narrow shaded area within which the efficiencies fall for any speed between 125 and 1,500 revs. per minute. Since the percentage core loss falls and that of the copper and friction loss rises as the speed goes up, the total losses remain nearly constant for a certain output. A comparison will show that the difference between the efficiencies of direct-current machines and alternating-current induction motors is not considerable. Single-

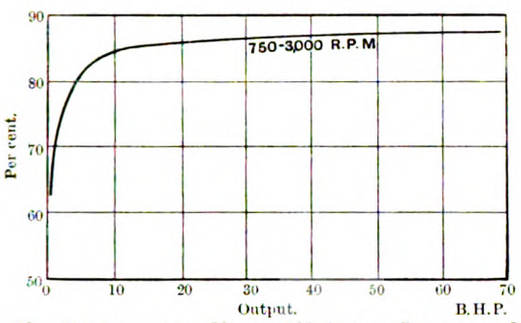


FIG. 19.—EFFICIENCY OF 50 AND 100 CYCLES INDUCTION MOTORS, SINGLE PHASE.

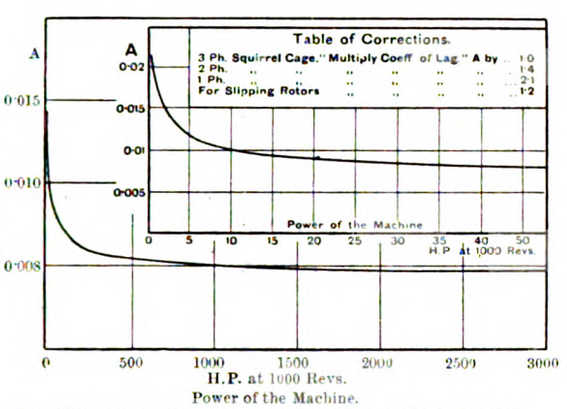


FIG. 20.—COEFFICIENT OF LAG OF INDUCTION MOTORS.

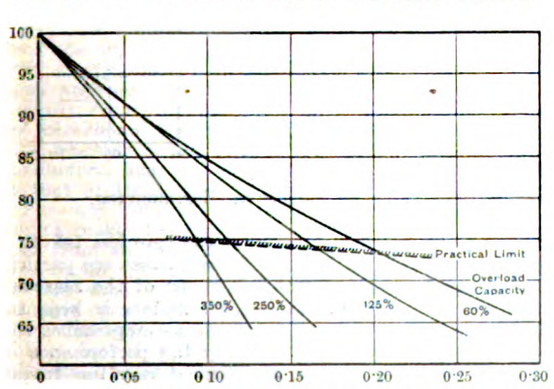


FIG. 21.—POWER FACTORS OF INDUCTION MOTORS.

phase motors naturally are considerably worse than both (Fig. 19).

Power Factor.—In saying that the efficiencies of direct-current and induction motors are practically identical, we have to restrict this to the real efficiency, the apparent efficiencies naturally being much worse with the latter class of machines. It is often important to know clearly beforehand what the power factor is likely to be before deciding on the speed, as a few revolutions may often convert a bad motor into a moderately good one. It is hardly practicable to draw a great number of power-factor curves which might enable one to read off the figures at a glance, as there are too many items influencing the power factor, namely, the size of machine, expressed by the "power" h.p. at 1,000 r.p.m., the number of poles, and the overload capacity. The air-gap also influences the power factor, but, as hitherto, this detail of design is taken account of in determining the "size," that is, the power of the machine. Instead of a great number of curves for Cos ϕ we use the two Figs. 20 and 21.

It is well known that the power factor of an induction motor greatly depends on the leakage of the machine, this leakage being smaller the smaller the air-gap, the larger the diameter, and the lower the number of poles. Apart from this latter item the leakage only depends on details of design, so that a factor which is an expression for the tendency to admit leakage can be plotted as a function of the "power" of the machine. We will call this factor the "*coefficient of lag*," A. All details of design have been crammed into this coefficient, and it has been

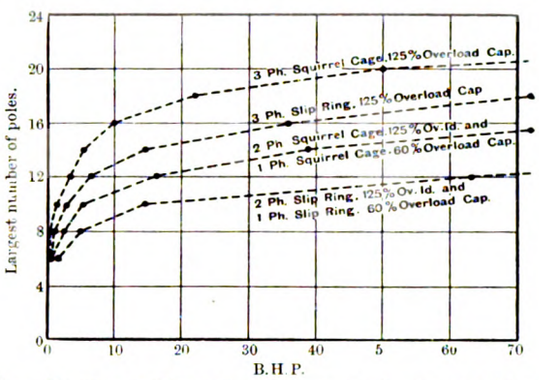


FIG. 22.—LIMIT NUMBER OF POLES OF INDUCTION MOTORS.

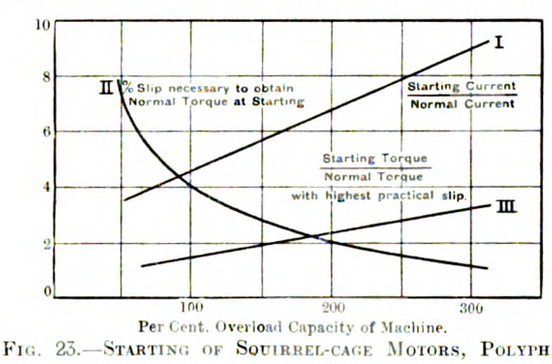


FIG. 23.—STARTING OF SQUIRREL-CAGE MOTORS, POLYPHASE.

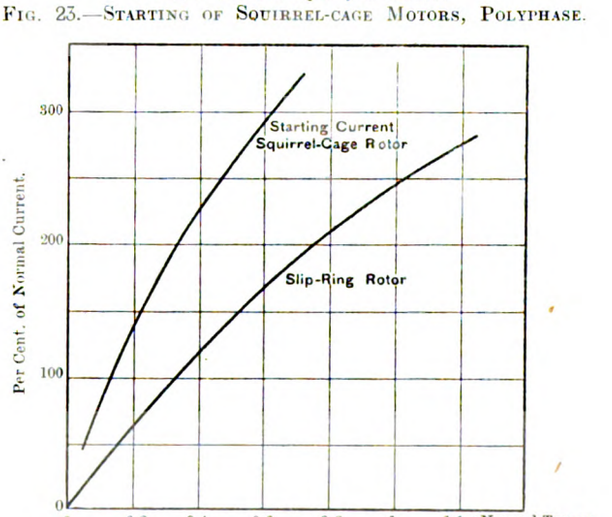


FIG. 24.—STARTING CURRENT OF SINGLE-PHASE MOTORS.

so selected that if multiplied by the number of poles Heyland's leakage factor appears.

Fig. 20 shows the coefficient of lag A dependent on the "power" h.p. at 1,000 for 3-phase motors with squirrel-cage rotors, whilst Fig. 21 directly gives the power factor at normal load for different overload capacities, dependent on the product "A × number of poles."

The coefficient of lag A in Fig. 20, referring to 3-phase squirrel-cage motors, is smaller than with any other class of motor, so that 3-phase squirrel-cage machines have the highest possible power factor. A has to be multiplied by the following constants: with 2-phase machines by 1·4, with 1-phase machines by 2·1.

In all cases where the rotor is a wound one the coefficient of lag increases another 20 per cent. I have drawn a line in Fig. 21

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which represents the line of desirable practical limits, which only in exceptional cases ought to be exceeded. To make this still clearer the chart, Fig. 22, has been added, giving the highest number of poles a motor ought to be built for, the overload capacity being 125 per cent. in the case of polyphase and 60 per cent. with single-phase machines. It is necessary to point out that, when finding the coefficient of lag for single-phase motors from Fig. 20, this is to be taken at an abscissa for 50 per cent. larger output, as the "size" of a single-phase machine is 50 per cent. larger than the corresponding 3-phase one.

The Starting of Polyphase Squirrel-cage Motors.—The starting performance of a slip-ring motor where resistance is inserted in the rotor is too well known to be mentioned here, and it does not offer any special points which depend on size or design. The starting of squirrel-cage motors, however, often causes uncertainty as to the current consumption and the torque obtainable. We have to distinguish between machines being thrown straight on to the line and those started by means of a starting transformer, which reduces the voltage on the motor terminals.

If thrown straight on to the line, the current taken by the motor depends on the overload capacity it has been designed for, the current being larger the stronger the motor. Fig. 23 shows in a curve the approximate ratio $\frac{\text{starting current}}{\text{normal current}}$ dependent on the overload capacity. With very bad machines

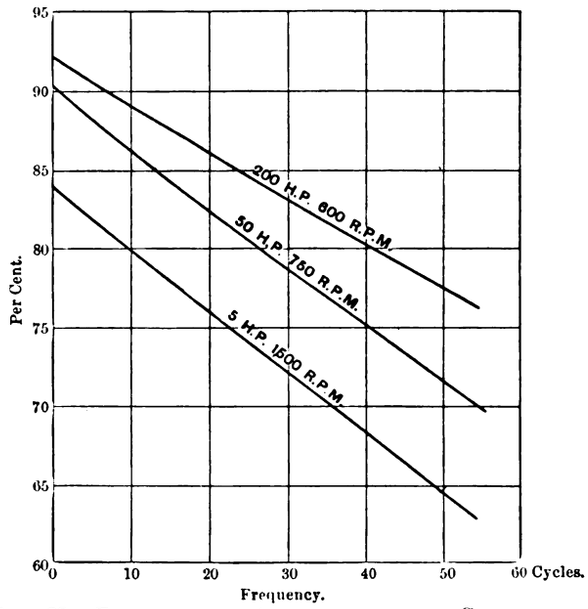


FIG. 25.—EFFICIENCY OF ALTERNATE-CURRENT COMMUTATOR MOTORS.

this ratio is somewhat smaller than that given here, due to the high no-load current. It will be noticed that with 125 per cent. overload capacity the starting current is about five times the normal current. If we wish to obtain a starting torque equal to the running torque, the rotor must have its resistance adjusted to give the percentage of slip as shown by the curve II. in Fig. 23. In some cases, especially with American machines, a good efficiency is not regarded as of great importance compared with good starting qualities. Also, short-circuit rings of the squirrel-cage are made of very high resistance metal, and slips of 6 and, with small machines, even 10 and 12 per cent. are considered quite permissible. In this case very high starting torques can be obtained. Curve III. shows about the highest starting torque practicable. Very often the windings are switched in star connection at starting, being in delta at normal load, in order to reduce the starting current. Then the starting currents are reduced, together with the torques, to one-third of the figures given in Fig. 23.

Starting of Single-phase Motors.—Single-phase induction motors with slip-rings are as a rule started with choking-coils, and squirrel-cage machines with resistances as a means of splitting the phase. Only rarely are condensers employed. Whatever means are used for phase-splitting, certain practical limits are encountered which without very much difficulty may also be followed up theoretically. I have given in Fig. 24 the starting current of single-phase motors as a multiple of the normal for different starting torques, the overload capacity being assumed to be about 75 per cent.

Maximum Voltage.—Before concluding the section on induction motors, I should like to allude to a question often asked, What is the maximum voltage for which a motor can conveniently be built? When ought a transformer to be used with the motor? This naturally depends very much on the design. Often the end brackets are too tight to take high-voltage end connections, and questions of detail of design have to be taken account of. If this is not the case, I may say that the voltage of an induction motor ought not to be so high that with large machines the current falls below $2\frac{1}{2}$ amperes and with small machines below $1\frac{1}{2}$ amperes.

SINGLE-PHASE COMMUTATOR MOTORS.

The real efficiency of a single-phase commutator motor is generally worse than that of a similar machine of the induction type, though the efficiency of the latter is not particularly good. The cause of this is chiefly to be attributed to the losses in the resistance connections between armature winding

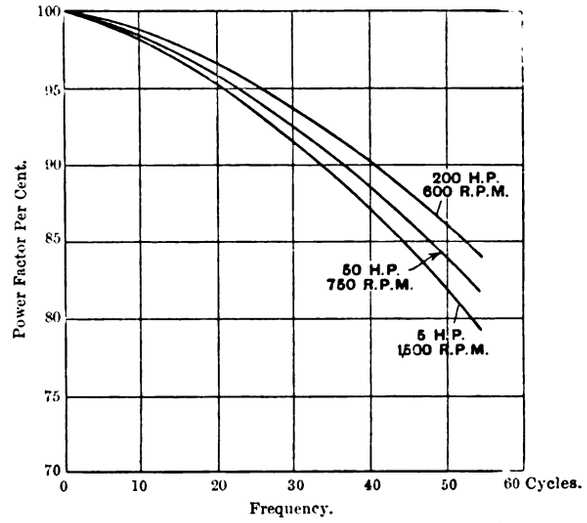


FIG. 26.—POWER FACTORS OF ALTERNATE-CURRENT COMMUTATOR MOTORS.

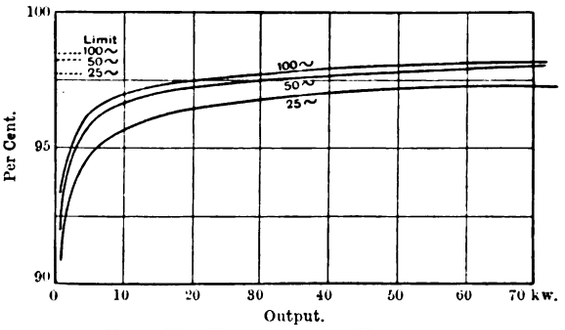


FIG. 27.—TRANSFORMER EFFICIENCIES.

and commutator lugs and to the enormous core loss taking place in the whole body of the machine. These losses are particularly high with high frequencies, and this is one of the reasons why generally the frequency of single-phase motors is kept as low as possible, so that actually its performance approaches that of direct-current machines. But naturally the performance of an induction motor would also be excellent at very low frequency, though it would under no condition approach the perfect behaviour at starting of the commutator motor. As characteristic motors I have chosen a small, a medium, and a large machine—5 h.p. at 1,500 revs. per minute, 50 h.p. at 750 revs. per minute, 200 h.p. at 600 revs. per minute—and efficiencies and power factors have been plotted as a function of the periodicity (Figs. 25 and 26). The power factors of Fig. 26 are those of plain single-phase commutator motors with compensating winding. They may be improved by using machines of the Latour and Winter-Eichberg type or by applying special means of other kinds to raise the power factor, generally at a sacrifice of 1 or 2 per cent. in the efficiency.

TRANSFORMERS.

Transformer efficiencies at normal load only do not always serve very well as an indication of the real quality of the apparatus, less so than in the case of the average motor and dynamo. This is true, at all events, with lighting transformers. With power transformers the normal efficiency is quite a useful figure.

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The efficiencies plotted in Fig. 27 are not the normal but the maximum figures obtainable from a certain transformer—that is, when core and copper losses are equal. Usually it is possible to shift this maximum somewhat, putting it with lighting transformers near half-load, with power transformers near full load. By stating the maximum efficiency only, the curves in Fig. 27 will prove useful, even for finding efficiencies at very small loads, if one only takes account of the fact that one-half of the losses are core losses and the other half copper losses, which vary as the square of the output.

I have not extended the scale of the KW beyond 70 kw., as such a transformer as a rule has as good an efficiency as a 700-kw. one. The following may be given as efficiency limits: 100- ~ transformers 98½ per cent., 50- ~ transformers 98¼ per cent., 25- ~ transformers 97¾—98 per cent.

DISCUSSION.

Dr. SILVANUS P. THOMPSON, F.R.S., who opened the discussion, said that although he had only been able to go through the Paper in a very hasty manner, it had struck him as being a really valuable contribution, for it gave a means, at any rate—if it did not give a great deal more—of studying the comparative values of designs for different sources. He had not yet been able to examine whether the curves would fit the data known to him, but in any case it would be possible for designers to plot on the same framework the corresponding values of machines with which they were acquainted, and thus see whether the points so plotted came anywhere near those on the curves, and in this way the curves would be of great use. But there was, he thought, something to be desired in the interpretation of the diagrams in the Paper. It was not quite obvious which of the curves were derived purely from experience and which were calculations from first principles. If he was not mistaken, they were nearly all derived from experience, and corresponded to actual average performances from actual machines. At the same time, if any of them were derived or derivable from first principles, it was well that it should be stated that they were not dependent upon any empirical result obtained from any particular make of machine. He next dealt with the early portion of the paper, in which the main principle of the paper was laid down, of comparing all machines on the basis of the kilowatts which the machine in question would give out at 1,000 revolutions per minute. He criticised Dr. Goldschmidt's use of the word "power" in this connection, and suggested some other name, such as "powerage," as being more suitable; the author's definition of this quantity was "kilowatts at 1,000 revolutions per minute," which was equivalent to watts per revolution, in considering a machine which gave a certain number of watts at full load at a certain speed, and they had then the statement that the number of watts per revolution was equal to a certain constant times the total number of ampere wires round the armature of the machine multiplied by the total flux coming in or out from all the poles. It resolved itself into a very simple expression, and the constant did not depend upon anybody's particular make of machine. It was derivable literally from first principles. Dr. Thompson then wrote upon the blackboard the familiar formulæ for the e.m.f. and current of a machine in terms of the speed, number of poles, armature conductors, flux, &c., and deduced from them a formula similar to that of Dr. Goldschmidt for the total watts output.

For any and every continuous current machine, of anybody's make, the watts per revolution were equal to the total flux from all the poles multiplied by the ampere wires all the way round multiplied by a constant which could not be greater or less than $0{\cdot}166 \times 10^{-8}$. The constant given by Dr. Goldschmidt was 0·165. Thus they were in agreement, only he (Dr. Thompson) said that 0·166 was the absolute and unalterable value of the constant for continuous current machines, whereas Dr. Goldschmidt had given it as the average for continuous current machines, polyphase alternators, and polyphase induction motors. Could it be any different for polyphase alternators or polyphase induction motors? It could, because the real power of polyphase alternators or induction motors was not the same as the volts and amperes multiplied together in the sense in which it was in continuous current machines. It would be true for polyphase alternators and induction motors assuming there was no trouble from the form factor question if the power factor were unity. If it were less, then the constant would be smaller than 0·166. This might in some cases be compensated for by the circumstance that, taking the form factor and the root mean square into account, the value that would be otherwise raised 10 per cent. if the value of the amount were raised 10, would go down by the same amount because of the power factor. The two effects belong to one another, and therefore they would have nearly the same value for the constant of these other machines. For single-phase machines, according to Dr. Goldschmidt, it was 0·145. He did not understand the particular result, because he could not understand how it could be very much lower unless the statement was to be believed that the power factor of single-phase machines was always a bad one, or that its form factor for the virtual value was always abnormally low. Fig. 1 was an exceedingly interesting diagram in which he presumed, as the result of experience, the values were plotted in curves of the armature wires all the way round, and the flux in terms of the watts per revolution. The two curves in Fig. 1 were parabolic in outline, and they showed, he presumed, as the result of experience, that there was for machines that had a similar number of watts per revolution about the same proportional height between the curves, and if they took the scales into account—the flux being given in millions and the ampere wires in thousands—it appeared that the ratio of the total flux from all its poles to the ampere wires all the way round was constant. The ratio of one to the other was 800 for all machines apparently. Why should this be so? Apparently because they would have trouble from a machine if this proportion were seriously departed from. If they had too much copper and too many ampere wires on the armature in proportion to the flux from outside, then there would be too much distortion or demagnetisation, and probably commutation troubles. If they required a machine to work without trouble in the commutation, the total loading of the armature must not be too great in proportion to the total flux coming in. Apparently it was something of that sort which determined that there should be this proportion of 800, and certainly it simplified the work of designing if experience showed such a fixed proportion as that. He had not been through all the curves, but he imagined that the paper contained a fund of most valuable information as to what was the average practice for particular classes of machinery when compared one with the other, and it was an exceedingly simple and rational basis to take the same number of watts per revolution. Therefore, so far as he was able to appreciate the paper, he desired to express his thanks to Dr. Goldschmidt for having put things on to such an exceedingly interesting and useful basis for consideration.

Mr. V. A. FYNN said the author gave 0·145 as the co-efficient for single-phase machines and 0·165 for two-phase. He also stated that, "with induction motors the ampere wires are those of the rotor only. The flux was the sum of all fluxes entering the armature from all poles together." He took it that the author was dealing with a two-phase machine, with the resultant of the two fluxes which were really present. If the same thing was done for a single-phase induction motor, then the co-efficient would not be the same, because the flux coinciding with the main stator winding contributed nothing whatsoever to the torque of the machine. It was simply there for the purpose of taking the energy inductively from the stator to the rotor, and it was the rotor itself which was producing the field. Therefore, if the resultant flux was taken as 1·41 of the main flux, the whole of this was not effective for torque purposes, and therefore the coefficient for the single-phase motor should be lower; he made it roughly about 0·115. This held good for induction motors, but if they dealt with conduction motors then there was only one flux in the machine, and that was produced by the field winding on the stator, and the coefficient ought, as far as he could see, to be practically the same as for the continuous-current machine. It really came to this: that in the single-phase machine there were two fluxes at right angles in space differing in phase by 90 degrees, and only one of these produces torque. In the two-phase machine there were two fluxes at right angles in space, and also at right angles in tune, and both of them produced torque.

There was another point which he would like to mention, and that was in connection with single-phase commutator motors. The author stated:—"The real efficiency of a single-phase commutator motor is generally worse than that of a similar machine of the induction type, though the efficiency of the latter is not particularly good." He supposed that the author had in mind in these remarks conduction machines only. The Paper also mentioned the "plain single-phase commutator motor," which he presumed was the series machine. (Dr. Goldschmidt: That is so.) In that case, no doubt, the power factors were roughly correct, but if the motor was worked at some 40 per cent. or 50 per cent. above the synchronous speed, as it should be, then they were too low. The efficiency curves, he thought, were most distinctly too low. He could remember motors built by Ganz & Co., in 1888 and 1890, in large quantities at 5 h.p., with 75 per cent. efficiency. He suggested that the curve in Fig. 25 should be put up roughly as follows:—If machines with a shunt characteristic were referred to, then the 5 h.p. curve should at least come up to 70 on the 50-cycle line, an increase of about 6 per cent. The 50 h.p. machine should come up 9 per cent. also on the 50-cycle line, and the 200 h.p. also roughly 9 per cent. These were good conservative figures. If the machine was a series conduction one, then all the efficiencies might be wrong by another 3 per cent. If it was a series induction machine, they would be, as a rule, the same; in fact, in some cases a little lower than the machine with a shunt characteristic. He thought this distinction between single-phase motors with shunt and series characteristics might very well be introduced into the Paper, although it must, of course, be on quite general lines, because the difference between the two machines was very marked indeed.

Mr. J. C. MACFARLANE (Messrs. Crompton & Co., Ltd.) read some remarks, which are given in a slightly abridged form below:—The first thing that I wish to draw attention to in

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Dr. Goldschmidt's valuable Paper is a reference near the beginning to a 5 h.p., two-phase induction motor for crane work, which runs at the low speed of 500 revs. on a 50-cycle circuit, and which also has a large overload capacity. Dr. Goldschmidt's Paper would be a valuable one, indeed, if it prevented buyers of electrical plant from making such mistakes as this. The combination of low speed and high frequency in induction motors is a very common error made by buyers of such motors, and the trouble they cause to the manufacturer, due to this, does not appear to be appreciated by them. Turning now to Fig. 1, it would appear that Dr. Goldschmidt has selected two curves, one representing the flux or magnetic loading of an armature as a function of the output at 1,000 revs., the other representing the ampere wires, or electrical loading of an armature also as a function of output at 1,000 revs., and it may be noted that the corresponding ordinates of those two curves bear a fixed ratio to one another. This ratio is approximately 800 : 1, *i.e.*, for any "power" whatsoever the magnetic loading of an armature is given by the curve as 800 times greater than the electric loading of the same armature. I cannot understand why Dr. Goldschmidt has selected this ratio in preference to any other ratio; nor can I see that any fixed ratio will suit the case—for I have known quite modern machines which have this ratio as great as 2,000 : 1, that is, the magnetic loading is 2,000 times as great as the electric loading of the armature. And I have also known machines having this ratio as small as 250 : 1, that is, the magnetic loading in this case is only 250 times as great as the electric loading of the armature. Dr. Thompson, in one of his Howard lectures before the Society of Arts, has recently given this ratio as about 1,000 : 1, but it must be remembered that this figure depends to a very great extent on whether a machine has an armature core length which is abnormally great compared with its diameter, or whether it has a core length which is abnormally small compared with its diameter. The very long machines will usually have a high ratio of magnetic to electric loading, whereas in narrow machines this ratio will usually be low. The machines quoted above, *i.e.*, the machines in which the magnetic loading was 2,000 times the electric loading, and the machines in which this ratio was 250 : 1, were quite normal machines, so far as core length goes. Another thing that may be noticed about the curves in Fig. 1 is that these are parabolas, and I should like to ask Dr. Goldschmidt why he has selected these curves for the purposes of this lecture. A little later on Dr. Goldschmidt makes two statements, which I consider are not quite correct. The first is :— In most cases these fluxes are identical with the most economical flux, especially with moderate speeds. The second is that in commutating pole machines, the flux may be 25 per cent. or 35 per cent. less than the flux given by the curves in Fig. 1. I presume he considers these are about the most economical fluxes for interpole machines. I do not know whether Dr. Goldschmidt refers to economy in the sense of electric and magnetic losses, or whether he refers to economy in material, but in neither of these cases are his statements correct. For in the case of electric and magnetic losses it is a well-known fact that the maximum economy is to be obtained when the sum of the constant losses of a machine is equal to the sum of the variable losses of a machine. Put more clearly, this means that the core loss, plus the shunt loss, should be about equal to the armature copper loss, neglecting for the moment the commutator losses. Taking the losses given for an 100-kilowatt machine, and adding these core and shunt losses together, you will find that they are exactly double the armature core loss. If we go further than this, and add to the constant losses the brush bearing and wind friction losses, and add to the variable losses the brush drop, we shall find that the case will be still further aggravated. With regard to economy in material, the maximum economy in material is to be obtained when the sum of the cost to the iron and steel, &c., in the magnetic circuit, plus the cost of the shunt copper, is equal to the cost of the armature copper. Or, for the interpole machines when the sum of the iron and steel costs, plus the shunt copper cost, is equal to the cost of the armature copper plus the cost of the interpole copper. What has been said may be more briefly put as follows :— The electric and magnetic losses in any machine are a minimum when the total losses in the magnetic circuit are equal to the total losses in the electric circuit. Also the cost of the material in any machine is a minimum when the cost of the material in the magnetic circuit is equal to the cost of the material in the electric circuit. I have with me some figures on two machines, one of which has the same ratio of magnetic to electric loading as given by Dr. Goldschmidt's curves in Fig. 1. The first of these machines is a non-interpole machine, and has an output of 470 kilowatts at 1.000 revolutions. The second machine is an interpole machine, and has an output of 475 kilowatts at 1.000 revolutions. The total magnetic loading of the first machine is 50.000.000 C.G.S. lines, and that of the second is 30.000.000 C.G.S. lines, *i.e.*, the magnetic loading of the non-interpole machine is 54 per cent. greater than that of the interpole machine. The electric loading of the first machine is 60.000 ampere wires, and that of the other machine is 100.000 ampere wires, *i.e.*, the electric loading of the interpole machine is 60 per cent. greater than that of the other. The total losses of the first machine amounted to about 14½ kilowatts, and the total losses on the second machine amounted to about 13 kilowatts. (It will be noticed that the total loss in the interpole machine is about 10 per cent. less than in the non-interpole machine.) The loss in the electric circuit of the first machine was 3·5 kilowatts, and the loss in the magnetic circuit was 11 kilowatts, *i.e.*, giving a ratio of 3 : 1 in favour of the magnetic circuit losses. The loss in the electric circuit of the second machine, *i.e.*, the interpole machine, amounted to 6·2 kilowatts, and in the magnetic circuit amounted to 6·8 kilowatts, making a ratio of 1·1 : 1 in favour of the magnetic circuit. Note that the losses, in the case of the interpole machine, in the electric and magnetic circuits are practically equal, whereas the losses in the case of the non-interpole machine are about 3 : 1, which tends to prove the rule given above. With regard to costs, the total cost of the material in the non-interpole machine came out at about £154, whereas in the case of the second interpole machine the cost came out to be about £128. *i.e.*, therefore there is about 20 per cent. more material on the non-interpole machine than there is on the interpole machine. The material in the electric circuit of the first machine cost about £12, and the material in the magnetic circuit of this machine cost about £142, giving a ratio of about 12 : 1, whereas in the interpole machine the electric circuit material cost about £38, and the cost of the magnetic circuit material amounted to £90, making a ratio of only about 2½ : 1. Although the interpole machine does not appear to be designed to give quite the most economical distribution of material, it has a considerable advantage over the non-interpole machine in this respect. It will be readily seen from the above figures, and also for other reasons, that the fluxes given by Dr. Goldschmidt in his curves, Fig. 1, are not by any means the most economical fluxes either from the point of view of efficiency or the economy of material. The temperature rise on both these machines was approximately the same, that on the interpole machine being slightly better if anything. As the magnetic loading in the non-interpole machine is about 46,000,000 C.G.S. lines, and the electric loading in this machine is about 60,000 ampere wires, then the ratio of magnetic to electric load is about 800 : 1, whereas in the interpole machine this ratio is about 300 : 1. The non-interpole machine is therefore a very similar machine to that which would be obtained by designing on the curves in Fig. 1, and the armature core, armature copper and shunt losses obtained from tests, compare very well with the figures obtained from the curves (Figs. 2, 3, and 6). The object of the above discussion is : (1) To show that the selection of a fixed ratio for the magnetic to electric loading of an armature is inadmissible, for in practice this ratio varies greatly, and although the author's method may give efficiencies within 1 per cent. or 2 per cent. in most cases at full load, yet it will not give any idea of the relative values of the various core and armature losses, &c., within the machines. This is important, because of the estimation of the efficiencies at other than full load. (2) To show that the fluxes given by curve in Fig. 1 are by no means the most economical, either from the point of view of power, loss, or economy in material in non-interpole machines, and in interpole machines fluxes of 25 per cent. or even 35 per cent. less than those given on the curve referred to are also not even the most economical for these machines. Mr. McFarlane added that he would like to ask Dr. Goldschmidt why he had not made Fig. 14 a parabola, in the same way as for the direct-current machines. As a matter of fact, it was not quite a parabola, and he should also like to say that it represented by no means the most economical curve from the point of view of the outputs of induction motors, *i.e.*, for certain fluxes he should think it would be possible to get 30 per cent. to 50 per cent. more output from an induction motor than was given in Fig. 14. Further on in the Paper the author stated : "It is well known that the power factor of an induction motor greatly depends on the leakage of the machine, this leakage being smaller the smaller the air gap, the larger the diameter and the lower the number of poles." He thought Dr. Goldschmidt must mean leakage factor there, because the leakage of an induction motor did not decrease with the decrease of the air gap; it increased with the decrease in the air gap, and it did not necessarily decrease with the larger diameter, nor did it necessarily decrease with the lower number of poles.

Mr. H. BURGE, referring to the statement that "It has to be borne in mind that the percentage copper loss increases as the square root of the number of poles," in induction motors, said this was not quite correct of the best design, because, by increasing the number of poles, the speed and the output was lowered proportionally, but the carcase being the same there was the same copper loss. They worked to a certain temperature rise, and, therefore, the percentage copper loss increased proportionally to the number of poles instead of the square root. Another point was in connection with heavy flux machines, and machines with heavy ampere wires. It was found that in comparing these two machines, although the total watts lost on the armature might be the same in each case, the machine with the heavy ampere wires would probably be about twice as hot as the machine with the heavy flux. The surface was the same on both armatures, and the total watts

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were the same, yet there was this strange result. Perhaps the author could give some explanation of this.

THE PRESIDENT (Col. Crompton) said a great deal was owing to Dr. Goldschmidt, who had introduced into this country many precise methods of calculating out the proportion of flux and ampere turns, and of which he had given them the benefit in the Paper. He was in sympathy with some of the speakers in the discussion, for he could not understand how such standardisation as Dr. Goldschmidt aimed at could be obtained with complete standardisation of form, *i.e.*, length in proportion to diameter. As had been pointed out, the proportion laid down by the author would be varied a great deal if there was any change in fashion in that respect. There was no doubt that the proportion of length to diameter had, as a rule, been arrived at in certain classes of machinery from a question of economy of material, modified to some extent by the question of economics in mechanical manufacture, and it was no doubt based upon facts as they were that Dr. Goldschmidt had given his figures. But he would ask him, with all due humility, what would happen if, from mechanical or other reasons, such as convenience in manufacture, the proportion of length to diameter were varied very considerably. It could be readily understood, for instance, that for reasons introduced by Parsons in the steam turbine when large centrifugal forces had to be dealt with, the proportions of the rotating parts were varied a very great deal, and then what became of the standardisation? He was inclined to protest, although a member for years of the Engineering Standards Committee, against an attempt to standardise design or lay down hard-and-fast rules of this kind, which were only laid down on existing practice, and not on such practice as might be determined in the future. He did not make this as a "nasty" criticism on the paper, but rather that he thought Dr. Goldschmidt was a little premature in thinking it was possible to lay down hard-and-fast rules of proportion without at the same time standardising design to an extent which would, he was sure, be hurtful to the progress of the electrical industry.

DR. GOLDSCHMIDT, in reply to the discussion, said that in attempting to standardise the efficiencies and power factors, or, rather, to give figures which he thought normal, he could not start from a certain design. The majority of manufacturers designed on an expansion system. They started with a very narrow machine of a certain diameter; then they had a second type a little bit broader, and a third type still broader, so that machines for manufacturing had a great number of ratios of diameter to length, which varied about 100 per cent.; the efficiencies varied accordingly, and he could well understand that Mr. Macfarlane found discrepancies of this sort. If they drew a curve of the efficiency, it would be found to rise gradually and then jump up again. As soon as the diameter was altered, the efficiency went up more rapidly than if the width was altered, so that they did not get a uniform curve if the efficiency was plotted as a function of the power of the machine, or watts per revolution. If they drew an average curve, then they got the average efficiencies which he had given in the Paper. The greatest difficulty was not to take account of the details of particular designs. He did not want to prejudice the manufacturers in any way. But the curves were intended as a guide, although those who used them might find that for particular sizes there was a slightly lower average. They would help, also, in so far as the mechanical engineer who could not go into details of design, and who wants to know beforehand what the efficiency of his 10 h.p. motor was likely to be. He would not have obtained any results at all if he had been bothered with assuming a certain ratio of designs. He had given flux curves and curves for the ampere wires of the armature, just as an approximate idea to show how a machine was approximately built nowadays. There might be 25 per cent., or perhaps 30 per cent. less on any curve, but he was trying to show that the influence flux had on the total losses was not very great, and that it might be varied a great deal without actually affecting the total efficiency. Dr.. Thompson had asked which of the curves had been developed from actual practice, and which from first principles. All of them had been based on first principles. As a guidance he had assumed the flux curves and ampere turns curves, and then he had actually designed machines and taken machines made by other people in order not to be guided only by his own experience, and he had then got these figures, which he considered normal, for the efficiency and the power factor; therefore the curves were developed at the same time from first principles and from actual experience. Mr. Fynn stated that he thought the efficiency curves for single-phase commutator motors were rather too low. It might be possible to get a few per cent. better efficiencies by making a more liberal design. It all depended upon the temperature. They could waste material by providing more copper than was actually necessary, and so raise the efficiency, but he thought that on the average it would be found that his curves were about right; perhaps slightly on the low side. In using the curves it would be easily discovered what differences ought to be made for induction motors. Dr. Thompson had pointed out that the curves for flux and ampere wires took the form of a parabola. As a matter of fact, he had not gone into it; he had not assumed them to be parabolic, and it was quite interesting for him to hear that they were. Consequently he could not answer Mr. Macfarlane's question as to why the curve of the flux for the induction motor was not a parabola. He simply plotted the curves as normal. The flux might be 25 per cent. more or 10 per cent. less, and so on: he did not say it was the most economical flux, but it was the one which he based his calculations upon. A manufacturer, taking the flux and ampere turns curves in the Paper, could develop for himself efficiency curves, and he hoped that the Paper had been useful to manufacturers as a suggestion as to upon what lines this could be done. Mr. Fynn had pointed out that the constant for single-phase induction motors was 0·115 instead of 0·145. As a matter of fact, in the Paper he was referring to single-phase generators, the constant for which was 0·145. Mr. Fynn was right in pointing out that for single-phase induction motors the constant would be lower, and probably 0·115 would be correct. He had noted the point put by Mr. Burge, that heavy ampere wire machines were hotter than machines with low ampere wires, but did not quite know how it was meant. If Mr. Burge would tell him afterwards all about it, he would be glad to get the information and give it in his fuller reply in the *Journal*.

On the motion of the President, a vote of thanks was accorded Dr. Goldschmidt for his Paper

ELECTRICAL WINDING AT THE AXWELL PARK COLLIERY

IN the autumn of 1905 the Priestman Collieries, Ltd., owners of the Axwell Park Colliery, Durnam, decided to replace their steam-winding plant by an electrically-operated winding plant. The shaft in question is 252½ ft. deep, and is used mainly for the workmen, most of the coal being brought out through a drift. In order to avoid large fluctuations in the current taken from the supply, it was decided to adopt the well-known Ilgner system, the principle of which is to interpose between the supply mains and winding motor a motor-generator having a heavy fly-wheel capable of storing up energy during periods of light load and of delivering energy by dropping in speed during times of heavy load, and thus equalising the demand upon the supply mains. The power for operating the plant is obtained at 550 volts, 40 cycles, from the Axwell Park sub-station (about 1,000 yards from the pit mouth), which in turn is fed with three-phase current at 5,500 volts from the Carville power station of the Newcastle-on-Tyne Electric Supply Co. some nine miles distant, and from the Priestman power station about five miles away, both working in parallel. The low-tension, three phase current, after passing through the fuses and main switches, is led to the three-phase motor of the Ilgner set, and continuous current at varying voltages is obtained from the continuous-current generator of the set, and led to the winding motor, which is mounted on a common bed-plate with the winding gear, about 55 ft. above ground, directly over the shaft. The order for the complete electric winding plant was secured by the Corlett Electrical Engineering Co., Ltd., Wigan, who sublet the entire work to Messrs. Siemens Brothers' Dynamo Works, Ltd. The principal data of the winding plant are as follows:—The total maximum weight to be hoisted is 6,700 lb., the cage weighing 3,200 lb., and the men 3,500 lb. A balance weight is provided approximately equal to the weight of the cage *plus* half the weight of the men. The time allowed for a complete cycle is 55 seconds in round figures, and of this time 12 seconds are taken up for acceleration, followed by 23 seconds of full-speed run, and 5 seconds for retardation, the remaining 15 seconds being sufficient to allow the men to enter or leave. The full speed is 8 ft. per second. In Fig. 1 the line A B C D E represents the calculated output at the winding drum during the working period, while the line A F G B E denotes the requisite energy to the driving motor, the mechanical efficiency of the winding gear being taken as 88 per cent. The horizontal lines represent the

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average h.p. at various points in the chain of transmission taken over a complete cycle. Although it is not possible to level out the peaks in such a manner that the energy taken from the supply is absolutely steady, yet the Ilgner flywheel converter will achieve this to a degree which meets all practical purposes.

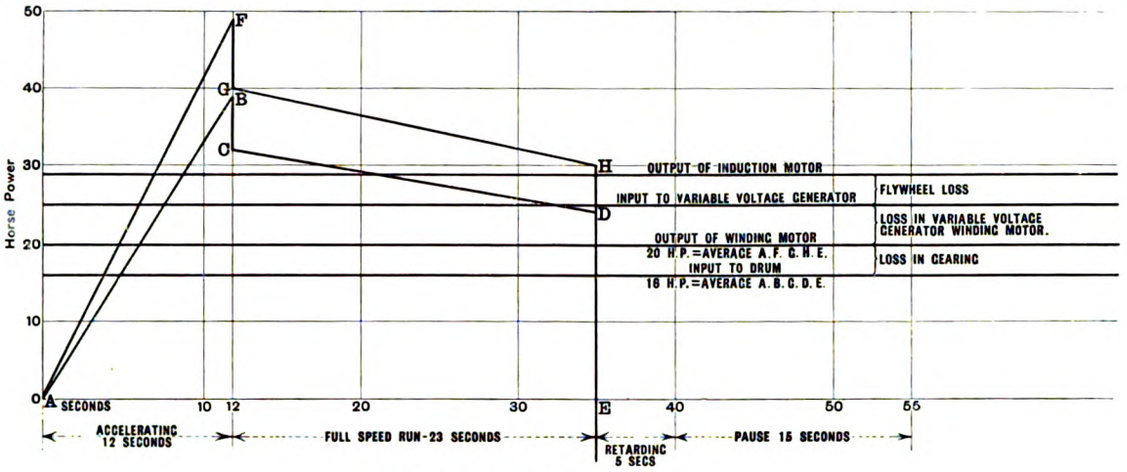


FIG. 1.—INPUT AND OUTPUT CURVES.

The Ilgner converter set consists, as shown in Fig. 2, of a three-phase motor on one side of the flywheel, and a continuous-current motor mounted on the other side. In the present instance a small exciter is also coupled to the set. This does not form an integral part of the converter system, however, and might as well be separately driven. The three machines are all coupled together and mounted on a common bedplate. The speed of the set is indicated by a tachometer, belt-driven from the coupling between the induction motor and exciter. The particulars of the various machines of the set are as follows:—The three-phase, four-pole motor is of the induction type, and provided with slip-ring rotor. Its normal output is 30 b.h.p., and its speed 1,200 r.p.m. In order to enable the flywheel to give off a portion of its stored energy during periods when the winding motor is heavily loaded, this induction motor must obviously be reduced in speed, and, *vice versâ*, the flywheel must be speeded up again during times of light load by increasing the speed of this induction motor. The regulation of speed is obtained by a regulator, which automatically adjusts the resistance in the rotor circuit in accordance with the magnitude of the current taken from the

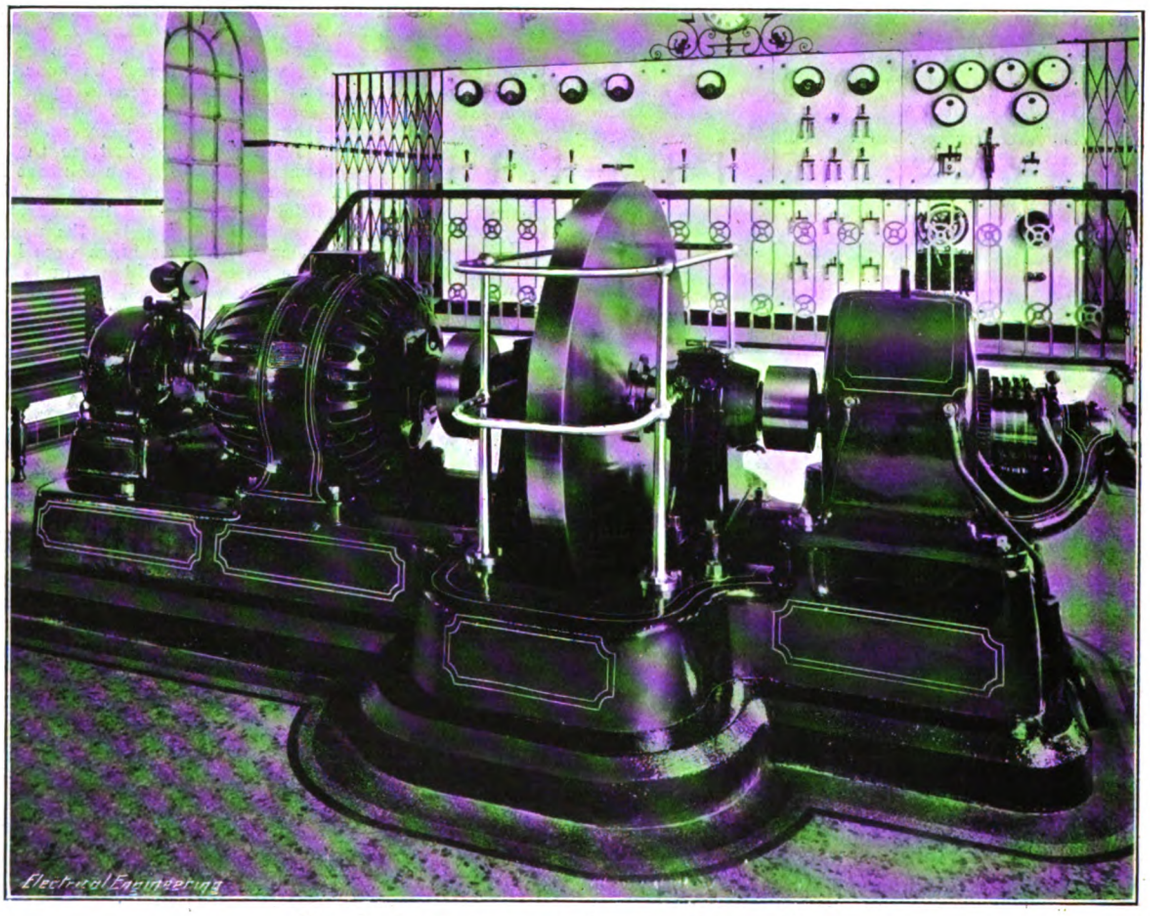


FIG. 2.—ILGNER FLYWHEEL SET FOR WINDING PLANT.

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supply. To this end one of the leads to the three-phase motor is connected in series with the primary winding of a small current transformer, the secondary winding of which is connected to a relay. At normal loads, *i.e.*, at a given supply current, the tongue of the relay floats between two contacts, touching neither. When an overload occurs, however, the relay tongue abuts against one of the two contacts, and closes a local circuit through a small auxiliary motor, which now commences to drive the regulating switch in a direction corresponding to a cutting-in of resistance in the rotor circuit of the three-phase induction motor. The latter at once tends to run slower than before, and the flywheel is called upon to assist the motor by giving off part of its stored energy. On the other hand, when the current taken from the mains drops below normal value, the relay tongue touches the second contact, and the auxiliary motor drives the rheostat in the opposite direction, thus increasing the speed of the three-phase induction motor. The surplus energy beyond that necessary for the winding plant is utilised to increase the speed of the flywheel. The relay may be adjusted to keep the energy taken from the supply within any pre-determined limits. In the present instance it is so adjusted that the input to the three-phase motor varies between 28 and 38 b.h.p., the maximum drop in the speed of the flywheel being 15 per cent. below normal. It may be mentioned that the automatic regulator is combined with the starter, the design being such that the first contacts are used for starting by hand, while the other contacts are for the speed regulation of the three-phase induction motor, as described above.

The flywheel is of the plain disc type of forged steel, 4 ft. 6 in. diameter, and turned true all over with slightly-rounded corners. It weighs 2,800 lb., the radius of gyration being 1·57 ft. It is essential that the flywheel be of the best material and most accurately machined and balanced, and the steel has a tensile strength exceeding 40 tons per square inch. In order to ensure perfect freedom of running, the flywheel is supported by a pedestal bearing at each side with spherical seats. The bearings are of ample dimensions and ring-lubricated. As indicated in Fig. 2, the three-phase induction motor is coupled to the flywheel by a flexible coupling. At the slipring end the three-phase motor is connected by a flexible coupling to a 2-kw., 240-volt exciter, which supplies the exciting current to the winding motor as well as to the continuous-current generator of the Ilgner set. The latter is mounted on the side of the flywheel away from the three-phase motor. It is fitted with commutation poles, and is capable of supplying current from a maximum positive voltage through zero to a maximum negative voltage by means of shunt regulation. For this two reversing field regulators are supplied, one placed in the cage, and the other near the top of the shaft. Only one is used at a time, however, and in order to avoid mistakes, only one handle is provided, which cannot be taken off unless the controller is in the "off" position.

The reversing shunt regulator in the cage is electrically connected with the generator of the Ilgner set by a flexible six-core cable, each core containing a flexible conductor made up of 176/36 tinned copper wires, and capable of carrying eight amperes. Each wire is separately insulated with pure and vulcanised indiarubber, taped and compounded, and the six cores are differently coloured in order to facilitate connecting up. Each strand is wound round a flexible cord centre with a fairly short lay, so as to secure flexibility. The whole is wound with jute yarn, braided, compounded, and finally braided with steel wires; the overall diameter of this cable is 0·92 in. The cable is supported at the top of the shaft by a distribution box and other suitable supports. The current from the variable-voltage generator of the Ilgner set is conveyed to the winding motor, the speed and direction of rotation of which are solely controlled by the Ilgner set. This motor has a normal output of 50 b.h.p. at 800 r.p.m. It is mounted together with the winding gear on a common bedplate, and drives the winding drum by means of double reduction spur gearing with a total reduction of 28·8 : 1.

The depth indicator is driven by a chain of bevel gears and shafting, and is fixed in a position convenient for the attendant. Fig. 3 illustrates the winding motor and part of the drum. The steel winding cable has a diameter of about 0·95 in. Both ropes wind towards the centre of the drum during the greater part of the lift, but at the highest position of either cage or balance weight the rope is exactly vertical. The safety appliances adopted are very complete, as will be gathered from the following:—The cage suspension is of an improved type, and would bring the cage at once to a standstill in the shaft if the winding rope were to break. In order to prevent the attendant in the cage from over-running the bank, there are fixed in the shaft both at the top and bottom wooden cams, which engage with a lever fixed to the controller, so that the latter

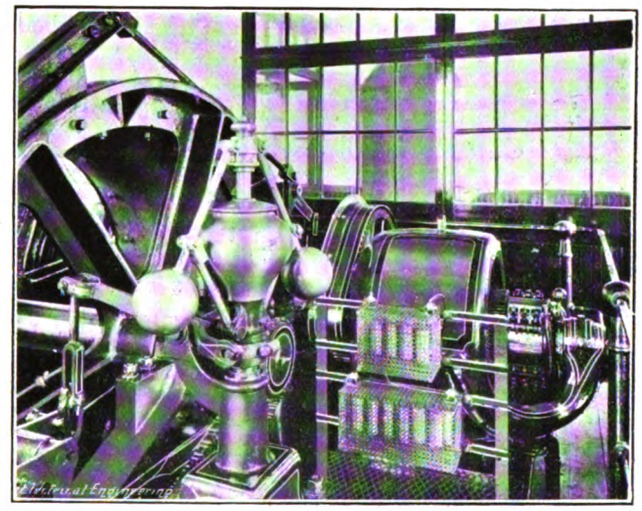


FIG. 3.—MOTOR GEARED TO WINDING DRUM.

is brought automatically to the "off" position should the cage rise higher than a few inches above the bank, or sink lower than a couple of inches below the bottom level. This arrangement, however, does not prevent the attendant from moving the cage in the proper direction. In case the cage is operated from the controller on the surface instead of the controller in the cage, it is moved to the "off" position—should the attendant neglect to do so—by a suitable mechanism engaging with cams fixed to the rotating dial of the depth indicator. These cams not only serve the above purpose, but also prevent the attendant from switching on too rapidly. In order to prevent arcing from the slow movement of the controller, a special switch of very substantial design is provided, which takes up the arc and prevents damage to the controller contacts. In order to bring the drum to a quick stop when the current is switched off from the winding motor, and to hold it in case anything occurs with the winding motor, Ilgner set, or wiring, there is an electric working brake of the post type fixed to the intermediate shaft of the winding gear. Normally, the wooden brake shoes are kept clear of the brake drum by a solenoid acting against a weight. This solenoid is energised as long as current is supplied to the winding motor, and the current to it is interrupted as soon as the controller is brought to the "off" position. The inductive kick is taken up by a suitable shunt resistance. It is obvious

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that this brake will also act automatically in case the supply is interrupted due to any cause. A second brake, also of the post type, acts directly on the winding drum. It is applied by an adequate weight which is generally held up so that the brake blocks clear the drum. The weight may be tripped in two ways: It will be tripped if the winding motor should exceed its normal speed by 25 per cent., the tripping mechanism consisting essentially of a centrifugal governor driven by the motor, and the weight may also be tripped by an auxiliary tripping rope, which passes down the shaft and through the cage. In the cage there is a clamping device, by means of which the attendant can give the rope a powerful pull sufficient to release the weight of the emergency brake. In addition, this brake rope is provided at its upper and lower ends with stops which, in the case of over-winding, will come into contact with the cage, and bring the latter to a standstill by application of the emergency brake before any damage is done. A dashpot, consisting of an iron cylinder 4½ in. in diameter, with brass piston and rod, is connected to the lever of the emergency brake, and prevents a too sudden application of the brake. The switchboard, which can be seen in Fig. 2, is of marble, and the panel containing the instruments and switchgear for the electric winding plant is shown on the extreme right-hand side, the other panels being for the lighting system.

THE DEVELOPMENT OF CONTINUOUS-CURRENT TURBO-GENERATORS

Leeds Discussion

DR. R. POHL'S Paper on the development of turbo-generators, which was read in London before the Institution of Electrical Engineers on November 28th (ELECTRICAL ENGINEERING, Vol. II., page 887), was discussed before the Leeds Local Section last Thursday. It will be remembered that the Paper outlined the considerations leading to the commutation and "flash-over" limits to the output of continuous-current turbo-generators and the limiting speeds for various outputs. The possibilities of homopolar designs were also discussed, but the author did not hold out any great hope in this direction, on account of the excessive weight involved. He described a new armature winding, designed to improve the conditions in commutating machines.

Mr. WILSON HARTNELL (Leeds), in opening the discussion, remarked that the author had not referred to several limitations in the design of turbo-generators which affected the result. The high speed of such machines necessitated the reduction of the magnetic density, because the heating effect due to hysteresis was far larger than is commonly supposed to be the case. To allow for this the magnetic flux had to be reduced to less than half the amount permissible in slow speed machines. He said little about the limitation of length due to reactance voltage, nor that due to mechanical considerations. Further, he left out of consideration the compensation to be obtained by windings on the polar faces, which could be made to reduce the voltage between the segments by 20 per cent. In the speaker's opinion the suggested modification in the winding was the pith of the whole Paper. He anticipated some difficulty in design, however, as there would have to be half the number of conductors inside as there were on the outside. If this problem could be satisfactorily met, the author would have solved one of the main difficulties in the construction of D.C. turbo-generators.

Mr. A. H. LAW (Parsons & Co.) considered that, although the temperature rise from Dr. Pohl's point of view could not be considered to impose an output limit, yet it was a difficulty to be overcome. The causes of flashing over are extremely complex, but an important one is the voltage per segment. In Messrs. Parsons' earlier machines the volts per segment were 25 per cent. lower than in later machines. These early machines were tested to a maximum of 75 volts per segment, and all means were tried to induce flashing over, but without success. Faulty machines could be improved by thickening the mica insulation. Slot-wound armatures were, from some points of view, not so satisfactory as surface wound. The latter could be made quite mechanically sound, and it was easier to obtain satisfactory commutation with them. In the speaker's opinion compensating poles have their limits. The curve of ampere conductors per centimetre given represented satisfactory practice. The speeds obtained by Messrs. Parsons were in excess of those given by the author, *i.e.*, 500 kw. machine, 3,000 r.p.m.; 900 kw., 1,800 r.p.m., and 1,500 kw., 1,200 r.p.m. Homopolar machines were quite out of the question for turbo work His firm had constructed a machine for 10,000 amperes at 5 to 7 volts, but the amount of iron and copper required was enormous, also the speed was too low. He wished to compliment Dr. Pohl on the ingenious solution presented by his proposed method of winding. If this proved satisfactory in practice it would, no doubt, be largely adopted.

Mr. HARDING CHURTON, Leeds, said the Paper had led him to wonder if some of the suggestions to increase the output of turbo-generators could be applied to ordinary D.C. machines. He would like to know how the cost of turbo-dynamos compared with slow-speed machines.

Mr. W. F. MYLAN, Sheffield (Westinghouse Co.), looked upon the subject from a commercial point of view, and asked whether these alterations were going to result in cheaper machines. If not, why trouble with turbines at all? It was sufficiently difficult at present to convince customers of the advantages of turbines over slow-speed reciprocating engines. No mention had been made of the use of carbon brushes. It was essential that th brushes should wear away more rapidly than the commutator, but with metal brushes the result was often the reverse. His firm were using carbon brushes on a flat face commutator at right angles to the axis of the armature. This plan overcame all chattering due to the whip of the shaft, and machines using this design were running with perfect satisfaction. He confirmed the author's adverse opinion respecting homopolar machines. They had built a 300 kw. set and used a homopolar exciter, but had to replace it by an ordinary commutator machine.

Mr. R. HOLIDAY (Acton Hall Colliery), also considered the Paper from a commercial rather than a theoretical aspect. His experience showed there was still need for improvement in the machines for power purposes. He was afraid the new winding would introduce complications which would do away with that extreme simplicity of present turbine plants, which was their great virtue.

Dr. POHL, in replying, said that the question of temperature limit came in for a finished machine, but not for a machine which had to be designed, as it was then possible to provide suitable means to keep it cool. He did not think that two-pole machines would survive, but that multipolar designs with six or eight poles would become the rule. Multipolar machines for turbines were much cheaper for a given output, just as they were with slow-speed machines. A turbo-generator for, say, 1,000 kw., was about 50 per cent. higher in cost than a slow-speed machine for the same output. The reactance voltage increased with the armature length, but the principal limitation in length of armature was the flash over limit. He did not like the plan of preventing flashing by increasing the width of the mica, as this weakened the commutator, and shortened the time of commutation, consequently increasing the reactance voltage. What was gained in one respect was lost in another. Referring to the various criticisms touching his suggested winding, he said there would be no difficulty with respect to the internal conductors, as they would only have to carry current during the period of commutation, and could be made relatively much smaller, also there would be no mechanical difficulty in accommodating them. Referring to Mr. Mylan's question, the commercial advantage of improving turbo-generators was in being able to reduce the size of the machines, consequently the cost would also be less.

Helion Filament Lamps.—According to the *Electrical World* (New York), three American patents were issued January 14th to Mr. W. G. Clark on processes for making incandescent lamp filaments of the type consisting of a combination of silicon and carbon. The deposits of silicon have been obtained by the decomposition of chlorides, and the object of the patent is to obviate the difficulty that has been experienced in getting a uniform product and to prevent the chlorine once free from combining with the silicon. The first patent describes a process wherein a carbon filament is placed into a receiver containing a small quantity of mercury, after which a silicon chloride, such as a tetra-chloride, and also a gas which contains carbon are introduced. When the current is passed through the filament the chloride is decomposed and the silicon deposited upon the carbon, and the free chloride combines with the mercury. The second patent covers the use of the carbon gas referred to above, the claims being for the mixture of marsh gas and an olefiant gas, or marsh gas, olefiant gas and carbon dioxide. The third patent states that the hydrocarbon gas may be some form of illuminating gas, but is preferably the marsh gas. When the deposition on the filament takes place the silicon and combination of silicon and carbon, which is a dense, non-porous combination, enter the pores of the carbon base, combine with and build up on the base, so that the latter becomes a combination of silicon and carbon, which gradually merges near the surface into a substance having characteristics similar to those of silicon.

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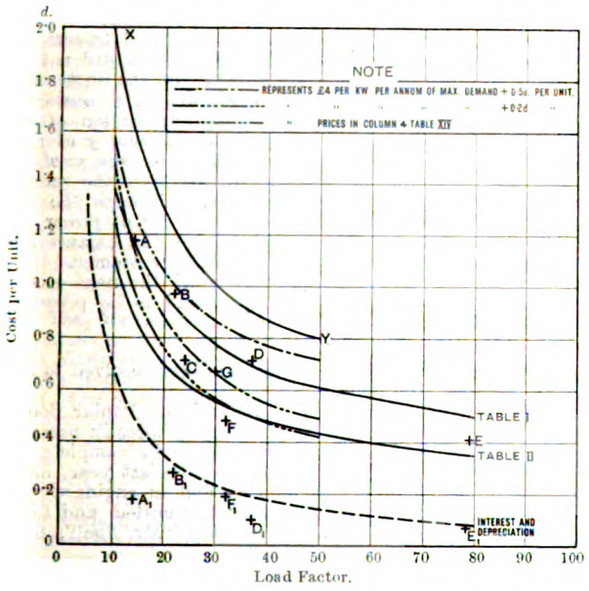
COST OF ELECTRICAL POWER FOR INDUSTRIAL PURPOSES

THE following is a report of the discussion on Mr. J. F. C. Snell's Paper in Glasgow on January 14th. For a report of the Paper itself, and the discussions in London and Dublin, reference should be made to ELECTRICAL ENGINEERING of January 16th and 23rd. The latter issue also contains several written communications of considerable interest, and some further ones are appended in this article.

DISCUSSION IN GLASGOW.

The CHAIRMAN (Prof. F. G. BAILY) invited Mr. Robert Robertson to open the debate.

Mr. ROBERT ROBERTSON, although he found little to take exception to in the general conclusions, thought that all the bases upon which the prices were given were too low, particularly in the case of the Tables Nos. I. and II. The author had pointed out that the examples of actual plants which he quoted were, in most cases, higher than these tables, but the difference between them was so enormous that it could not be passed over merely by a simple remark. The diagram below was made out practically in the same form as that shown in the Paper on Fig. 2, having the ordinates representing the cost per unit, and abcissæ, &c., representing the load factor. Two of the curves represent the figures given in Tables I. and II. of the Paper as the ascertained cost of power per unit generated for independent plants, in the one case for installation up to 100 horse-power, and in the other case for installations from 100 to 500 horse-power. The dotted line marked "interest" has been calculated on the basis that the cost of the station per kilowatt of maximum demand is taken at £25, a figure which might be taken to agree with certain concrete cases. The points *A*, *B*, *C*, &c., represent the actual figures cited in the Paper for certain plants that had been tested. Thus, *A* shows the cost obtained in the first shipyard mentioned (ELECTRICAL ENGINEERING, January 16th, p. 74). Although considerably greater than the corresponding figure in Table II., the cost agrees with those in the table for the smaller-sized plants; but the proportion of it representing interest and depreciation, shown in the diagram by the point A_1, is considerably less than half what it should be if the cost of the plant was something like the average that assumed of £25 per kw. The point marked *B* represents the next example given—a



combined shipyard and engine-works—and with this 1,000 horse-power the cost was enormously greater than the 100 to 500 horse-power in the Table. The next example, shown by the point *C*, is also for a plant of 1,000 horse-power, and the cost of it lies between the cost of the small plants and the cost of the 100 to 500 h.p. The point *D*, represents an example taken from Mr. Williamson's Paper, read before the Institution of Electrical Engineers in 1903, in which a 640 kw. plant, costing £20·5 per kw., was run at a cost of 0·716*d*. per unit, with a load factor of 37. The cost was again very much higher than in the table for plants up to 500 h.p. Point *E* is for the paper mill mentioned by the author, with 79 per cent. load factor. It relates to steam-driven plant, not to an independent electric generating station, and from the difficulty of arriving at the average amount consumed by steam engines, the speaker thought it was very difficult to accept figures of that sort. He had had a case recently of a plant with a power very much like this, where he was informed that the engine was practically running at six days a week, which would give a load factor of something like 80 per cent. It was electrified, when it was found that the load factor was only 50 per cent. Point *F* is a jute mill, mentioned in the Paper. It is slightly under the 500 h.p. cost in Table II., although the power was over 900 h.p. The points A_1, B_1, C_1, &c., on the diagram indicate the proportion of costs applicable to interest and depreciation in the examples *A*, *B*, *C*, &c. From these examples, it was evident that with smaller plants the cost in reality should be very much greater than that given in the tables, and in many cases of small installations up to 400 or 500 h.p., if everything was taken into account, he was doubtful whether the actual cost, within the limits of 10 and 50 per cent. load factor, would come much under the line marked XY, which came down to 0·8 at 50 per cent. load factor; interest and depreciation are allowed for in this curve. He had several figures that closely approximated to that line. Mr. Robertson next discussed the cost at which power companies or power suppliers could supply. The figures indicated by the author were based upon a total cost of £25 per kilowatt, but no electricity works of any size supplying power in this country had been erected to approximate to that price. The only example cited by the author was the Newcastle Power Company, whose capital cost was given at £59 per kw. The most reasonable method of charging for supply was, he thought, making a charge of so much per kilowatt per annum, with the addition of a small amount per unit. The figure at which companies could supply, he thought, might be taken as £4 per annum per kilowatt and from 0·5d. down to as low as 0·2d. per unit.

The first and third chain-dotted lines in the diagram indicate these charges as they work out for different load factors, and between them is a dotted line indicating the figures given by the author as the real cost (given in column 4 of Table XIV.) of the Newcastle Company based on the 1906 figures. There were a great many other points in the paper that one might go into in detail, but it would only be, so far as he was concerned, in most cases to concur generally with the author. He had examined the costs of sub-stations, and whilst he thought the prices were taken rather on the low side, the difference between them and real costs which he had recently incurred was not so great as to warrant taking much exception to them. In dealing with the limit of distance to which a supply company could distribute current, they had to deal with a question of average. If a company went a distance of 20 miles, it also had probably a much larger proportion of consumers, if the situation of the station was well designed, within a very short radius, and it depended on the density as to the distance that might be gone economically, taking the supply as a whole. If each individual case was first taken, then, of course, it would be necessary to differentiate in charge between consumers near the generating station and consumers far away. That, he thought, was not a reasonable ground for differentiation in charge, because it was not the fault of the consumer, but the fault of the situation of the generating station, and the differentiation between charges among consumers should be based upon the different value of these consumers' operations to the supply.

Mr. C. P. SPARKS dealt to some extent with the same points to which he alluded in the London meeting reported in our last issue. He also referred to Table VI. of the Paper, in which the cost of a power-house and transmission were given at £13 and £12 respectively. A £12 transmission scheme was unknown in this country and in the world, and at the moment only existed on paper. At Newcastle the cost was £26, and there they would find great difficulty in dividing it by two. If Mr. Snell would tell them how to do it, he would welcome him as a pioneer. On the other hand, he thought that municipalities could supply very much below the figures set forth in Table IX. Some of them took several years before they brought the tariff down, so that business passed them. If they looked at it from the point of view of the additional capital necessary to deal with the additional load, they could, at all events in some cases, supply this at half the figure, and make a profit.

Mr. LACKIE (Engineer-in-Chief, Glasgow Electricity Works), after complimenting Mr. Snell on his Paper, and expressing gratification that Mr. Snell himself was present, gave, as an example of the fallacy of thinking only of the load factor, the case of electric hoists. The load factor of an ordinary hoist motor in the city was under 9 per cent., but, by all the hoist motors getting their supply from one source, the supply authority was enabled to give the hoists energy at a rate per unit corresponding to at least a 20 per cent. load factor. The same reasoning must apply to the industrial user, and therefore it appeared to him that a maximum price for electrical energy for power or industrial purposes might be fixed at a price corresponding to 20 or 25 per cent. load factor, and the price thereafter should be made to meet a better load factor than 20 or 25 per cent. Those 10 per cent. load-factor users could not generate power at a rate to compete with a 20 per cent. load factor if all considerations were taken into account. He would not take up the time of the meeting elaborating the points with which he agreed, but would rather confine himself to a few notes on matters regarding which he was inclined to differ. He maintained that the supply from a town installation

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or power company should be cheaper and better than the private user could hope to do with his own plant, if all considerations were taken into account. The "critical" load factor and size of plant within which any outside supply could hope to compete against the user's own local plant was not fixed, as Mr. Snell seemed to convey in his second axiom, but depended entirely on the size of the outside supply plant. Mr. Snell had also stated that many electricity undertakings were supplying power at less than cost price; he must emphatically state that in Glasgow they were not doing that. In Tables I. and II. the outstanding fact was that the cost of steam was less in every case than the cost of suction or producer-gas plant. That was contrary to all the data that had been put before him. Where was the 10 horse-power for a penny man with his suction-gas plant? The example given of a gas plant in a shipyard, which had also been referred to by Mr. Robert Robertson, had apparently a serious error in its capital cost. It was stated that interest and depreciation would amount to £60 for four months, or £180 for a year, so that the capital cost of the plant would be £1,800, or £8 2s. per kilowatt. He was perfectly certain that that plant was never put down for £8 2s. per kilowatt, and in support of that would point out that in every other case stated by the author the cost ran between £15 and £20 per kilowatt. It was also stated that the gas consumption in this plant was 36 cubic feet per kilowatt-hour—a large figure even on so low an annual load factor as 14 per cent. He was of opinion that the annual load factor had nothing whatever to do with the gas consumption, but only the plant load factor; and the fact that the plant load factor was 48 per cent. (a very good percentage), the only conclusion that one could come to was that 36 cubic feet per kilowatt was about the average figure that one got with gas engine plant instead of the figure of 15 to 20 cubic feet quoted by gas engine makers. It really amounted to this, that the cost of gas per unit with gas at 2s. 4d. per 1,000 cubic feet was about a penny. In all the examples stated, of course, Mr. Snell had not allowed for land and buildings or rent, rates and taxes. Mr. Snell had estimated a colliery load factor as about 36 per cent., and the annual load factor of a steel works and other similar works at about 20 to 25 per cent. But it must not be forgotten that with a public supply they were able to offer a consumer having an annual load factor of 20 to 25 per cent., a rate corresponding to a load factor of about 40 per cent., owing to the fact that some of the plant which was used during the day to supply the day consumer was also used during the night for supplying some night consumers. Mr. Snell stated that the modern power station of important magnitude and favourably situated could be now equipped completely for £12 or £13 per kilowatt installed. That did not agree with the modern power station of Carville (which he spoke of later on), where the capital cost was £59·6 per kilowatt, and it was of interest to note that the Newcastle charges with their capital cost of £59·6 per kilowatt compared favourably with the theoretical London County Council figures, with an alleged capital cost of only £25 per kilowatt. The horse-power of motors installed in a factory had generally a diversity factor of about 2, and the result of an individual diversity factor of 2 divided amongst all the consumers gave a diversity factor on the station of about 3. In tramway supply the diversity factor was about 10, *i.e.*, for every 100 kw. of motors, only 10 kw. of maximum demand was made upon the power house. Hoists had about the same diversity factor as a tramway supply, and each trade had its own diversity factor. Probably the worse the load factor, the greater the diversity factor. In his recommendation of alternating current supply through static transformers, the speaker continued, Mr. Snell had not mentioned the effect of these transformers on his power factor, nor the wattless current and the loss in cables. Further, if, as advocated, works having 100 kw. or more each had their own local static sub-station, that would add tremendously to the cost per kilowatt, and the cost quoted would be probably doubled. After boldly stating that many London companies were selling energy under cost price for power purposes, Mr. Snell had added: "This means that the power user is being supplied by these undertakings at the expense of their lighting consumers, who are paying an unduly high rate for their supply, or, in the case of certain London municipalities, at too high a cost of public lighting." If it was not for these power consumers in Glasgow, at least, the coal consumption would be about 7 lb. per unit, whereas to-day it was under 4 lb. If it was not for that sale of current for power purposes, they would require something like a farthing per unit more for lighting to make up for the difference in coal consumption. Mr. Snell did not indicate in any way whatever how he arrived at the correct charge to be made by the London local authorities and larger municipalities, and he must state that he did not at all agree with the figures he had given for Glasgow. In Tables IX. the "mean" column simply represented the mean of the five figures given in the five columns. Now, the probability was that in Manchester there were ten times the units consumed that there were in Nottingham, and, consequently, to get the true mean one would require to take the number of units sold at 5d. and the number sold at 4·9d. in Nottingham, and similarly with Leeds and Glasgow, and so get the true mean or average. The conclusion of Mr. Snell's paper was a most unfair one. He stated that, looking back, it would have been much wiser if the authorities, viz., the Local Government Board and Board of Trade, had prevented some of its smaller local burghs from adopting separate electricity stations. He did not agree with that statement at all, for if the Local Government Board and Board of Trade had not allowed the smaller local burghs to do so, a company would have stepped in and done the work, and the companies would be in no better position to-day than those small local burghs. Further, those local burghs had done pioneer work and given a supply while the demand for electrical energy was growing and the public being educated to its use. Would a power company ever have erected a large works in the vicinity of those burghs if the burghs had not first shown that there was a demand and profit to be made from the supply of electrical energy? Some people might think that the Corporation of Glasgow should have started away with a station such as they now have at Port Dundas. If they had, he did not for a moment believe that their revenue would have been more than it was for the first three or four years with their Waterloo Street Station, and if that had been the case the revenue would not have paid interest and sinking fund on the lands and buildings and machinery put down. The undertaking would further have been put down as a financial failure, and would have acted as a stumbling block to other electrical undertakings. He was afraid also that the remedy Mr. Snell suggested would not prove a beneficial one to the power companies, although it was quite correct. Those smaller local burghs would only call upon the power companies to supply their peak load in the winter months, and instead of a load factor of 30 or 40 per cent., it would be more like 2 or 3 per cent. for some years to come.

Mr. J. ROBERTSON (Engineer-in-Chief, Greenock) said that the shipyard load factor was a very bad one, owing partly to the class of tools, and partly because of fluctuations in trade that they did not get in an ordinary factory. It was because of that that the public supply came in. If they took half a dozen works of that kind and supplied them from a public station, it followed that the supply from a public station would be less than the individual plants in private generating stations, and for that reason the public supply had an advantage. There was a curious likeness between the figures relating to shipyards supplied by Mr. Snell and the figures at Greenock. He thought he was altogether too pessimistic, however, in his views regarding the future of municipal stations in this country. At the station at Greenock, which had been in existence for nine years, the capital expenditure came out at £43 per kilowatt. The figure of £70 which was put down as the average cost per kilowatt included such stations as Liverpool, Bradford, Leeds, and Birmingham, where large sums had been paid to companies in order to buy them out. Moreover, Mr. Snell did not take account of the fact that in a great many of the instances of these stations that they had been in operation for a considerable time, and had already paid back a large proportion of their original capital. He thought, apart from the supply of power to big users, there was still plenty of hope for the small and medium-sized station. The lighting load had been the backbone of most of the stations in the country. Although the units generated might show a large balance in favour of power, they generally found that on the revenue side of the balance sheet the biggest income was still from the lighting customer.

The discussion was then adjourned until the next meeting of the section, when Mr. Snell has promised to be present to reply.

Additional written communications have been received to those published in our last issue.

Mr. J. H. BOWDEN (Chief Electrical Engineer, Poplar Borough Council), in his letter, added to the censure already passed on Mr. Snell's Table VII. When this table in its complete form was laid before the Parliamentary Committee last year, he had understood it simply as a means to an end in engineering the L.C.C. Bill through the Parliamentary Committee, and that it should not be taken seriously. He compared Mr. Snell's figures for Poplar with his own:—

Mr. Snell's statement:—

Actual charge, 1·43d. Correct charge, 1·68d.
Probable charge for direct current by Power Company, 0·83d.

Mr. Bowden's figures:—

	1906.	1907.	1908.*
Actual charge by Poplar.	1·389	1·156	1·12
Load factor of system ...	22·84	24·26	23·5
Power units sold	1,379,620	2,423,538	3,500,000
Net profit	£600	£635	£3,340

* Based on actual balance sheet to Dec. 31, 1907, and estimated to March 31st, 1908.

"I am accredited," writes Mr. Bowden, indignantly, "with charging the sum of 1·45d. per unit for something which ought to be charged at 1·686d., but which might be obtained elsewhere for 0·85d." Referring once more to Table VII., Mr. Bowden again objects to the figure 0·83d. per unit as misleading, as it represents what would be charged to authorised distributors under last year's L.C.C. Bill, not to consumers who might be charged 1·254d. per unit for low pressure direct current, which is more than the average charge for power at Poplar to-day. Mr.

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Bowden then gives figures to show that Mr. Snell's scheme would be no more economical to Poplar than their own extensions. He also finds fault with his Tables VI., which, he says, are worked out upon the capital cost per kilowatt installed, whereas they should be based upon the capital cost per kilowatt of maximum demand. By this alteration he raises Mr. Snell's figure of £29·73 per kw. to something in the nature of £50.

Mr. W. B. ESSON writes that Mr. Snell had arrived at practically the same conclusions as he himself had done in an address on "The Industrial Power Problem" to the Civil and Mechanical Engineers' Society in October, 1906. He had then estimated the cost of electrical power for a factory which could be served by an engine of 500 b.h.p. It was assumed that the generator would give 350 kw. maximum, and would supply 750,000 units per annum, this corresponding to a load factor of about 25 per cent. The cost of the fuel was put in at rates somewhat different from Mr. Snell's, but the total cost, taking 10 per cent. as the interest on capital outlay and depreciation, was given as follows :—

	Mond gas.	Suction gas.	Steam condensing.	Steam non-condensing.	Oil.
Total cost per unit	0·516d.	0·564d.	0·513d.	0·536d.	0·592d.

He also agrees with Mr. Snell's remarks as to prices charged by existing supply stations, and has no doubt that for a big increase in the amount of power supplied by the companies at the same rates, it would be found that the total receipts are not commensurate with the total costs.

The British Correspondence School of Electrical Engineering.—Several attempts have been made from time to time to establish institutions for giving a technical training by correspondence. In those originating on the other side of the Atlantic, we are afraid that there has been somewhat of a tendency to undertake impossibilities, and to create an impression in the mind of the untrained aspirant to electrical knowledge that a few magic correspondence lessons will immediately put him in a position to make an income several times as great as that he is already earning. Leaving extremes on one side, however, there is quite a considerable legitimate field for such enterprises, provided that the information imparted is carefully chosen in relation to the capabilities of the pupil. We do not consider that correspondence tuition can ever be as satisfactory as more direct instruction, but there are vast numbers of cases where it is a question of this class of teaching or none, and here the opportunity comes in. In starting a British Correspondence School of Electrical Engineering, Messrs. Broadbent and Andrew Stewart are providing facilities of this nature, and, so far as we can gather from a glance at one or two sample "lessons" forming part of one of their practical engineering courses, the information imparted is just of the practical nature required, while it is sufficiently detailed to escape the imputation of providing only the "little knowledge" which is apt to be a "dangerous thing." The questions which the student has to answer in particular appear well chosen from the point of view of stimulating thought as well as testing the result of the instruction.

The Manchester Electrical Exhibition.—The Organising Committee with reference to the forthcoming Electrical Exhibition at Manchester is now complete. A meeting was held on January 20th at the Town Hall, Manchester, when Councillor Kay, J.P., of Manchester, was elected Chairman of the Committee, and Councillor Barrett, J.P., of Salford, Deputy Chairman. The Secretary gave a full report of the scheme as existing up-to-date, and it was unanimously decided to put same into effect, and to enter into the necessary arrangements for holding the Exhibition in Manchester next October. In order that matters should be dealt with promptly, an Executive Committee was appointed, consisting of the following gentlemen :—The Chairman, the Deputy-Chairman, the consulting engineers, Messrs. Pearce & McCowan, Messrs. H. Berry, H. Bevis, D. N. Dunlop, F. Nalder, C. D. Taite, H. Talbot, and a meeting of this Committee was held at the offices of the Exhibition, 2 Queen Anne's Gate, Westminster, London, on Monday last, when arrangements were considered with reference to the site of the Exhibition, necessary buildings, &c., &c. In order that the Committee may be able to decide definitely as to the size of the buildings which it is immediately necessary to place the contract for, it is intended to send out a preliminary circular to the trade, asking for an indication as to space required by various exhibitors, and the design of the buildings will be such that extensions can readily be effected up to within three months of the date of opening. Large numbers of applications have already been received from the principal electrical and engineering firms throughout the country, and it is hoped that all those likely to be interested will assist the Committee in concluding their final arrangements by dealing with the matter promptly, and by getting in touch with the management at the earliest possible moment. The Executive Committee have been instructed to enter into agreements with Messrs. Northcote & Davenport for the carrying out of their requirements.

RAILWAY ELECTRIFICATION

AT the Royal Institution on Saturday last, Prof. G. Kapp delivered his second lecture on the electrification of railways. A report of the first lecture will be found on page 113 of our last week's issue. The lecturer pointed out that, as a result of the lead taken by American engineers in continuous-current electrification, all the railways in England on that system, with one exception (the Liverpool-Southport line, equipped by Dick, Kerr & Co.), had been electrified by American engineers.

Some years ago Continental engineers had realised that the continuous-current system would not satisfy the requirements of main-line working, and had given that attention to alternating-current systems.

A recent improvement in the continuous-current system is the application of commutating poles to the motors, thereby increasing the output and the safe working pressure per motor. The motors used on the Cologne-Bonn and Moselhütte railways (ELECTRICAL ENGINEERING, Vol. II., p. 639) are examples of 1,000-volt interpole motors. Another improvement is the use of gearless motors, as on the locomotives of the New York Central Railway, where the armatures of the two-pole motors are mounted direct upon the axles, and the field system is part of the body of the locomotive. For main lines, a high trolley-wire pressure is essential, and, to use this in conjunction with continuous current motors, Krizik has devised the following system : Two trolley-wires are used, one of which has a pressure of 15,000 volts above, the other 15,000 volts below, earth. The rails are used as the neutral conductor, but only at starting. When running, four motors are in series across the two trolley wires; the voltage per motor is thus 750 volts. At starting, the four motors are in series between one trolley wire and the rails; the voltage per motor is then 375 volts. The motors are geared in pairs to ensure that the pressure is equally divided. Prof. Kapp was of opinion that an ordinary three-wire system, as in use on the City and South London Railway, would not be suitable for main-line working, as the load would not be sufficiently balanced.

Particulars were given of several English railways, mentioning in particular the system of buffer battery stations on the Liverpool-Southport line for equalising the load on the generating station.

In passing on to three-phase working, the lecturer pointed out that the Burgdorf-Thun railway, electrified nine years ago on the three-phase system, had been a marked success. The fixed speeds were not such a drawback as had been expected, and lost time could be made up on a down grade by inserting resistances in the rotor circuits of the motors and running considerably above the synchronous speed. On the Valtellina Railway, measurements extending through the whole month of October showed that the energy consumption was only 80 watt-hours per ton mile; this included transmission and trolley-wire loss, as well as heating and lighting.

For single-phase working, the direct use of alternating current with compensated series or repulsion motors had superseded the Ward Leonard converter system. A few remarks were added on the methods to be adopted on the London, Brighton, & South Coast Railway, where motors of the Winter Eichberg repulsion type will be used.

Wireless Telegraphy in the Caribbean.—The De Forest Wireless Telegraph Company are erecting wireless telegraph stations at Belize, Puerto Barrios, Puerto Cortez, Cebia, and probably at Port Limon, and Costa Rica. The operations between these places and the United States are to be completed by the first week in February. The installations are being erected for the United Fruit Company, U.S.A., but they will be open to public service.

Liverpool and the New Telephone Tariff.—The question has arisen in Liverpool as to whether the new telephone tariff can be enforced there, as it seems that in an agreement entered into between the Liverpool Corporation and the National Telephone Company in 1896, there is a clause which is as follows :—"Clause 13.—The scale of charges for telephonic service at present applied to the Liverpool Central Telephonic Exchange of the company shall not be increased beyond the present amounts as set out in the schedule hereto, and such scale, subject to any reduction that may be made as hereinafter mentioned, shall be equal in its application throughout the city, and every citizen of Liverpool prepared to pay the charge and to sign the company's usual form of agreement for an exchange line shall have the right to demand telephonic service to his premises in Liverpool, and the service to be provided in pursuance to such demand shall be constant and continuous." This clause appears to be very clear on the subject, and it seems as if the subscribers of Liverpool are protected from the new tariff, and this agreement will bind the Post Office authorities when they take over the telephone systems.

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THE HEAT CONDUCTIVITY OF IRON STAMPINGS

Birmingham Discussion

A SHORT discussion followed the reading of Mr. T. M. Barlow's Paper read on January 15th before a meeting of the Birmingham Local Section of the Institution of Electrical Engineers. Mr. Barlow himself was prevented by illness from being present. We gave a lengthy abstract of the Paper in our last issue (page 121). In it the author gave the results of a series of experiments on the heat conductivity of assembled insulated iron stampings both in directions parallel and at right angles to their surface. The results emphasised the importance in dynamo design of the amount of edge surface of the stampings of a laminated iron core exposed to a cooling medium. The most efficient ratio of the linear dimensions of the edge side to the plate side was given as 1 : 10, a much higher ratio than commonly in use.

Dr. W. E. SUMPNER (Birmingham Municipal Technical School) said that the author was to be congratulated on his Paper. The apparatus used was very well designed, the experiments had been well carried out, and the results obtained should prove valuable. He criticised the mathematics used in the Paper, describing it as vague. He then referred to the constant C^2. It was stated in the Paper that C^2 was the ratio of conductivity along the stampings to the conductivity across the stampings. This formula was quite true if the temperature gradient was the same in each direction. Inside the core the heat flow is quickest in the direction of the greatest gradient. On the outside surface, however, a unit of area dissipates equally whether it is edge-on or face-on. The temperature excess of the outside surface over the air was therefore different for different portions of the surface, and the ratio of which he spoke depended consequently upon shape and dimensions. The discrepancy referred to near the end of the Paper could be explained in this way.

Mr. LINDSAY FORSTER (Messrs. Chance Bros., Birmingham) asked the author whether the heat did actually come out of the stampings as assumed in the Paper. Were the wood ends which were used in connection with the testing apparatus sufficient insulation against heat leakage? He knew an example of design in which the cooling of the armature iron was effected solely by edge conductivity.

Mr. D. K. MORRIS (Coventry) said it was remarkable how long designers had been content to do without such important information as that contained in the Paper. Although the Paper and particularly the mathematics might be criticised, still, the results obtained were broadly correct, and should prove useful to the designer. He objected to the statement that the iron loss increased with the rise of temperature. Losses due to both hysteresis and eddy currents decreased with increase of temperature.

Prof. KAPP then explained that the increased loss referred to by Mr. Morris was a secondary effect arising from a change in the flux distribution as explained in the Paper.

Prof. G. KAPP said that he did not intend to reply to the discussion, but there were a few remarks he would like to make. First, as to how the investigation came about. Some time ago, at his suggestion, the committee of the German Institution of Electrical Engineers had voted a sum of money to Prof. Linde to carry out experiments on the subject. In these experiments, which were done on packets of plates and paper, one face was heated with hot water and the other cooled with melting ice, a number of precautions being taken the necessity for which had been pointed out by Mr. Forster. The work had been in progress two years, and as a preliminary result Prof. Linde had given the value of the constant C^2 as 80. But this result had not been confirmed, so he had suggested to Mr. Barlow that he should investigate the subject, using an apparatus which would approach more nearly to standard conditions. A question raised by the Paper was—Is the flat surface of a packet of stampings of any real value? In order to get a clearer idea, he had worked out the value of the combined or total surface in terms of the edge surface for different shapes of packets.

Ratio $\frac{\text{flat surface}}{\text{edge surface}}$ =	1.	2.	3.	4.	5.	7.	10.
Factor expressing value of total surface ... ... =	1·01	1·04	1·09	1·16	1·25	1·5	2·0

In practice it was customary to make packets about seven times as long as thick. Theoretically this should be 10, but such a ratio would lead to waste of room, so that seven was not a bad compromise. In reference to Mr. Forster's remarks, it was quite possible that the wood ends used with the apparatus did not entirely prevent the flow of heat, but in any case the flow of heat was all right on the medium line. He had no doubt that the experiments were substantially correct. Mr. Barlow's figure for C^2 was 100, as compared with Prof. Linde's 80. The difference was probably due to the amount of end compression on the stampings.

Telephonic Developments in Sweden.—On Friday the Swedish Government introduced a Bill providing for a loan of five million kroner (£278,000) for the development of the telephone service.

The Euston-Watford Electric Railway.—In reply to a communication from the Watford Urban District Council, the London and North-Western Railway Company state that owing to the unfavourable state of the Money Market at the present time, they do not feel justified in attempting to raise the large capital which will be required for the construction of the electric railway between Euston and Watford. It will be remembered this line received Parliamentary sanction last session, and will run partly in tube and partly on the surface.

Bournemouth and Poole Corporations and Poole and District Electric Traction Co.—On Thursday, in the Court of Appeal, before the Master of the Rolls, Lord Justice Fletcher-Moulton, and Lord Justice Buckley, the hearing was commenced of an appeal by the defendants in the action brought by the Corporations of Bournemouth and Poole against the Poole District Electric Traction Co., Ltd. The appeal was brought from a judgment of Mr. Justice Joyce, the case being heard before him in the Chancery Division (see ELECTRICAL ENGINEERING, Vol. II., p. 623). This case arose out of the claims made by the Corporation of Bournemouth, when taking over the Poole and District tramways from the company. The claims were for outstanding amounts, viz., the sum of £7,000 in respect of a loan from the London & South Western Bank, and £4,558 in respect of liabilities from sundry creditors. These amounts were afterwards reduced by accountancy to £6,476, and £2,570, which his Lordship held the company were entitled to. It was stated that the question arose as to whether Mr. Justice Joyce had rightly decided that the company was to pay to the corporations three sums on deposit of £1,875, which required to be paid under the Light Railways Act, and which was returnable when the line was opened for traffic, a sum of £544 9s. 4d., due for sundry debts to the company, and a sum of £1,410 cash in hand, and at the bankers. The company, said counsel, was formed to construct a light railway between Bournemouth and Poole in 1899, and it subsequently acquired an extension order and powers to construct another tramway to Christchurch. They also had running powers over the Bournemouth Corporation tramways. The Bournemouth Corporation also had sundry tramway undertakings, and they had powers to construct another line, in respect of which they had to commence within a year of the date of the order. It was alleged by the company that they had not done so, and an action was brought to restrain them from carrying the order out. Mr. Justice Joyce found in favour of the Corporation, but his decision was reversed on appeal. The Corporation intended to appeal to the House of Lords, but the litigation was comprised in an agreement for the sale of the company's enterprises in Bournemouth to the Corporation, and it was in respect of this agreement that the present dispute arose. The Corporation was to pay £5,500 in cash, and a sum, which was fixed by the arbitrator at £100,000 as being the fair market value of the undertaking as a going concern. Mr. Justice Joyce had decided that the Corporation was, in addition, entitled to the three sums he had mentioned, but the appellants contended that they did not form part of the undertaking as defined in the agreement. Mr. Hughes, K.C., appearing for the Corporation, supported the judgment of Mr. Justice Joyce, and contended that the three sums were all included in the valuation of £100,000, which the corporation had paid. There was also a cross-appeal by the Bournemouth Corporation in respect of two sums of £6,476 odd out of a bank loan of £7,000, and £2,570 for sundry creditors, which the judge below had allowed to the company. Judgment was delivered on Friday, when the Master of the Rolls said the deposit had been returned to the depositors before the date appointed for the transfer of the undertaking, and he found nothing which gave the Corporation any claim to it. He found, if possible, still less ground for the second item for sums due for sundry debtors to the company, because it was really an accountant's mode of apportioning sums which had been paid over a period partly extending beyond the appointed day. Every word he had said with regard to the deposit applied with equal force to the third item of cash in hand and balance at the bank, and it was only part of the company's undertaking that was purchased, and there was no ground for the suggestion that any part of the cash in hand was acquired by the Corporation. As to the second appeal, the Corporation had undertaken to indemnify the company in regard to liabilities or engagements outstanding on the appointed day, and he saw no ground whatever for limiting it as the Corporation proposed. Lord Justice Fletcher-Moulton and Lord Justice Buckley agreed, and the company's appeal was therefore allowed, and the Corporation's appeal dismissed with costs.

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CATALOGUES AND PAMPHLETS RECEIVED

COLLIERY CABLES.—Messrs. W. T. Glover & Co., Ltd., have sent us a copy of a reprint of a Paper read by Mr. G. G. L. Preece some time back before the Institution of Mining Engineers on recent improvements in the design of electric cables for collieries, in which two forms of cable developed by Messrs. W. T. Glover & Co. specially for mining work are described. The feature of the first of these cables is what is known as the patent solid strand filling, and consists of the filling of the interstices between the wires composing the strand with a solid compound which will not run or become displaced by the heating of the conductor through overload. In course of manufacture the central wire and each succeeding layer of the stranded conductor is covered with a thin tube of plastic bituminous compound. This compound being thoroughly worked into the irterstices of the strand, all capillary passages for moisture are stopped—in fact, water cannot be forced in even under pressure. The second cable described is called "the patent solid three-core bitumen-cable." The mode of manufacture is as follows:—The conductors of this cable are each separately insulated with bitumen compound; they are then laid together round a shaped central core of bitumen which fills up the central space; and the whole is sheathed over with a solid tube of bitumen, which is forced on so as to be ribbed internally and to fit exactly the interstices between the three cores (Figs. 1, 2, and 3). The cable can then be taped and protected by armouring as desired. Among the advantages claimed are, higher dielectric strength, greater chemical protection against bad water, &c., better mechanical protection of the cores, and special suitability for use as a shaft cable in a vertical position. Messrs. Glover ask us to state that they will be glad to send a copy of the pamphlet to anyone interested.

FLEXIBLE METALLIC TUBING.—A price list is to hand of various forms of flexible metallic tubing, manufactured by Ch. Rudolph, of Paris. Rubber and asbestos packed tubing, with and without steel plaiting, is included, with several patterns of unions and connections. A special non-air-tight covering for cables and wires is listed. The London office is at 11 Queen Victoria Street.

PETROL AND PARAFFIN ENGINES.—We have received from Messrs. Bolton & Paul, of Norwich, a price list of vertical cylinder petrol and paraffin engines, suitable for coupling directly to dynamos and pumps. The sizes listed range from 1¼ to 5/ b.h.p., the latter of which engines has eight small cylinders, and runs at 800 r.p.m. A useful feature of the list is the addition of particulars as to the time of delivery of each size. Illustrations of engines applied to various purposes are given.

TELEPHONES.—The General Electric Co.'s new telephone catalogue reaches us just as we go to press. It is an excellent production, and the company has brought out several new types of instrument and alterations in their standard designs. A feature that we particularly notice is that the cases of a large number of instruments have been modified so that the terminals are protected and out of sight. We hope to publish a fuller notice in our next issue.

TRACTION SPECIALITIES.—New leaflets are being issued by the Consolidated Accessories, Ltd., of some tramway appliances of Messrs. G. W. Green & Co., for which the company are agents. These include the devices manufactured under the patents of Mr. P. J. Pringle (Borough Electrical Engineer, Burton-on-Trent), namely, a two-blade rail cleaner, a trolley tension indicator, which is an apparatus fixed to a special car which is lifted by the trolley wheel as it passes and causes different signal lamps to light up according as the pressure is within a certain range, and a trolley standard earthing device for indicating when a trolley standard becomes alive and providing means of removal of the earth connection for the car to be taken back to the depôt.

TUBULAR FUSES.—Among the new leaflets issued by Messrs. A. Reyrolle & Co., Ltd., is one dealing with L. T. tubular fuses for use in distributing panels or boxes. In these fuses, which are listed up to 600 amperes for voltages not exceeding 600 volts, there are two tubes, one surrounding the fuse wire and the other between the first tube and the porcelain handle, so that thorough ventilation is provided.

LETTER OPENER.—We have received from Electrical Installations, Ltd., a well-made and useful letter opener.

American Tribute to Lord Kelvin.—At a meeting at the Engineering Societies' Building, New York, a series of what are described as "Memorial Exercises," were held on Sunday, January 12th, in honour of the late Lord Kelvin. The ceremony was under the direct auspices of the American Institute of Electrical Engineers, but several other engineering organisations participated. The observances included prayers and an address by Rev. W. T. Manning, D.D., and Mr. H. G. Stott (president of the Institute). Prof. Elihu Thomson and Prof. E. L. Nichols spoke of Lord Kelvin's scientific and electrical engineering work, and Mr. G. G. Ward and Admiral G. W. Melrose referred to his position with regard to submarine telegraphy and navigation. The friendly relations between the great man and the American Institute were mentioned by Mr. T. C. Martin. Music of a suitable character was performed during the meeting, and the programme contained a sonnet written by Prof. W. M. Stine.

THE AIR-GAP CORRECTION CO-EFFICIENT

AN original communication by Mr. P. H. Powell has been selected by the Institution of Electrical Engineers for publication in a forthcoming number of the *Journal*. The communication is supplementary to a paper by the same author published in 1905 in Vol. 34 of the *Journal*, page 21, and contains a short account of some experiments in continuation of an investigation of the air gap correction co-efficient. In the earlier Paper open slots were dealt with, whereas the second investigation was devoted to partially closed slots. The experiments were conducted on the stream-line method, and a number of photographs of the stream-lines obtained with sectional models of teeth of various proportions were taken, from the measurements of which the corresponding values of the required co-efficient were deduced for 28 different cases given, values varying from 1·062 to 1·320. The chief factors determining the co-efficient are the length of air-gap and the width of slot opening. The rounding of the corners is unimportant, as also is the width of iron in the lip of the slot, provided this width is above a certain limit. The ratio of the width of slot to width of tooth is of some importance. A few typical examples of the stream-line photographs are reproduced in the Paper, from which it can be seen that only a very small proportion of the lines manage to keep in the slot; this is very marked in comparison with some of the diagrams in the previous Paper for open slots. As might be expected, the disturbing effect of the presence of the teeth on the distribution along the pole-face and in the pole shoe becomes more and more marked as the gap decreases. A number of tables and curves are given showing how the co-efficient varies with different values of the ratios of the dimensions.

Moscow Tramways.—It is stated that the municipality intend to issue a loan of £187,000 in connection with the construction of the existing tramway system to electric traction, the contract for which has been granted to a British syndicate.

New Zealand Tariff.—In the memorandum on the recently adopted new tariff of New Zealand, published by the Tariff Commission itself, it is to be noted that British electrical machinery is admitted free of duty.

The Junior Institution of Engineers.—At the last meeting of this Institution, a Paper on "The Conduit System of Electric Tramway Construction and Recent Improvements" was read by Mr. Fitz Roy Roose, of the L.C.C. Engineers' Department. The salient features of the original line from Westminster to Tooting were briefly described, and the differences between them and the present system of construction were dwelt upon at length. The extended yokes which were now used, besides carrying the slot rails, formed anchors to which the track rails were fixed at intervals of 7 ft. 6 in., and would be found of great advantage when renewals of track rails had to be carried out. A cast-iron plate now formed the cover to the insulator pockets, instead of cast-iron boxes as previously, which, as they became worn by traffic, had to be replaced, and were also the cause of a great deal of dirt getting into the conduit. Drainage, insulators, cable connectors, &c., were dealt with, and special work at crossovers and junctions, and insertion of junctions during reconstruction were referred to. The side slot system was touched upon, as also the electrical supply to the line. A description was given of the plough or collector, and in conclusion the following figures were cited as the cost per mile (single) of the respective systems, including special work as pipe diversions, &c.:—Conduit, £17,000; surface contact, £9,700; overhead, £9,200. On the following Saturday afternoon, by permission of Mr. Maurice FitzMaurice, Chief Engineer to the London County Council, an inspection was made of the reconstruction work in progress in Stockwell Road. The method of forming the concrete conduit by means of the improved sheet-iron centring, the process of inserting the copper connecting pieces between the lengths of conductor bars, with the insertion of the insulators and manner of carrying out other special work was demonstrated. The members afterwards proceeded by one of the latest types of cars to the sheds at Clapham High Street. The car was run into the shed on to the electric traverser, and moved thereon to illustrate the method of bringing the cars into their place in the depôt. The Motor School, where the drivers are instructed in the manipulation and operation of the controllers, brakes, &c., was then shown, much interest being manifested in the skeleton stationary and working car. All the leads, &c., for traction and lighting being visible, the men can be readily taught how the various connections are made. The sub-station was also seen, containing three motor generators (a fourth is now being erected). Delivered at a pressure of 6,600 volts from the generating station at Greenwich, the three-phase alternating current is transferred to 550 volts continuous for use on the lines. About five miles of double track are fed from the sub-station.

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ELECTROCHEMISTRY AND ELECTROMETALLURGY

IN the January number of the *Electrochemical and Metallurgical Industry* there is an interesting account of the Electric Induction Furnace used for the refining of steel in the Roechling iron and steel works at Voelklingen, Germany (compare ELECTRICAL ENGINEERING, Vol. I., p. 852). With the furnace now in use it is possible to make a very soft, medium, or hard steel, starting with steel from a basic lined converter. The steel is supplied to the electric furnace in the molten condition, and can be decarburised, deoxidised, and recarburised. The particular feature of the Roechling-Rodenhauser furnace which distinguishes it from the Colby-Kjellin design is that it combines two methods of electric heating. The first is the ordinary heating by means of electric induction currents; the second kind of heating is also with induction currents, but these are introduced into the molten bath through metal plates, termed electrodes. The second form has some similarity to heating with ordinary alternating currents. The furnace is designed for a 5-ton charge, to be operated at 5,000 volts with a frequency of 15 periods per second. The furnace is shown in Figs. 1 and 2. It is essentially a transformer with a single primary winding *A* round both iron cores *H* of the transformer. There

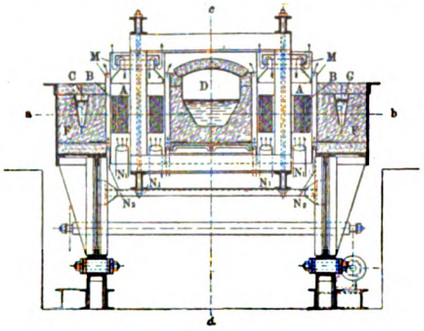


FIG. 1.

are two secondaries, one being the molten bath, which is in the form of an ∞, the channel *D*, in which the metal is smelted and which is situated between the two cores, being very broad. The other secondary is the copper winding *B*, which is connected with the metal plates *E* (Fig. 2). These metal plates are inserted into the furnace walls *F*, so that the currents pass from the windings *B* through the plates *E*, and through the refractory electrolytic conductors to the molten mass *D*. These electrolytic conductors are on the principle of the Nernst filaments. The molten mass *D* is thus subjected to the heat of the direct induction currents, and also to that of the electrolytic conductors.

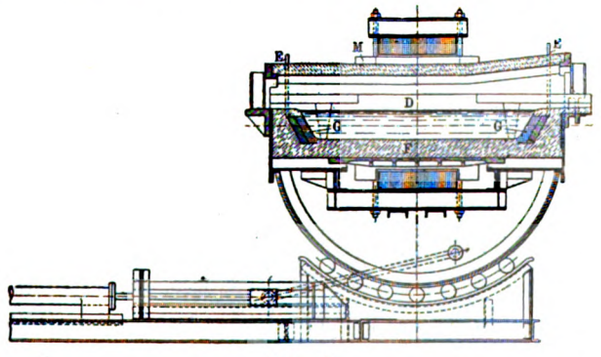


FIG. 2.

The windings are protected against the high temperature by thin walled copper canals *M M*, through which a blast of air is passed, being expelled at *N*, *N*; the transformer iron is also ventilated by means of slits. The charging door is at one end of the furnace, the tapping door at the other. When in operation sufficient circulation takes place to dispense with all manual agitation, it only being necessary to see to the correct formation of the slag and to tap it off. Fig. 2 shows that the furnace can be tilted, and in general design it is not unlike the Siemens-Martin open-hearth furnace. The normal charge is from 3 to 3½ tons, but about 15½ cwt. are left in the furnace at the end of each operation, so that the new charge only consists of from 2½ to 2¾ tons. The reason for leaving some metal in at the end of the operation is to keep the furnace hot. The method of procedure in starting is to first provide a basic lining of magnesia containing 10 to 12 per cent. of tar, after which the inside of the furnace is strongly heated. For this purpose rings of soft steel are placed in the furnace, and are heated to from 900 to 950° C. by induction currents. As soon as smoke ceases to be given off from the volatilisation of the tar, fluid pig iron is introduced from the blast furnace. The electric circuit is then closed, and the temperature commences to rise. At the end of 18 hours the furnace is at full heat.

All except 15 cwt. of the pig iron is then tilted out, and steel from the basic converter is introduced. Burnt lime containing about 6 per cent. of magnesia is placed on the surface of the molten metal, and about 18 lb. of fluor-spar, to get a sufficiently fluid slag. The refining now commences; if the slag becomes too fluid lime is added, if too thick, fluor-spar. The first operation is finished when bubbles no longer rise up through the molten mass. The slag is removed and a pure lime slag added, and ferro-silicon to deoxidise. If high-carbon steel is required, then powdered coke is also added. For ordinary steels Spiegeleisen is added as usual.

In order to make hard steel free from sulphur, the steel must be left for a longer time in the furnace, and the sulphur must be removed by oxidation, or by addition of manganese and a slag.

Compared with converter steel, the electric steel runs exceedingly smoothly when cast, this being due to the very high temperature of the molten metal. With the electric furnace it is possible to remove completely all impurities from the steel. Two men are sufficient to work the furnace, a third being required to attend to the electrical equipment. The power factor is satisfactory. At 2,600 volts with 145 amp. the kilowatts were 330. The power factor—cosine of the phase difference between E.M.F. and current—was 0·875. The cost of refining for a 5-ton furnace for one ton of soft steel is 24s. 6d.

The final conclusions of Prof. Wedding, who reported upon the process, are :—That the furnace serves simply for refining. It enables the last impurities to be removed, and the introduction of any desired amount of carbon or other elements. It is a substitute for the crucible process, and has not the disadvantage of absorbing silicon from the crucible walls; further, there are no deleterious gases. The process appears to be economical on a large scale.

In the *Engineering Supplement of the Times* of Jan. 22nd there is an article upon the manufacture of calcium nitrate and calcium cyanamide. Mention is made of the increase of the Notodden works already noticed in our columns (ELECTRICAL ENGINEERING, Vol. III., p. 57). The bulk of the article, however, is devoted to a description of the various works erected or about to be erected in connection with the manufacture of cyanamide by the Frank and Caro process (ELECTRICAL ENGINEERING, Vol. I., p. 223 and 613). Owing to the success which attended the original installation at Piano d'Orta, in Central Italy, which was erected in 1905, other plants have been erected. In France the Société Française des Produits Azotes has been formed, and works are nearly completed at Nôtre Dame de Briançon, in Savoy, which will have an annual capacity of 3,750 tons of cyanamide. In Switzerland a company has been formed, and works are being erected at Martigny, on the Rhone above Geneva. In this country the North-Western Cyanamide Co., of London, are erecting a large factory at Odde, upon the Hardanger Fiord in Norway.

The power for the company is generated by an independent company, the power-house being located higher up the Fiord, 11 kilometres from the cyanamide works. The water is brought by means of a tunnel 4 km. in length to a point on the cliff, above the generating station, where an effective head of 1,350 ft. is obtained. The present installation is designed for an output of 20,000 h.p., but four times this amount can be obtained if required. It is hoped that the works will be in operation by March, 1908. The carbide for making cyanamide is to be obtained from the Alby United Carbide Factories, Ltd., which have their works at Odde.

In Germany the Bavarian Government have granted a concession to the Cyanid Gesellschaft of Berlin to utilise the waters of the River Alz at Trostberg. It is expected to obtain about 15,000 h.p.

At Mühltal (Bromberg), in Posen, the Brandenburgische Carbidwerke are producing 2,500 tons annually of cyanamide under a licence from the Italian company. The Gesellschaft für Stickstofferdungen are also producing cyanamide at Westerglen by a rival process. The American Cyanamide Co. is also referred to (ELECTRICAL ENGINEERING, Vol. II., p. 144).

The cyanamide is being sold at 1s. to 1s. 6d. per unit of combined nitrogen cheaper than ammonium sulphate, and from 3s. to 3s. 6d. per unit cheaper than nitrate of soda. The price is thus about £10 10s. per ton, and unless there is a large turnover it can hardly be remunerative, seeing that it is made from calcium carbide which cost rather more than £8 per ton.

New Wireless Telegraphy Station at Paris.—A Reuter's Paris telegram states that the Minister of War is approaching the Municipality of Paris with a view to purchasing a piece of land on the Champ de Mars, near the Eiffel Tower, on which to build a new wireless telegraphy station. It is stated that the new apparatus will make wireless communication between Paris and New York possible.

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ELECTRICAL SCIENCE

British and American

Relation of Mass to Energy.—In the January *Philosophical Magazine*, D. F. Comstock investigates mathematically the motion of a system of electric charges. The charges, which may be single electrons, are supposed to obey the condition that they maintain the same, or nearly the same, distances from one another. He finds that the total momentum of any isolated, moving, purely electrical system is

$$2W_T \Big/ \left\{1 + \left(\frac{v}{V}\right)^2\right\} V^2,$$

where W_T is the energy arising from those components of the electric and magnetic fields which are perpendicular to the velocity v of the moving system, and V is the velocity of light. From this expression, if v/V be small, the author deduces that the mass, due to the motion of the electric system, is $4W/3V^2$, where W is the total electrical and magnetic energy of the system, and V is the velocity of light. This agrees with the well-known expression for the electro-magnetic mass of a charged conducting sphere moving slowly, and also with Searle's more elaborate formula. The former is obtained at once from the present author's formula by putting $W = \frac{1}{2}$ (charge × potential). The formula shows that the electro-magnetic mass of a system is proportional to the electro-magnetic energy, which is, on the corpuscular theory of matter, the internal energy of the atom. If this is true, the loss of internal energy occurring in material transformations should involve a diminution in mass. The diminution in mass following an ordinary chemical change is calculated by the author to be too small to be detected by experiment. In radioactive changes the alteration of energy is much greater, and the loss of mass by the whole system is large enough to be detected. On the disintegration theory of the elements this loss of mass affords a ready explanation of the small irregularities in the tables of atomic weights; and it should be noticed that it is not necessary for the whole energy of the atom to be electro-magnetic for this loss of mass to take place. The author points out that his theory that mass is proportional to internal energy indicates that gravitational attraction is an action between quantities of energy, and he computes on this basis that the weight of a caloric at the surface of the earth is of the order 10^{-11} dyne.

Continental

Undamped Electric Oscillations.—There are ways of producing steady electric oscillations apart from Poulsen's arc. One of these is described by O. M. Corbino in *L'Elettricista* for December, p. 329. It consists in coupling a series dynamo with a shunt motor, and does not require a condenser. The principle underlying the system is put as follows:—"A shunt motor, having field magnets and armatures of laminated iron, when subjected to an alternating sine p.d. at the terminals, behaves as an inductive resistance, whose inductance may have a negative value. Hence such an apparatus is equivalent to an inductance connected in series with a capacity. For a certain value of the speed, the inductance and the capacity are independent of the frequency." At this speed, therefore, the impressed p.d. need no longer be sinusoidal. A dynamo is equivalent to an inductance and a negative resistance as far as the period of the entire system is concerned. The author gives formulæ expressing the inductance, capacity, and resistance of the whole combination, and shows that the damping is, under suitable conditions, automatically compensated.

Dielectric Constant of Tysonite.—The fluoride of rare earths known as Colorado tysonite shows the magnetic displacement of absorption bands very clearly. These bands are greatly sharpened in liquid air, and the magnetic displacement in opposite directions, which at ordinary temperatures merely amounts to a broadening, develops a doublet at a temperature of −188° C. But the sharpening of the bands is not purely a matter of absence of damping. J. Becquerel shows, in *Bulletin* No. 270 of the French Physical Society, that there is a decided increase in the dielectric constant at the lower temperature, whose most striking manifestation is a fivefold increase in the magnetic rotatory dispersion. More energy is absorbed, more of the molecules being apparently capable of absorbing it. The rotatory dispersion appears to be entirely due to the simultaneous effect of anomalous dispersion and the separation of bands into two components corresponding to opposite circular orbits of electrons. The total number of absorbing electrons is $3{\cdot}54 \times 10^{13}$ per c.c. in xenotime at 20°, and $5{\cdot}96 \times 10^{13}$ at −188° C. It is just possible, the author remarks, that every electron absorbs energy, and that its charge is about a billion times smaller than hitherto assumed. But that, he admits, is exceedingly improbable.

Spectra of Alkali Metals.—The new series of lines discovered by Bergmann in the infra-red spectra of potassium, rubidium, and cæsium is attracting a good deal of attention among spectroscopists and those interested in the intimate anatomy of the elements. C. Runge manages to allocate to the new series a proper place among the three series already known. The new series bears the same relation to the first sub-series as the principal series does to the second sub-series. All the series are known to crowd up to definite limiting frequencies called "terminators." Subtracting the terminator of the new series from that of the second sub-series, we get the frequency of the first pair of lines of the first sub-series. The terminators of the new series are: Potassium, 13482·4, rubidium, 14344·4, and cæsium, 16848·8. In cæsium all the line pairs are equidistant on the scale of frequency. In the other metals the pairs are too close to pronounce on this point. In all three cases, the principal terminator is higher than either of the terminators of the first and second sub-series. The new terminator, on the other hand, is lower than either. There is, in fact, a kind of mirror symmetry between the four series.

Electron Theory of Magnetism.—In their attempts to formulate a theory of magnetism in accordance with modern views of electricity, both Thompson and Voigt encountered the difficulty that there must be a resistance to the translation of electrons in orbital rotation. By considering the effect of electro-magnetic induction upon revolving electrons, Langevin overcame this difficulty, and arrived at a theory which agreed with all the phenomena observed in diamagnetic and paramagnetic bodies. Weiss has recently extended this theory to ferro-magnetic bodies. An important contribution to a fuller theory has now been made by Z. Thullie, who bases his calculations upon the general assumptions of Voigt, but supposes that the magnetic field impressed upon the substance is generated within a time which is of the order of magnitude of a single revolution of an electron round its positive atom. This allows of a much more accurate investigation, and closely touches magneto-optic phenomena. The final result of the somewhat elaborate mathematical investigation is a complete vindication of Langevin's theory. Diamagnetism is a fundamental property of all matter, and Weber's and Ampere's molecular currents are best represented by electrons in orbital motion.

"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published Jan. 23rd, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from abroad.

1906 Patents

27,358. W. P. HAMLYN. This specification describes an automatic electric circuit-breaker, of the free handle type. The circuit-breaker is operated by means of a toggle, which forms in the closing and closed positions of the circuit-breaker a collapsible closed polygon, not forming a part of the toggle device. The latter is prevented from collapse to allow the circuit-breaker to open independently of the position of the closing switch, by a catch controlled by the automatic tripping gear of the circuit-breaker. The operating mechanism is in the form of a collapsible closed triangle, of which the contact arm forms one of the sides in combination with the toggle for actuating the contact area and cramping it in the closed position under control of an automatically-operated catch. Three claims, three figures.

1907 Patents

98, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*, New York.) This is a method for direct-current electric transmission systems of the high-tension type, and its object is to provide a system of this character, having advantages not hitherto attained. The invention consists of employing unipolar generators connected in series for producing the high voltage

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required, and providing means for keeping a constant line voltage for varying loads. The employment of unipolar generators avoids the necessity of a constant current transmission, as there is no commutator at which a flash-over might occur during variation of the current or a short circuit of the line, a self-excited shunt field can be provided with any desired fraction of the total voltage of the machine by connecting the field winding to the collector rings. The generator may be arranged so as to maintain a line voltage which is constant, or slightly increasing as the load increases, but will drop the voltage rapidly when the load increases above the output of the station. Five claims, two figures.

155, THE BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*, New York.) A new method of sealing the lamp filaments to the leading in wires of metallic-filament lamps. Filaments, of refractory metals, alloys, or compounds, have operating temperatures considerably higher than that of the ordinary type of carbon-filament, so that the usual method of attachment is not practicable with metallic filaments. The metallic filament is welded directly to the lead wire, by melting the end of the lead wire into a compact globule within which the filament is enclosed. The fusing or welding operation is carried on in a protective atmosphere by electricity. The means of performing this consists of a glass jar, to the bottom of which is secured a standard, provided with a clip for holding the stem of a lamp in a horizontal position. A small tube extends downward to the bottom of the glass jar, and serves as a means of conducting carbon dioxide or other inert gas into the jar, to act as a protective medium during the sealing operation. A second tube of copper or other material extends down into the jar, and then bends up in a semi-circle, and is provided with small openings so disposed that when the gas is supplied to these tubes it will impinge on the ends of the leading in wires. Two electrodes, one of copper and the other of carbon, are attached to the jar. Each of the leading in wires is bent in the form of a hook, and one end of the tungsten, and when the current is switched on the two metals fuse together. Three claims, three figures.

521, E. PEARCE & S. WALTON. Is an improvement in inclined carbon arc lamps, and particularly those in which two sets of carbons are used, and is to obviate the chances of the carbons overfeeding and sticking. The usual type of weighted carbon holders to feed the carbons are used, regulated by a series and shunt solenoid acting through a rocking lever, controlling the rotation of a pulley around which cords pass to the carbon holders. The improvement consists in mounting fast upon the pulley spindle a large and small ratchet wheel. The smaller ratchet wheel engages with a pawl mounted on the pulley, so that the movement of the pulley in relation to the ratchet wheel is in one direction only, namely, that in which the carbons are wound up. Engaging in the teeth of the main ratchet wheel is a double toothed rocking pawl pivoted on any suitable part of the frame. This double pawl is acted on by a spring, so as normally to take up a position in which one of its teeth engages the main ratchet wheel, and the movement of this double pawl is effected by the rocking arm worked by the solenoids. Thus the ratchet wheel is only allowed to move relative to the length of carbon consumed, and the carbons are prevented from feeding too freely by the restraining influence of the small ratchet wheel. Four claims, two figures.

4,363, THE BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*, New York.) A new substance for insulating electric conductors, providing a means by which a conductor may be coated with a thin, tough, elastic, firm adherent film, which has high dielectric properties and is waterproof, infusible at all temperatures, non-inflammable, does not crack or scale off when the wire is bent, even in curves of small radii. The process consists of previously thickening a quantity of vegetable oil, such as linseed by the application of heat, and dissolving the residuum in a solvent, and the thickening is provided by mixing a quantity of linseed oil with 2 per cent. of oxide of zinc, and a similar quantity of oxide of lead. The mixed mass is heated to a temperature of 500°–600° F., and this is continued until the oxide is entirely taken up by the oil, and the required degree of dissolution is effected. When the mass has reached a suitable stiffness, 25 per cent. of rosin oil is added, and the mass allowed to cool. The film is hardened by the application of heat; a coating of a non-drying material is then applied. Three claims.

4,802, V. POULSEN. This relates to improvements in signalling in wireless telegraphy, and the object is to signal in such a manner that the vibrations in a circuit of the transmitting apparatus are periodically damped, which is accomplished through the operating key, by inserting in the vibration circuit or in parallel with it a device for damping the vibrations, so that the vibrations of the circuit connected to the antenna can be damped as required. The arc is placed in an atmosphere containing hydrogen. The vibration circuit may be closed directly by means of an operating key, so that the ohmic resistance is short-circuited. If the circuit is opened by the operating key the vibrations are damped by the ohmic resistance, and the system ceases to transmit waves. Three claims, three figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Names in brackets indicate communicators of inventions from abroad.

Summaries of the more important of these patents will appear in our next issue.

1906 Patents

24,582, BRUCE, PEEBLES, & CO., & LA COUR. Phase transformers specially applicable for transforming single-phase electric currents to polyphase electric currents, or *vice versa*.
27,445, PARSONS & BALL. Electrical contact making and breaking devices.

1907 Patents

298, RAVENSHAW, MIDDLETON, & TOWNSEND. Magnetic clutches and brakes.
523, GODDIN. Electro-capillary apparatus.
2,595, ATELIERS THOMSON-HOUSTON. Dynamo-electric machines.
3,927, COUADE. Electric motors.
3,996, ELECTRIC IGNITION CO. & HALL. Magneto-electric ignition apparatus for internal-combustion engines.
4,429, COUADE. Synchronous operation of phonographs and kinematographs by electric motors.
5,751, MACKENZIE (*Ludwig Bolle & Co*). Electric melting furnace.
6,133, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Signalling systems for railways and the like.
7,141, ALBRECHT. Dynamo-electric differential driving gear more especially intended for motor road vehicles.
7,408, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric locomotives.
8,287, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Lightning arresters.
9,515, BULLERS, LTD., & CHAMBERS. Insulators for telegraph poles and the like.
9,516, THOMAS. Combined door latch and electrical alarm.
10,597, TAYLOR. Apparatus for automatically operating electric switches for starting and stopping electrically driven pumps.
11,621, BROOKS & AKERS. Means for operating alternating-current machines in parallel.
11,828, SIEMENS BROS. & CO. (*Siemens & Halske Akt.-Ges.*). Transformers for use in making electrical measurements.
12,932, BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO. (*Westinghouse Electric and Manufacturing Co.*). Means for preventing inductive disturbances in telephone and other electrical transmission circuits.
13,940, FORSTER. Trolley-pole holders for electric railways.
14,838, SIEMENS BROS. DYNAMO WORKS, Ltd. (*Siemens-Schuckertwedke Ges.*). Compounding of alternate-current dynamo-electric machines.
15,453, LATOUR. Single-phase electric motors.
16,618, ALLGEMEINE ELEKTRICITÄTS-GES. Transformers and controlling apparatus therefor.
18,319, GIRDLESTONE & JONES. Apparatus for automatically limiting an electric current to a predetermined value.
18,955, ARTOM. Transmitters for electro-magnetic waves.
19,829, GILMORE. Process of manufacturing reflector incandescent lamps.
20,651, HARTENSTEIN. Carbon holders for electric furnaces.
21,030, MÄRKISCHE MASCHINENBAUANSTALT LUDWIG STUCKENHOLZ AKT.-GES. Magnets for lifting.
22,301, NOEGGERATH. Current-collecting devices for dynamo-electric machines.
23,497, SIEMENS-SCHUCKERTWERKE GES. Spring support for an electric motor arranged on the axle of a vehicle.

Complete Specifications open to Public Inspection before Acceptance, under the Patents Act, 1901.

1907 Patents

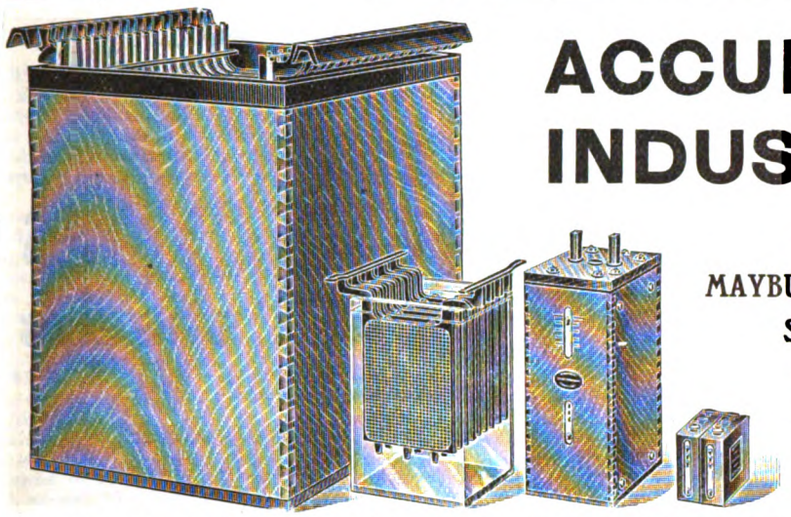
24,288, BOSCH. Contact breakers for electrical ignition in internal-combustion engines.
26,762, SCHÄFFER. Transforming machine for operating arc-lamps and incandescent lamp-circuits of low voltage.
27,926, ALLGEMEINE ELEKTRICITÄTS-GES. Apparatus for welding rings, hoops, chain-links, and the like, by means of an electric current.
28,427, ALLGEMEINE ELEKTRICITÄTS-GES. Electric measuring instruments.
28,542, HIORTH. Electric induction furnace.
28,634, LAMME & STORER. Electric locomotives.

1908 Patents

66, LITTLE. Arc lamp electrodes.
324, CHRISTIAN. Electrically-heated hot-water bottles.

For LOCAL NOTES, &c., see pp. 175 to 180

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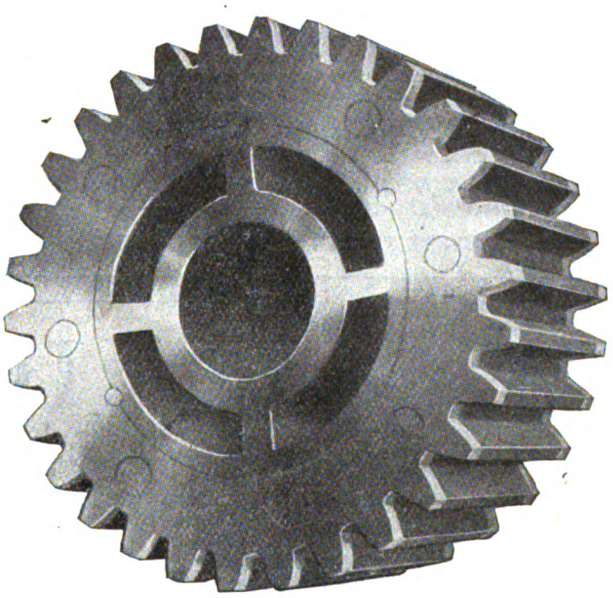
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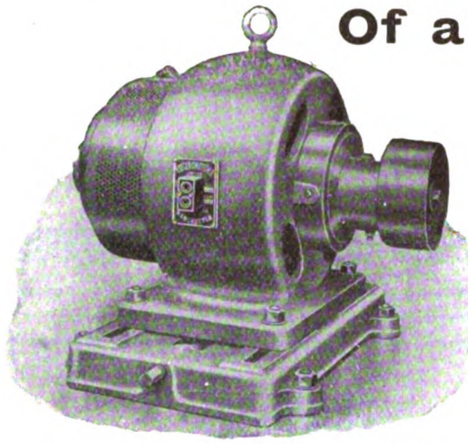
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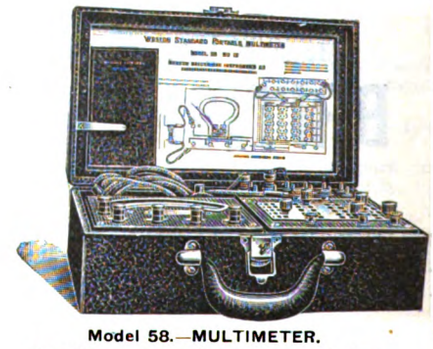
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LOCAL NOTES

BRENTFORD: *London United Tramways Co.'s Bill.*—Brentford District Council has decided to offer no opposition to the London United Tramway Co.'s Bill, now before Parliament, for the construction of tramways over Kew Bridge, to connect the Middlesex system of the company with the line from Kew to Richmond. Opposition to the Bill has, however, been lodged by the Middlesex County Council, which, with the Surrey Council, controls the bridge and its approaches.

BRIGHOUSE: *The Electricity Supply.*—At the monthly meeting of the Brighouse Town Council, held on the 22nd inst., it was decided to purchase for £800 a plot of land with a frontage to the Huddersfield Road, on which to build a sub-station in connection with the Yorkshire Electric Power Co., and to purchase electricity from that company, and distribute the same throughout the district.

BRISTOL: *New Tramway Regulations.*—The Board of Trade has issued new regulations for the Bristol tramway system. The regulations comprise all the equipment, which is required for braking, &c., which is in force in other towns, but they also enforce each car to carry a speed indicator, and no trailers are allowed to be attached to the cars. The speed of the cars must not exceed 16 miles an hour at certain places, and four miles an hour at all facing points and round all curves.

CARDIFF: *Tramway Track Repairs.*—It is estimated that the repairs which are necessary on the tramway track will cost £100,000. The track is reported to be in very bad condition, which has been caused by the sinking of the rails, due to faulty foundations. The wearing out of the rails is due to the system of running four-wheel cars, which rock very badly in some places.

CHISWICK: *The Noisy Tramcars.*—The District Council has contributed £50 towards the costs of the action proposed to be instituted in the name of the Ealing Town Council against the Tramways Co., for an injunction in respect of the alleged nuisance caused by the noise of the tramcars by reason of the defective track and the defective machinery of the cars.

DUNFERMLINE: *The Electricity Undertaking.*—Sir Alex. Kennedy, who was invited to give expert opinion on the electricity undertaking of the Dunfermline Town Council, has issued his report, dealing elaborately with the whole question. He advises the Council to transfer their Provisional Order to the Fife Power Company.

EXETER: *Electricity Returns.*—The Electric Lighting Committee states that the results of the nine months' working of the electricity undertaking to December 23rd shows an improvement in all departments over those of the corresponding period of 1906. The total revenue has increased by 16 per cent., and the total units only 14 per cent., due to economy in distribution. The generating costs had only increased 7 per cent., although the price of coal had increased 20 per cent. The increase in gross profits for the nine months was £800 over the corresponding period of the previous year.

FINCHLEY: *Electricity Bulk Supply.*—The North Metropolitan Electric Supply Co. are considering the tariff of the supply in bulk of electricity to the Finchley Council.

FIFE: *Mining Fatality.*—At the Frances Pit, Dysart Collieries, Alexander Coombs, a miner, was nailing a piece of corrugated iron on the box covering the electric cables, when the nail pierced the cable, and the shock instantly killed him.

GREYSTONES: *Electricity Scheme.*—It is proposed to form a small company to undertake the provision of a power station and the electric lighting of the town. The scheme comprises the use of suction-gas plant and gas engines to drive the generators. The contractors, Messrs. Coates & Son, Ltd., are providing part capital, of which the total for the whole undertaking is not to exceed £3,000. It is estimated that 34,000 units per annum will be generated, and the proposal is to sell at 6d. per unit.

HANLEY: *Electricity Reports.*—The monthly reports for October and November, 1907, were submitted. In the month of October 149,357 units were sold, against 113,005 in October, 1906. The total generated were respectively 174,110 and 136,144 units, the maximum loads 960 and 835 kw. The coal consumption per unit was 8 lb. against 9·93 lb. a year ago, and the works cost 0·853d. compared with 0·970d. per unit sold. In the month of November 162,296 units were sold, against 144,399 in November, 1906. The total generated were respectively 183,326 and 162,699 units, the maximum loads 1,011 and 894 kw. The coal consumption per unit was 8·23 lb. against 8·35 lb. a year ago, and the works cost 0·720d. compared with 0·709d. per unit sold.

The Tramways.—The Board of Trade has written concerning the North Staffordshire Tramways that they have consented to the use of electrical power in Hanley. Col. Druitt reported that he had inspected the North Staffordshire Tramways, with reference to an application by the Potteries Electric Traction Company for a renewal of the consent of the Board of Trade for these tramways to be worked by electric traction. He said that in Hanley, two long portions had been entirely relaid as double line with heavy rails (100 lb. to yard), and now the track in this borough on the original tramways was in good order. The state of these tramways was very much better than when he inspected them in March last year, and the company had done their best to get the track into good order as far as they could. They had spent over £20,000 on the renewal of their lines in this district since last year. They were also buying some new cars and repairing some of the old ones. The condition of the track of the old North Staffordshire tramways in Longton, Fenton, and Hanley was now satisfactory, and if a difference could be made between the tramways and these areas to those in Stoke and Burslem, he could recommend the Board of Trade to give a general consent to the tramways in Longton, Fenton, and Hanley being worked by electric traction.

HEANOR: *Proposed Supply of Electricity.*—At a general meeting of the Tradesmen's Association, a report was read of the deputation appointed to visit Ilkeston and Long Eaton electric light stations. The estimate of the cost of laying cable was stated to be 8s. per yard. At Ilkeston the price was 3d. per unit, and there was a profit of £2,400 last year. Long Eaton, with 10 miles of cable, cost £25,000, and charge 3½d. per unit. A committee was appointed to appear before the Heanor Council with a view of securing electric light for the district.

HENDON: *Electric Lighting Order.*—A Provisional Order is being sought under which it is proposed to transfer the Hendon Electric Lighting Order from Messrs. Crompton & Co., Ltd., to a company known as the Hendon Electric Supply Co., Ltd. The committee recommended that subject to proper Parliamentary undertaking being given by Messrs. Crompton & Co., under agreed terms, the Council offered no opposition to the transfer. The Board of Trade notified the Council that as the Board had now received their inspector's certificate saying that the sum expended upon the works executed within the area of supply under orders, the Board now proposed to release the deposit placed with it when the undertaking was commenced.

LEEDS: *Tramway Receipts.*—The receipts of the Leeds city tramways last week amounted to £6,022, as compared with £5,788 in the corresponding week of last year, an increase of £233. The number of passengers carried during the week was 1,371,652, an increase of 47,253. The total receipts during the present financial year amount to £274,710, as compared with £265,175 at the corresponding week of last year, an increase of £11,534.

LONDON: *County Council Trams.*—At a meeting held on Tuesday last, the chairman of the Highways Committee said that he was unable to give any definite date when the reconstruction, on the "G.B." surface system, of the tramways in Mile End Road would be completed.

The receipts of the London County Council tramways show a substantial increase over those of last year. The County Council has now in operation 116 street miles of track. During the week ended January 18th this year, the electric cars carried 5,561,684 passengers, as against 3,966,428 of the corresponding week of last year. The traffic receipts were £24,655 against £17,612, or an increase of £7,043 for the week. From April 1st, 1907, to January 18th of this year, the traffic receipts on the electrified tramways was £990,208, an increase of £371,702 compared with the corresponding period of the former year.

Forest Hill: The Proposed Tramways.—A deputation representing Lewisham Borough Council, and the Sydenham and Forest Hill Tradesmen's Association, are to wait upon the Highways Committee of the L.C.C. to impress upon them the necessity of connecting up the Forest Hill district with the general system. The L.C.C. have obtained Parliamentary sanction to construct lines which would link Forest Hill to the Lewisham High Road service on one side, and to that at Dulwich on the other. The difficulty which is hindering the service, is that the L.C.C. and Lewisham Borough Council cannot agree as to the method of transmission, as the L.C.C. want to put down the overhead system, and the Borough Council oppose it. It is proposed to take a vote of the residents of the district on the subject, and that the Borough Council be guided by that vote.

Hammersmith: Tramways Extension.—With a view to the ultimate use for traffic of the tramway across Hammersmith Broadway, the London County Council has agreed to contribute £30,000 (or two-thirds) towards the cost of widening the thoroughfare in order that the Borough Council might proceed with the negotiations. Half the contribution will be charged, when the line is used for traffic, to the tramways account.

Islington: Electricity Plant Extensions.—The Borough Council has decided to put down new plant at a cost of £23,000. Owing to a breakdown of plant just before Christmas, practically doing away with all their reserve plant, for the time being, the Council apparently has been stimulated to provide additional spare plant.

Marylebone: Electric Cookery Exhibition.—The Electricity Committee has prepared a pamphlet descriptive of the generating station and electricity undertaking, which is to be printed at a cost of £50 for 500 copies. The pamphlet is to be on sale to

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ratepayers at one shilling a copy. Messrs. D. H. Evans & Co., of Oxford Street, are giving for two weeks a demonstration of electric cooking apparatus, and a request from the firm to be supplied with the necessary current free has been granted. Messrs. Evans have allowed the use of a stall on their premises for the purpose of exhibiting the Council's pamphlets, &c.

Stoke Newington: Proposed Generating Station.—At the last meeting of the Borough Council, deputations of ratepayers were received in opposition to the proposed scheme for the establishment of a generating station. It was reported by the joint committee of the Electric Lighting and Public Health Committees that they had communicated to the North Metropolitan Electric Power Supply Co. a suggestion that a supplementary agreement should be entered into, setting out the charges in respect of the proposed extensions, which are to be charged against the general revenue, and to be borne by the company, and the company had agreed thereto. The joint committee recommended the agreement for sealing by the Council. The recommendation was carried. A debate, extending over four hours, ensued upon the motion for the adoption of the joint report of November 15th last, recommending the erection of a generating station, and the provision of plant, at an estimated cost of £3,700. In the result the motion was carried by a majority of two.

PLYMOUTH: *Electricity Returns.*—A return made by the Electrical Engineer for the quarter ended December 31st, 1907, shows that in that period 688,013 units were sold, producing receipts of £7,701, against 624,387 units and £7,195 in receipts for the corresponding quarter last year. The income from private lighting for the three months was £4,628, as against £4,572, and for motors £171 against £123 for the corresponding period of the previous year.

Tramways Committee Report.—On the 20th inst. the Plymouth Tramways Committee dealt with the financial estimates for the ensuing year, when the income was estimated at £34,776 and the expenditure at £34,628. The monthly traffic returns showed total receipts for the five weeks ended January 11th of £2,912, compared with £2,782 in the corresponding period of last year, an increase of £130. The average consumption of current per car mile was 1·43 units, as against 1·44 units last year, although the current consumed amounted to 106,978 units over a mileage of 74,521, compared with a consumption of 95,209 units and a mileage of 67,206. Up to January 11th the total income of the undertaking from the beginning of the present financial year amounted to £27,390 and the expenditure to £26,480, while last year the corresponding figures were respectively £26,870 and £25,920.

RICHMOND: *Electrical and Trades' Exhibition.*—The success of the present Electrical and Trades' Exhibition now being held at Richmond undoubtedly owes much to the co-operation of the Richmond (Surrey) Electric Light and Power Co., Ltd. The company gave considerable assistance in various ways in organising the electrical exhibits. The cookery section is particularly prominent, and included a very comprehensive set of apparatus kindly lent by the British Thomson-Houston Co. The ironing and goffering electric equipment shown by the Sheen Laundry Co. was of great interest. The display of the new metallic filament lamps was a great point of interest, especially to the shopkeeping visitors. The number of visitors and the resulting business most certainly fulfilled all expectations.

SHEFFIELD: *Tramway Reports.*—In a report just issued by Mr. A. R. Fearnley, the tramways manager, it is shown that during the nine years of its existence the system has been extended to four times the length the lines were when owned by the company. There are now 268 cars, of which 100 are covered top deck cars, 110 open top, and 58 are single deck cars. The Corporation is now manufacturing its own cars, and has made twelve in the last two years. The generating costs at the power house are extremely low, being only 0·658d. per unit. There are 73 miles of overhead trolley wire, and during the last two years about 25 miles of wire has been renewed. On an average each car runs 117 miles per day, and accidents have been very few, the compensation for injuries, which have mostly been caused by people getting on or off cars in motion, works out at 4·233d. per 1,000 passengers. The system employs 1,500 men. The total number of miles run in 1907 was 7,000,000; number of passengers carried, 74,000,000; traffic receipts, £287,000; and working expenses, £170,000. The receipts per car mile equal 9¾d. and the working expenses 5·963d., leaving 3¾d. per car mile profit.

STOURBRIDGE: *The Electric Lighting Order.*—At a special meeting of the Stourbridge Urban Council, held on the 21st inst., it was stated that a deed of transfer had been executed between the Council and the Shropshire and Worcester Electric Power Co. (Ltd.), by which the company are to pay the Council £500 and all costs.

WEST HAM: *Electricity Estimates and Expenditures.*—The Tramways Manager (Mr. H. E. Blain) reported on Monday as to the cost of roof covers for tramcars constructed in the Council's depôt. The cost for 20 covers worked out as follows:—Materials, £817; wages, £523; total, £1,340, or £67 per cover. The former contract price paid to Messrs. Milnes, Voss & Co. was £97 per roof cover. Alterations of seats were made on the cars dealt with by the Council, and the cost of these was £131 11s. 6d. Ten per cent. is to be added to the cost of the work done in the Council's depôt to cover establishment charges, and this amount, £147 3s. 3d., will go to the credit of repairs and maintenance of cars. The Committee has decided in favour of 20 additional cars being fitted with covers at the Council's depôt, the cost to be charged to the revenue account in the ensuing financial year.—The Electrical Engineer (Mr. Seabrook), in a report as to the loan for extensions at the generating station applied for in 1906, states that up to September 30th, 1907, £14,564 had been spent, against the estimate of £17,076. Balances on contracts, if all paid, would amount to £3,541, on a total against the estimate of £17,905. The difference is £829, and is partly caused by the item mechanical stokers estimated at £2,600, which cost £3,175 12s. 5d., as in excavating some old concrete sewage tanks were found, considerably increasing the cost of digging out. Another item exceeded is switchgear and cables for turbo-generators and motor-generators. The expenditure was £2,365 9s. 9d., against an estimate of £1,685, practically all on cable, due to the 37 per cent. rise in the price of copper, and extra runs for motor-generator cables. These machines are at the extreme end of the engine room from the switchboard. One of the engines has been sold to the Government of Uruguay, and a motor-generator is now on its site. The cable recovered has been credited to capital account. At Silvertown the estimate for the work was £17,212, and £22,706 has been spent, owing to more work having been done than was anticipated, and the rise in price of copper and lead, the cost of cable amounted to £12,331, against the estimate of £9,826. The ground covered by mains was 9,197 yards, against 7,496 yards estimated. Conduits and excavation amounted to £6,175 12s. 5d., against £3,441 estimated. The amount allowed for transformers, £2,427, was exceeded by £954 2s. 5d., owing to more transformers being installed than were estimated for, over 1,500 kw., against 1,100 estimated. The amount estimated for distribution was £23,300, and the amount spent £24,022 0s. 10d. The total estimate was £57,588, and the total expenditure £64,632 18s. 1d., the excess being £7,044 18s. 1d. Application is to be made to the Local Government Board for sanction to borrow the £7,045 excess expenditure.

TENDERS INVITED AND PROSPECTIVE BUSINESS

AUSTRALIA.—Capt. R. Muirhead Collins, C.M.G., has also received tender forms, specifications, &c., relating to the following:—Required by the Postmaster-General's Department at Melbourne:—(*a*) Apparatus for exchange: one common battery switchboard, of 30 sections in all, together with all associated frames, racks, power plant, and parts; (*b*) apparatus for subscribers' premises: 3,000 telephone wall sets, 1,000 telephone table sets, 150 extension switches (complete), 70 switchboards for 2 and 6 lines, 50 switchboards for 3 and 10 lines, 10 switchboards for 6 and 20 lines, 10 switchboards for 8 and 50 lines, 200 telephone wall sets, and 100 telephone table sets for party lines. Tenders will be received at the Office of the Deputy Postmaster-General, Melbourne, until 3 p.m., on May 26th.

The representative of the Commonwealth in London (Captain R. Muirhead Collins, C.M.G.), notifies that he has received tender forms, specifications, &c., in connection with the supply and delivery of thirty-three switchboards for private branch exchanges for common battery working, for which tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 2.30 p.m. on March 4th. Specifications, tender forms, &c., may be obtained at the Commonwealth Offices in London, 72 Victoria Street, S.W., where also preliminary deposits on tenders may be paid. Copies of the specification and conditions may be inspected at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, London, E.C.

BELFAST.—Tenders are invited by the Corporation for the supply of low-tension cable during the twelve months ending March 31st, 1909 (see an advertisement this week).

BRISTOL.—The Docks Committee invite tenders for the supply, delivery and erection, and maintenance for 12 months after they have been in use, of electric cables for the supply to Avonmouth Docks. The tenders are also to include the construction, delivery, erecting in place, fitting, completion, and testing and the maintenance for 12 months after they shall have been taken into use of the electric lighting installations, complete in all details, for the various buildings, railway yard, wharves, &c., at the Royal Edward Dock, now in course of construction at Avonmouth. Specifications, &c., from the Secretary of the Docks Committee (fee £5, returnable), and tenders to 19 Queen Square, Bristol, by February 17th.

BURNLEY.—Tenders are invited for the supply of a booster to the electric lighting station at Burnley Union Workhouse. Tenders should be sent in by February 12th.

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CLONES (IRELAND).—The Urban District Council is inquiring into the possibility of electric lighting for the district.

EDINBURGH.—Tenders are invited for an extension switchboard panel. Specifications, &c. (fee, two guineas, returnable), from Sir Alex. B. W. Kennedy, the consulting engineer to the Corporation, 17 Victoria Street, London, S.W., and tenders to the Town Clerk by February 10th. (See an advertisement this week.)

HULL.—The Education Committee of the Corporation invite tenders for an electric light installation and fans at the Selby Street West School, now in course of erection. Full particulars may be obtained from the City Architect, and tenders should be sent to the Town Clerk by February 10th.

KINGSTON-ON-THAMES.—Application is to be made to the Local Government Board for sanction to borrow £12,600 in connection with the electricity undertaking.

LEEDS.—Tenders are invited by the Electric Lighting Committee for steam, exhaust, overflow, and other pipes, valves, &c., in connection with a steam turbo-generator of 3,000 kw. capacity. Particulars from H. Dickinson, manager, the Whitehall Road, Leeds (fee, two guineas, returnable), and tenders to the Town Clerk by February 10th.

The Tramways Committee invite tenders for the supply of stores during the year ending March 31st, 1909, including electrical sundries.

Tenders are also invited for the supply of steam coal for the generating set for six, nine, or twelve months' supply. The consumption is approximately 500 tons per week; also for the supply of household coal and delivered at the various offices and depôts as required. Particulars may be obtained from the General Manager, at the Tramway Offices, City Square, Leeds, and tenders should be sent to the Town Clerk not later than February 21st.

LONDON: *London County Council.*—The Council invites tenders for (*a*) the manufacture, delivery, and laying of about five miles of low-tension, lead-covered electric cable, and about two miles of telephone cables, &c.; and (*b*) the laying of stoneware cable ducts, building manholes, repaving, &c., for the reconstruction for electric traction of the Council's tramways in Caledonian Road and Seven Sisters Road. Tenders to the Clerk by February 4th.

Bermondsey.—Tenders for the supply of the following stores during the year ending April 1st, 1909, are invited:—Arc lamp carbons and brushes, cable and jointing material, conduits, electricity meters, demand indicators and main fuses, engine oils, meter boards, street frames and covers and joint boxes. Full particulars from the Electrical Engineer, and tenders to the Town Clerk by February 17th.

Fulham.—A site is to be selected by the Electric Lighting Committee upon which to erect a sub-station, and put in the necessary transformers and cable connections, at an estimated cost of £400. Two flame arc lamps are to be put up in Wandsworth Bridge Road at an estimated cost of £17 10s.

Hammersmith.—The Electrical Engineer has prepared reports upon immediate extensions of plant, &c., and further developments at the generating station. He states that it is imperative that the boiler plant be increased by placing two boilers in the No. 1 boiler house and equipping all five boilers with forced draught. His estimate for this work is £4,400. Switchboard accommodation: He also recommends the addition and removal of the main switchboard. This work can only be carried out in sections, and will take some time to complete, as the supply must be maintained. £1,000 is the estimate for this. A sub-station, which it is suggested should be put up in the Hammersmith Road, will cost £283. Provision should be made for five 100-kw. transformers at £114 each. Extensions of mains are estimated at £1,899. Services, upon which £1,038 has been overspent, are estimated to March 31st, 1909, at a further £3,000. The Electricity Committee have approved the Engineer's report, and the Finance Committee likewise have passed an estimate for the work suggested to the total of £12,190. Application is to be made to the L.C.C. for a loan of £10,000 on account.

Islington.—The Borough Council invite tenders for the supply of the following stores during the year ending April 1st, 1909: Engine-room stores, &c., arc lamp carbons and globes, oil, transformers and accessories, &c.; electricity supply meters, prepayment meters, cables; electrical sundries: lamps, brushes, arc lamp parts, **&c.; terminal** service and network boxes. Particulars from the Town Clerk, to whom tenders by February 18th.

Tenders are also invited by February 25th for (*a*) one 1,500-kw. steam-turbine alternator, &c., (*b*) water-tube boiler, conveyor, &c (see an advertisement this week).

OLDHAM.—A Local Government Board inquiry was held last week into an application by the Corporation for sanction to borrow £1,500 for the provision of electricity meters. There was no opposition.

PORTSMOUTH.—The Tramways Committee invite tenders for the supply of points, crossings, and junctions. Full particulars from the Tramway Manager, and tenders to the Town Clerk by February 3rd.

Tenders are also invited by February 3rd for the supply of best smokeless Welsh steam coal for periods of six or twelve months.

RATHMINES AND RATHGAR.—Tenders are invited for the supply of the following stores during the twelve months to March 31st, 1909:—Coal, arc lamp carbons, incandescent lamps. Tenders to the Town Clerk by February 15th.

RAWTENSTALL.—The Corporation invite tenders for the supply of one balancing set, one rotary transforming set, direct to alternating current: eight static transformers, and also Lancashire boilers with condensers fitted with circulating pumps, pipe works, &c. Copies of the general conditions, &c., may be seen at the offices of Messrs. Lacy, Sillar & Leigh, 2 Queen Anne's Gate, Westminster, or 78 King Street, Manchester, and obtained on payment of a fee of £2 2s., returnable. Tenders to the Town Clerk by February 7th.

SHEFFIELD.—Tenders are invited for a supply of stores as follows for the twelve months ending March 25th, 1909:—Electrical supplies and fittings, cable, car fittings, car lamps, wood slipper blocks, steam tubes and fittings, overhead line material. Full particulars from the General Manager, Tramway Department, Division Street, Sheffield, to whom tenders by February 10th.

SOUTHAMPTON.—The Tramways Committee recommend the purchase of three additional tramcars at £2,000, and as a result of a discussion in the Council, it has been referred to the Committee to consider the question of adopting tramcars with top covers.

TUNBRIDGE WELLS.—Tenders are invited for the annual supply of high- and low-tension cables. Particulars from the Consulting Engineer, Mr. Horace Boot, Electricity Works, and tenders by February 1st.

WEST HAM.—Tenders are invited for the supply of engine-room stores, rubber-covered cable electric wiring materials and accessories, and chemicals. Particulars from the Borough Electrical Engineer's office, 84 Romford Road, Stratford, E. Tenders by February 6th.

The Engineer has submitted the following estimates as to capital requirements until March 31st, 1910:—Five chaingrate stokers and driving gear, £1,750; feed-water purifier, capacity 8,000 gallons per hour, £550; feed-water settling tank, capacity 38,500 gallons, £500; feed-water pipework, £450; boiler house sundries, testing apparatus, &c., £300; railway siding, £1,000; ash conveyor, 400 tons per hour, £1,200; grab, £175; switchgear, exciter switchboard, £150; cellular switchgear, to complete gear on present level, £600; platforms and stairway, £475; switch cells and operating gear, £1,350; pressure regulators and instruments, £300; testing cables (water load), £400. Step-up transformers—two transformers (500 kw.), £600; cellular control and isolators, £200. Turbine generators—one 1,500-kw. turbo generator, £7,900; pipework, £400; foundations, £200; cables, £250; sundries, £200; one 3,000-kw. turbo-generator, No. 12, £10,000; pipework, £600; foundations, £450; cables, £480; sundries, £300. Circulating water equipment—Spray coolers (750,000 gallons per hour), £3,000; increasing capacity of circulating water supply from the river, £1,600; circulating water sundries, £100. Station lighting and power—Transformer chamber, £400; tools and tackle, not workshop tools, £200; workshop tools, £500; office sundries, £50. Total, £36,630. High-tension triple concentric feeder to Silvertown, £4,000; switch and transformer chamber, £500; H.T. cable, £3,000; E.H.T. cable, £4,000; L.T. cable, £1,500; conduits and ground work, £5,000; transformer chambers, switchgear, &c., £8,000; meters, £2,000; testing apparatus, £250. Total, £28,250. Application is to be made to the Local Government Board for sanction to borrow this sum. The Electrical Engineer is to be empowered to invite tenders at once for the turbo-generator included in the estimate.

WIMBLEDON.—The Corporation invite tenders for the supply and erection of the undermentioned plant at their electricity works, and are prepared to accept tenders subject to the sanction of the Local Government Board being obtained for the necessary loan:—(*a*) A 1,000 kw. turbo-alternator, with condensing plant; (*b*) two water-tube boilers, economisers, pipe-work, and feed pump; (*c*) high-tension main switchboard and switchboard gallery. Forms of specification and tender, with the general conditions, may be obtained from Mr. H. Tomlinson-Lee, the Borough Electrical Engineer, Electricity Works, Durnsford Road, Wimbledon (fee £1 each specification, returnable), and tenders to the Town Clerk by February 18th.

YARMOUTH.—Tenders are invited for the supply, delivery, and erection of a 400 kw. continuous-current traction generator. Particulars and forms of tender from the Borough Electrical Engineer, 20 King Street, Great Yarmouth (fee £1 1s., returnable), to whom tenders by February 1st.

TENDERS RECEIVED AND ACCEPTED

AUSTRALIA.—The New South Wales Postmaster-General's Department has accepted the tender of Mr. R. B. Hungerford (Sydney) for 500 telephone wall sets at £2 10s. 6d., and 100 party line sets at £3 2s. 6d. each.

CARDIFF.—At a special meeting of the Electrical and Tramways Committee on Tuesday, the following tenders were accepted:—British Insulated & Helsby Cables, Ltd., high-tension cables at £593; British Westinghouse Electric & Manufacturing Co., 700-kw. motor generator for the Hayes sub-station at £1,345.

EAST PRESTON GUARDIANS.—The East Preston Guardians have received alternative tenders for electric and gas lighting.

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Messrs. Foote & Milne, of London, have sent in two tenders for electrical installations at £1,152 and £996 respectively, whilst the Littlehampton Gas Company have sent in an amended offer for a gas supply at 3s. 9d. per 1,000 cubic feet, and also to lay inside and outside piping, &c., at £217 10s. After a long discussion the consideration of the matter was deferred for a fortnight.

EAST HAM.—The Town Council has accepted the quotation of Callender's Cable and Construction Co., Ltd., for cable at £224 7s. 1d.

ELECTRICAL INSTALLATIONS, LTD.—We understand that Electrical Installations, Ltd., have some important contracts on hand, including a complete power, light, and telephone equipment for the Marmite Food Extract Co., Ltd., at their new factory, Camberwell. Installations are also being provided for, among others, the London and Paris Exchange, Parr's Bank, Ltd., Slater's, Ltd., Oxford Street, &c., &c. An elaborate system of secret service telephones and bells has just been installed for Messrs. S. Pearson & Sons, Ltd., contractors, at their new offices, the old Whitehall Club, Parliament Street, S.W.

FINCHLEY.—The Council received 21 tenders for the supply and erection of a 350-kw. high-speed engine and dynamo combined, with spare parts. The lowest was that of the British Electrical Plant Co., at £2,521. The Electricity Committee, with the Electrical Engineer, Mr. E. Calvert, have the tenders under consideration.

LONDON: *London County Council.*—The following tenders for 500 tons of steel slot rails and 190 tons of conductor rails for the reconstruction of the Caledonian Road and Seven Sisters Road tramways have been received:—The Frodingham Iron and Steel Co., Ltd. (accepted), £5,654 5s.; Walter Scott & Co., Ltd., £6,490; Steel, Peech & Tozer, Ltd. (incomplete tender for slot rails only), £4,462 10s. The Chief Engineer's estimate was £5,622 10s.

The Council has accepted the tender, at £6,392 12s. 11d., of Wimpey & Son for paving works in connection with the Hammersmith to Harlesden tramways. Although this was not the lowest tender, it was thought best that Messrs. Wimpey should have the contract, so that the paving and trackwork may be completed together. The lowest tenders were Underwood Bros., Dukinfield, Cheshire (£6,142 19s. 11d.).

Hammersmith.—The Borough Council has received the following tenders for the construction of a sub-station in Hythe Road:—Cowans, Ltd. (accepted), £212 15s.; Ferranti, Ltd., £215 8s. The Council has also accepted an offer from the Crynant Colliery Co., Ltd., to supply the generating station with 3,000 tons of Crynant coal at 15s. 4d. per ton. Owing to the acceptance of this quotation the price of the 1,000 tons ordered from the company in June last is to be reduced from 16s. 10d. to 15s. 10d. per ton.

Lambeth.—The Borough Council has placed an order with the General Electric Co., Ltd., at £150, for the supply of 1,000 Osram lamps for the Town Hall.

Stepney.—The Borough Council has received the following tenders in connection with the electricity supply undertaking:—Thirty-seven street boxes: Universal Electrical Manufacturing Co. (provisionally accepted at £62 11s. 3d), original tender £74 12s., subsequently reduced to £62 11s. 3d. by the company in consequence of themselves having received a more favourable price for castings; British Insulated and Helsby Cables, Ltd., £65 10s.; Lucy & Co., Ltd., £73 17s. 6d.; Henley's Telegraph Works Co., Ltd., £85 2s. 6d.; Richmond & Co., £117; J. Every, £120 17s. 6d.; Reason Manufacturing Co., £135 15s. 6d.; W. Cottis & Sons, £143 19s. Twenty-five large and 25 small cast-iron chambers for containing street disconnecting boxes:—E. & J. Wright (incomplete), £68 15s.; J. Every (accepted), £82 10s. 4d.; J. Warner, Ltd., £92 10s.

Woolwich.—The Borough Council has placed an order with John Spencer & Co. for the supply of pipework for connecting up the new boilers at the generating station at £11 5s.

RAWTENSTALL.—The Corporation have accepted the tender of Messrs. W. T. Glover & Co., for electric lighting and tramway cables, and that of Messrs. Browett, Lindley & Co., for steam generating sets.

WEST HAM.—The Electricity Committee has agreed to extend the contract of Messrs. W. Lucy & Co., Ltd., for the supply of house cut-out boxes for two years from March 31st next, the contract price being subject to a reduction of ten per cent. on payment of the account within seven days from the date of delivery.

Fire at a Paris Generating Station.—On the 23rd inst. a fire broke out in the electricity generating station, which is situated below the Central Markets. There was an extinction of the lighting in the Avenue de l'Opéra. The firemen had great difficulty in subduing the fire, and owing to the great number of cables destroyed the generating station will be unserviceable for some time, and a large part was without electric light for three days.

COMPANIES' MEETINGS AND REPORTS

CENTRAL LONDON RAILWAY.—The report for the half-year ended December 31st, states that the the capital expended during that period amounts to £19,482. The chief items are for the additional generating plant at the power-house and the new line at Shepherd's Bush. Compared with the corresponding period in 1906, there has been a decrease of £18,508 in the revenue receipts and of £5,152 in the working expenses; rates and taxes have decreased by £168. The available balance is £59,620. The number of passengers carried during the half-year amounted to 16,646,620, compared with 20,721,508. The decrease in the number of ordinary passengers carried during the half-year is 3,710,636, and of workmen 364,252, the total decrease being 4,074,888, or 19·67 per cent., compared with the corresponding period. An arrangement, subject to one month's notice, has been entered into with the omnibus companies, in accordance with which they reduced the length of their penny fare sections on the route of the Central London Railway, the latter retaining the minimum fare of 2d. The average receipt per passenger for the half-year is 2·01d., as compared with 1·84d. in the half-year ended December, 1906. The cost per passenger is 1·28d., as compared with 1·09d. in the corresponding period. Continued attention has been given to the reduction of the working expenditure, to lessen, as far as possible, the loss resulting from the diversion of traffic by omnibus and other surface competition, as well as from the opening and development of other tube railways; and with the same view improvements in the working and controlling of the trains have been adopted. After providing for interest on the debenture stock and other payments, the net revenue, including £25,891 brought in from previous half-year, shows a balance of £70,750. The directors recommend the declaration of the following dividends:—On the undivided ordinary stock, at the rate of 3 per cent. per annum for the half-year; on the preferred ordinary stock, at the rate of 4 per cent. per annum for the half-year; on the deferred ordinary stock, at the rate of 2 per cent. per annum for the whole year. After providing for these payments there remains a balance of £20,218. Of this balance £10,000 is to be credited to the reserve fund, and the £10,218 remaining is to be carried forward. The directors also propose that the outstanding accounts for Parliamentary expenses incurred in the promotion of the company's Bills in the sessions 1901 to 1905 be now cleared, and that the amount, £25,366, be charged to the reserve fund, leaving a credit balance of £72,880 at that account. The locomotive account placed in suspense in 1903, pending the sale of the materials of the superseded engines, is now closed, and the balance of £66,590 has been re-transferred to the capital account. The line from Shepherd's Bush Station to the depôt is in course of construction, and is to be completed in time for the opening of the Franco-British Exhibition in May next. A new station is being provided, immediately opposite the entrance to the Exhibition. In addition to the through booking arrangements with the Charing Cross, Euston & Hampstead Railway Co., and the Baker Street & and Waterloo Railway Co., similar arrangements are now being entered into with the Great Northern, Piccadilly & Brompton Railway Co., and the City & South London Railway Co. From 10,000 to 12,000 passengers are at present through booked daily.

DIRECT UNITED STATES CABLE.—At the annual general meeting on Tuesday, the report and accounts, abstracted in our last issue, were adopted. There was a decrease of about £2,000 in the receipts, principally during August and September last, which is attributable to the financial crisis in America, and with the steadier conditions now prevailing, a return to the normal traffic is confidently anticipated.

DUBLIN UNITED TRAMWAYS (1896).—The report and accounts for the half-year ended December 31st, 1907, show that the amount available for division is £64,840 11s. 6d., out of which it is recommended that dividends be paid for the half-year at the rate of six per cent. per annum on the preference shares, and at the rate of six per cent. per annum, free of income tax, on the ordinary shares, together with a bonus of 1s. per share, also free of income tax, on the ordinary shares. It is proposed to set aside £5,000 to reserve and renewals fund, £1,000 to accident insurance fund, £10,000 towards reconstruction and maintenance, and £2,000 as further provision against the guarantee to the Irish International Exhibition, 1907, in addition to the £6,250 already paid in respect of this guarantee and charged to revenue in these accounts. The dividends recommended and the sums added to reserve, &c., will absorb £56,100, leaving £8,740 11s. 6d. to be carried to next account. The meeting will take place on Tuesday.

EAST LONDON RAILWAY.—At the half-yearly general meeting on Monday, Lord Claud Hamilton, the Chairman, said the decrease of £2,023 in their passenger receipts was mainly due to the withdrawal of the Metropolitan Railway Co.'s through train service between Hammersmith and New Cross, in consequence of the non-electrification of the East London line. He said that it really surpassed the wit of man under existing conditions to find an effective remedy. As a company they were absolutely unable to find the money for the electrification of their line without the help of the lessee companies, but neither of the lessee companies would move, whilst both

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the District and the Metropolitan companies would, he thought, gladly see a resumption of the through services. Their own experience of electrification had not been of such a character as to tempt them, or even to justify them, in coming to the assistance of the East London company. The experience of these two companies of electrification, from a shareholder's point of view, had proved a disappointment, though it had conduced both to the advantage and to the comfort of the travelling public, but he did not despair of the enterprise of those two railways being ultimately rewarded. One thing was certain, they could not go back to steam; they must continue in the course they had laid down for themselves; and that being so, he trusted they might be induced—both in their own and the public interests—to join in some scheme which would result in the resumption of the through traffic over an electrified East London railway. If any scheme could be devised by which any of the other railway companies would contribute towards the electrification of the East London line, he would do all he could to induce the Great Eastern Railway Co. to become a party to it.

METROPOLITAN RAILWAY.—The report of the directors for the half-year ending December 31st, 1907, shows that the total receipts (deducting this company's proportion of the revenue of the City lines and extensions) have been £347,651 7s. 11d., and the expenses £191,959 7s. 4d., leaving a profit of £155.692 0s. 7d. Compared with the corresponding half-year of 1906, the receipts show an increase of £3,775 11s. 7d., and the expenses a decrease of £5,914 7s. 8d. The net revenue account, after providing for the interest upon the debenture stocks and other fixed charges, and the dividend upon the preference stocks, and placing £6,000 to the depreciation fund, shows a balance of £19,845 15s. 10d. available for dividend upon the ordinary stock. The directors accordingly recommend the proprietors to declare a dividend upon the ordinary stock, for the past half-year, at the rate of 10s. per cent. per annum, and to carry forward the balance of £5,515 12s. 9d. to the next half-year's accounts. The Surplus Lands Committee announce, as shown in the report and accounts appended hereto, that the dividend on the surplus lands stock, for the past half-year, will be at the rate of £2 15s. per cent. per annum. Reference is made in the report to the conference which was formed a short time ago of representatives of the various passenger-carrying companies in London with a view to limiting competition, adjusting fares, arranging through bookings, &c. It is hoped in this way to help the interests of the companies concerned and at the same time to give increased travelling facilities to the public. All the electric underground lines likely to be made are now open, the report continues, and it is possible to gauge the effect they may have upon this company by diversion of traffic. On certain routes the loss has been considerable, but the extra accommodation which all these lines afford has induced a large increase in the travelling habit of the people of London which will no doubt further grow, and the directors have every reason to think that any loss incurred on particular routes will soon be balanced by gains in other directions. The result on the traffic of the electrification of the Hammersmith and City line and its extension to Addison Road has been satisfactory, and an appreciable increase is shown in the business in consequence. In conjunction with the Great Western Company, who are partners in the line, it has been arranged to build a special station where the railway abuts on the site of the Franco-British Exhibition, with an entrance directly into the Exhibition grounds. From this it is expected that a large business will result during the ensuing summer. The directors regret that during the half-year two accidents have happened—one at West Hampstead, and the other at Farringdon Street. To meet the expenses arising from them it is proposed to take £4,500 from the reserve fund. The directors greatly regret to report that in consequence of failing health Col. Mellor has felt compelled to retire from the Board after having been associated with the company for twenty years. Mr. Thomas Parker, M.I.C.E., under whose direction the electrification of the line was carried out, has been elected to fill the vacancy. The accounts show that the company now has 20 electric locomotives, an increase of 10 during the half-year. The only other items in the rolling stock for electric traction that has increased during the half-year is the number of compartment coaches converted to trailer coaches, these now standing at 12 instead of 10. The other items are as follows: Motor coaches, 102; trailer coaches, first class, 76; composite, 20; third class, 96; converted compartment coaches, motors 4, first class 4, composite 4. The electrical renewal and depreciation fund has been credited with £6,000, and this now stands at £30,000. The mileage run by the electric passenger trains during the half-year under review was 1,545,149. The annual meeting was held yesterday.

NEW PUBLICATIONS

"Whittaker's Arithmetic of Electrical Engineering." (London: Whittaker & Co.) 1s.

"Wireless Telephony" in Theory and Practice. By Ernst Ruhmer. Translated from the German by Dr. J. Erskine-Murray, with an Appendix by the Translator. (London: Crosby Lockwood & Co.) 10s. 6d. net.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Son, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars net c.i.f. port of arrival, quoted on Tuesday night, was £64 to £64 10s. per ton. (Last week, £65 to £65 10s. per ton.)

HIGH-TENSION SWITCHGEAR.—Messrs. A. Reyrolle & Co. inform us that owing to further facilities in their works they are now able to supply switchgear embodying what is known as the Merz-Price protective system in larger quantities than formerly.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—The first meetings of the creditors and contributories, under the winding up order of Messrs. Johnstone, Benjamin & Co., Ltd., electric wire and cable makers, Kentish Town, London, were held at the offices of the Board of Trade, Carey Street, before the Official Receiver, last week. The winding up order was opposed on behalf of the directors by Mr. B. T. Norton, the receiver for the debenture holders. Gross liabilities amount to £6,296, of which £3,134 15s. 9d. rank for dividend against assets, estimated to produce £3,257 0s. 11d., and as regards creditors a total deficit of £6,959 10s. A committee of inspection has been appointed. Among the creditors are the following:—Electrical Co., Ltd., £162; Fielding & Platt, Gloucester, £65; Felten & Guilleame, Carlswerk-on-Rhine, £95; Kynoch, Ltd., Birmingham, £77; Land & See Kabelwerke, London, £151; Leyland & Birmingham Rubber Co., Leyland, £140; Union Cable Co., Ltd., London, £19.

Creditors of the Victor Arc Lamp Co. are required to send in particulars of their claims to the liquidator, Mr. W. C. Penny, Clarence House, 8 Arthur Street West, London, E.C., on or before February 22nd.

The discharge of Albert Dickinson, electrical engineer, 19 Upper Mill Hill, Wortley, Leeds, has been suspended for two years.

An order for immediate discharge has been issued in the bankruptcy of Samuel Henry and James Edgar Thompson, trading as Thompson Bros., electrical engineers, 6 East Street, Plymouth, subject to bankrupts consenting to judgment being entered against them by the Official Receiver for £50 and £1 10s.

THE FIRE AT MESSRS. COWAN'S WORKS.—In connection with the fire at Messrs. Cowan's Salford works last week, we are informed by the firm that arrangements are being made for a full resumption of work immediately, in order to avoid delay in execution of contracts.

PERSONAL.—The Cheltenham Electricity and Lighting Committee recommend that the salary of Mr. Walter Bache be increased from £400 to £500 per annum.

MISCELLANEOUS CITY NOTES

ANGLO-AMERICAN TELEGRAPH.—After placing the sum of £20,000 to the credit of the renewal fund, the directors recommend the following dividends:—A balance dividend of £1 5s. per cent. upon the ordinary consolidated stock for the year ending December 31st, 1907; a balance dividend of £1 10s. per cent. upon the preferred stock; and a first and final dividend of £1 per cent. upon the deferred stock. A balance of about £2,400 remains to be carried forward. The above dividends, together with those already paid, will amount to £3 10s. per cent. on the ordinary consolidated stock, £6 per cent. on the preferred stock, and £1 per cent. on the deferred stock for the year 1907. The register of transfers will be closed from January 22nd to February 7th, both days inclusive.

BRISTOL TRAMWAYS AND CARRIAGE CO.—Applications were invited last week for an issue at par of £250,000 4½ per cent. mortgage debenture stock. This stock, which is needed in connection with the general development business of the company, will be redeemable in ten years, and is secured by trust deed in favour of trustees giving a special mortgage upon freehold and leasehold properties and a charge upon the undertakings of the company generally.

BRITISH ELECTRIC TRACTION CO.—In a circular to the shareholders the directors state that they have had under consideration the question of the payment of the half-yearly dividend on the 6 per cent. cumulative preference shares on February 15th next, and the majority of the directors are of opinion that this dividend should be paid, but the two directors who joined the Board last year are of opinion, having regard particularly to the present depreciation of some of the company's investments, that the available profits should not now be distributed. In these circumstances the directors, in order to avoid disunion of the Board, which would be prejudicial to the interests of the company, have agreed to the settlement of this question being postponed until the general meeting of the company, which will be held as soon as the accounts for the year ending March 31st next can be presented. An estimate of the profits for the year shows:—Dividends and interest on shares, debentures and Consols, £153,000; interest on loans, &c., £7,200; net profit on working sundry undertakings, £5,500; sundry profits on contracts, &c., £14,000; net profit on sale of

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investments, £20,000; balance of Bombay profits, £41,900; making a total of £241,600. From this must be deducted :—General and sundry expenses, £24,000; sundry losses and provisions, £12,000; leaving a balance of £205,600. The interest for the year on the first and second debenture stocks amounts to £97,484; and the interim dividend paid on the preference shares from April 1st to August 15th last to £36,754, a total of £134,238. There remains £71,362, to which must be added the balance brought forward from last year, viz., £13,115, leaving £84,477 available for further dividends, and the company has cash in hand to approximately this amount. The half-year's dividend on the preference shares to February 15th requires £48,431.

CENTRAL ELECTRIC SUPPLY CO.—A dividend of 5s. per share is recommended for the year 1907, carrying forward £45.

CITY & SOUTH LONDON RAILWAY CO.—After providing for debenture stock interest, payment of the full dividend on the preference stocks, and adding £1,500 to the renewal fund, there is a balance for the year ended December 31st, 1907, sufficient to pay a dividend of 1¾ per cent. per annum upon the ordinary stock. The sum of £1,119 is carried forward.

GREAT NORTHERN AND CITY RAILWAY.—It is announced that no dividend will be paid on the preferred ordinary "A" shares for the half-year ended December 31st, 1907.

LANCASHIRE AND YORKSHIRE RAILWAY.—A dividend for the past half year at the rate of 4¾ per cent. per annum is recommended. A sum of £32,500 is carried forward.

MARCONI'S WIRELESS TELEGRAPH CO.—An announcement has been made dealing with the postponement of the general meeting beyond the date originally proposed for it. It is stated that a new audit of the accounts has been rendered necessary, and the auditors, Messrs. Cooper Brothers, are now engaged upon it. The accounts will be made up to September 30th, 1907, and the directors propose to hold the general meeting as soon as the accounts are prepared. It is anticipated that the auditors will have finished their work not later than the second week in February, which will enable the directors to call the shareholders together early in March. Mr. Marconi returned to England on the 12th inst., and both from his reports and from the practical tests to which the stations have been subjected in transmitting many thousands of words for Press purposes, the directors are of opinion that the problem of designing stations for establishing wireless telegraphic communication across the Atlantic on a commercial basis has been solved. While continuing the Press service, which has now been carried on successfully for three months, it is proposed to open the stations at the beginning of February for ordinary commercial messages.

RIO DE JANEIRO TRAMWAY, LIGHTING AND POWER.—A telegram has been received to the effect that the first 8,700 h.p. generator in the Rio das Lages power station is now in operation.

ST. JAMES'S & PALL MALL ELECTRIC LIGHT CO.—A dividend of five shillings per share is recommended upon the ordinary shares for the half-year ended December 31st, 1907, making a total of 10 per cent. for the year.

NEW COMPANIES

BECKENHAM HYDRO.—This company was registered on January 10th, with a capital of £500 in £1 shares, to acquire (1) the hydro business carried on at the Mansion, Beckenham; and (2) the business of electrical and medical baths carried on at 16 York Place, Regent's Park, N.W. No initial public issue. Registered without articles of association. Registered office : The Mansion, Beckenham Park, Beckenham, S.E.

ELECTRICAL FITTINGS CO.—This company was registered on January 18th, with a capital of £15,000 in £1 shares (3,000 6 per cent. cumulative preference), to acquire the business of electrical engineers and fitters, manufacturers, and sellers of electrical fittings, &c., carried on by Samuel Heath & Sons, Ltd., at 38 Conduit Street, W., as the "Electrical Fittings Co.," and to carry on the said business and that of electricians, suppliers of electricity for light, heat, motive power, or otherwise, manufacturers of and dealers in electrical apparatus, &c. The subscribers are : S. B. Marshall, A. W. Mills, E. J. Arnold, C. E. Lowndes, J. Thomas, C. M. Field, E. J. Peerless. No initial public issue. The number of directors is not to be less than two nor more than five; the first are S. B. Marshall and A. W. Mills (both permanent), and W. K. Sutton (representing debenture stock holders). Qualification, £100. Remuneration (except managing director) as fixed by the company. Registered office : 38 Conduit Street, W.

LEA, SON & CO.—This company was registered on January 21st, with a capital of £12,000 in £5 shares, to acquire the business of electrical and general engineers, metal workers, dealers in scientific and electrical appliances, &c., carried on by J. A. Lea and J. F. Lea at Shrewsbury, Salop, as "Lea, Son & Co.," and to carry on the same and the business of iron and brassfounders, hardwaremen, &c. The subscribers are :—J. A. Lea, J. F. Lea, S. B. Ebrall, G. Dean, W. Craven, J. Pye, and J. F. George. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first. Qualification, £100. Remuneration as fixed by the company.

ROWELL, JONES & CO.—This company wes registered on January 15th, with a capital of £2,000 in £1 shares, to take over the business of general merchants, experts, and contractors carried on by Rowell, Jones & Co., at 27-8, Broad Street Avenue, E.C., to acquire and deal with any right, privilege, concession, or contract for generating, supplying, and employing electricity, galvanism, magnetism, electric, gas or other light or power in any part of the world, and to carry on the business of electricians, electric, water, gas and mechanical engineers, suppliers of electricity, galvanism, magnetism, and gas, &c. The subscribers are :— J. Jones, Mrs. M. C. Jones, C. A. Lewis, A. E. Reiffer, J. Hawkridge, D. I. Evans. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first. Qualification, 50 shares.

SQUIRRELL & CO.—This company was registered on January 21st, with a capital of £3,000 in £1 shares, to carry on the business of electrical, heating, ventilating, sanitary, gas, water, and mechanical engineers, builders, &c. The subscribers are :—F. H. Lee, Mrs. R. M. D. Lee, H. T. Squirrell, E. A. Cole, Mrs. H. E. Cole, Mrs. A. Squirrell, and A. T. Gammon. No initial public issue. The number of directors is not to be less than two nor more than five; the first are F. H. Lee and W. F. W. R. Giesler. Qualification, 50 shares. Registered office, 4 Upper Station Road, Bexhill

STONES BROS.—This company was registered on January 23rd, with a capital of £10,000 in £1 shares, to acquire the business of a nut and bolt manufacturer carried on by Mrs. K. Stones at Vulcan Works, Albion, West Bromwich, Staffs., as "Stones Bros.," and to carry on the same and the business of manufacturers of rivets, washers, nails, chains, spikes, couplings, tools, tram fastenings, telegraph fastenings, hooks and rings, &c. The subscribers are :—Mrs. K. Stones, W. Marsh, A. Challingsworth, F. Screen, C. F. Grigg, A. E. Goode, and J. W. Higgs. No initial public issue. The number of directors is not to be less than two nor more than five: the first are Mrs. K. Stones and W. Marsh. Qualification, £300. Remuneration of first directors, £100 each per annum.

Fire at Cowans' Works.—A destructive fire broke out early on the morning of the 21st at the electrical manufactory of Messrs. Cowans, Ltd., of Salford, when a large three-storeyed building in Springfield Lane was destroyed. The fire, owing to the combustible nature of the goods, was very difficult to control, and by eight o'clock in the morning the walls only were left standing. The damage was considerable, and is estimated at £5,000. Messrs. Cowans desire us to state that complete arrangements have been made for full resumption of business, and that all delay is being avoided in the execution of their contracts.

TENDERS INVITED.

CITY AND COUNTY BOROUGH OF BELFAST.

TRAMWAYS AND ELECTRICITY DEPARTMENT.

Low Tension Insulated V.B. Cable.

THE TRAMWAYS AND THE ELECTRICITY COMMITTEE OF THE BELFAST CORPORATION are prepared to receive Tenders for the supply and delivery of Low Tension Insulated V.B. Cable during the twelve months ending 31st March, 1909.

Specifications, with Form of Tender and General Conditions of Contract, may be obtained from the undersigned on making a deposit of £1 1s. for each Specification.

Such deposit will be returned on receipt of a *bona fide* Tender, accompanied by the Specification and General Conditions.

The Corporation do not bind themselves to accept the lowest or any Tender.

Sealed Tenders endorsed "Tenders for Cable" Tramways and Electricity Department must be lodged with Sir Samuel Black, City Hall, Belfast, not later than 12 noon on Saturday, 22nd February, 1908, and must remain open for acceptance until Wednesday, 26th February.

THOMAS W. BLOXAM,
City and Electrical Engineer

Corporation Electricity Works,
East Bridge Street,
Belfast.

(*Continued on page* ix.)

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PARLIAMENTARY INTELLIGENCE

The London Power Bills to Commence in the House of Lords

Lord Onslow (Lord Chairman of Committees) and Mr. Emmott (Chairman of Ways and Means) decided on Tuesday which Bills in the coming session of Parliament shall commence in the House of Lords, and which shall commence in the House of Commons. As will be seen from the lists below, the three Bills relating to the supply of electric power for London will originate in the House of Lords.

House of Lords.—Bristol Tramways; Croydon and Southern District Tramways; Great Northern, Piccadilly and Brompton Railway; Highgate Hill Tramways; King's College, London (Transfer); London and District Electricity Supply; London and Windsor Motor Roads, Tramroads and Tramways; London County Council (Tramways and Improvements); London Electric Supply; London (Westminster and Kensington) Electric Supply Companies; Metropolitan District Railway; Metropolitan Electric Tramways; South Wales Electrical Power Distribution; West London, Barnes and Richmond Tramways.

House of Commons.—Belfast Corporation; Blackburn Corporation; Bolton Corporation; Burnley Corporation; Doncaster Corporation; Dublin and Central Ireland Electric Power; Kingston-upon-Hull Corporation; Leeds Corporation; Liverpool Corporation (General Powers); London United Tramways; Macclesfield and District Tramways (Abandonment); North-East London Railway; Rochdale Corporation.

Among the Bills which it has been decided shall come before the Police and Sanitary Committee are those promoted by the Blackburn, Burnley, and Kingston-upon-Hull Corporations.

STATUTORY PLANS AND NOTICES FOR RECONSTRUCTED TRAMWAYS.—A Bill is now before Parliament providing for the reconstruction for electric traction of the old cable tramway down Highgate Hill, and the alteration of its gauge to 4 ft. 8½ in. An interesting point to tramway promoters was raised last week, when the Bill was before Mr. Campion for proofs of compliance with Standing Orders. Under the Standing Orders, Bills are divided into first and second class measures. In the latter category are classed Bills proposing absolutely new works, and in connection with which notices have to be served to frontagers, and plans, estimates, and so on deposited in the Private Bill Office. First-class measures are those promoted by existing companies or bodies and which do not relate to absolutely new works, and do not involve notices, plans, and estimates. In connection with the Highgate Hill Tramways Bill, Mr. Pritt, Parliamentary agent, on behalf of the London County Council, argued that this should be considered a second-class measure for the reason that the alteration of gauge constituted a new tramway. Mr. Lees, Parliamentary agent, for the Tramway Company, said that the point had never been raised before the Examiners previously, but it had been tacitly agreed, at any rate since the City of Birmingham Tramways Bill in 1901, that mere electrification of a line should not constitute a Bill a second-class measure. In the case of the Birmingham Bill, for instance, it would have involved an extra expenditure of £5,000. The Examiner, giving his ruling, said it seemed to him that from what had been done in the City of Birmingham case, the mere electrification of a tramway would not constitute a Tramway Bill a second-class Bill, and he did not think the alteration of gauge was sufficient to make a tramway a new tramway.

OPPOSITION TO TRAMWAY BILLS.—The General Purposes Committee of the Wandsworth Borough Council has decided to present petitions against the London County Council (Tramways and Improvements) Bill, the West London, Barnes, and Richmond Tramways Bill, and the Croydon and Southern District Tramways.

LONDON COUNTY COUNCIL AND PRIVATE BILLS.—The following Bills, in addition to those relating to electric power supply in London, mentioned elsewhere, are to be petitioned against by the London County Council:—Great Eastern Railway (General Powers), Great Northern, Piccadilly and Brompton Railway, Metropolitan District Railway, Highgate Hill Tramway, London and Windsor Motor Roads, Tramways and Tramroads, Metropolitan Electric Tramways, West London, Barnes and Richmond Tramways, and London Motor Roadways Approach.

BILLS ABANDONED.—When the Examiner of Standing Orders sat to consider a number of Bills last week, no appearance was entered in respect of the Erith Tramways Bill and the Morecambe Tramways Bill, and the Bolton Corporation Bill, an indication that the promoters do not intend to proceed with their measures. The latter measure proposed, *inter alia*, to revive tramway powers granted in 1887 and the borrowing of £6,100 in putting them into force.

STANDING ORDERS COMPLIANCE.—The following Bills have been sent forward for first reading, Standing Orders having been complied with:—Keighley Corporation, Kingston-upon-Hull Corporation Leeds Corporation, King's College, London (Transfer), Macclesfield and District Tramways (abandonment), Great Northern, Piccadilly and Brompton Railway, Highgate Hill Tramways, North-East London Railway, Croydon and Southern District Tramways, Wolverhampton Corporation, Stockport Corporation, Bromley Corporation, Belfast Corporation, London Motor Roadways Approach, Blackburn Corporation, Bristol Tramways, Rochdale Corporation, South Wales Electrical Power Distribution, Manchester Corporation.

Non-compliance with Standing Orders has been reported in connection with the London County Council (Tramways) Bill. The point involved, however, is a small technical one in regard to the preparation of the Parliamentary estimates, and was not raised by an opponent to the measure.

The West London, Barnes, and Richmond Tramways Bill, the London United Tramways Bill, and the London and Windsor Motor Roads, Tramways and Tramroads Bill, all of which are opposed, will come before the Examiners of Standing Orders on February 3rd.

LONDON ELECTRIC POWER BILLS. The three Bills relating to electric power supply in London, viz., London Electric Supply, London and District Electric Power, and the London (Westminster and Kensington) Electric Supply, have passed the Standing Orders stage, there being no opposition. Some particulars of the action of various local authorities with regard to these Bills are given in another column.

SCOTCH PROVISIONAL ORDERS.—The following Provisional Orders, promoted under the Private Legislation Procedure (Scotland) Act, 1899, have passed the Standing Orders stage:—Ayr Corporation Tramways, Lanarkshire Tramways, Wishaw Burgh Electricity.

PARLIAMENTARY ESTIMATES.—The following estimates of the cost of the works proposed in the following Bills have been deposited in Parliament in accordance with the Standing Orders:—Blackburn Corporation Tramways, £9,119. Rochdale Corporation Tramways, £1,306. Burnley Corporation Tramways, £70,000. Bolton Corporation Tramways, £6,092. Croydon and Southern District Tramways, £59,489. Liverpool Corporation Tramways, £2,900. Doncaster Corporation Tramways, £7,700. London County Council Tramways, £206,890. London United Tramways, £7,598. Ayr Corporation Tramways, £18,250. Kingston-on-Hull Tramways, £74,000. Metropolitan Electric Tramways, £50,744. West London, Barnes and Richmond Tramways, £164,350. London and Windsor Motor Roads Tramroads and Tramways: Tramways, £316,467; motor roads, £1,132,977. Leith Corporation Tramways, £56,722.

MIDDLESEX COUNTY COUNCIL.—Petitions are to be lodged against the Highgate Hill Tramways Bill and the Metropolitan Electric Tramways Bill, in order to preserve the Council's *locus standi* in case of necessity.

Long-Distance Telephony.—It is stated that the Associated Swedish, Danish, and Russian Telephone Co. has increased its share capital by £400,000 in order to put into effect a proposal to link up St. Petersburg, Moscow, Warsaw, Copenhagen, Stockholm, Berlin, Christiania, Frankfurt, and Paris.

Track-Circuit Signalling on the Great Western Railway.—A new installation of track-circuit automatic signalling on a short section of the Great Western Railway is described in the *Railway Gazette*. In common with other automatic systems "normal line clear" working is adopted. The object of this new installation is to shorten a block section of 2¾ miles between Goring and Pangbourne stations, and electrically-controlled intermediate home and distant signals have been provided for both up and down main and relief lines at Basildon, midway between the two stations named. Each line of rails has been divided into track circuits, so that the stop signal at the rear of a train or vehicle standing at any point between Pangbourne and Basildon, or Basildon or Goring, is held at danger until the train has left the section. The track signals are the down advance starting signals for the main and relief lines at Pangbourne, and the starting signals for the up-main and the advance starting for the relief at Goring; also the up and down main and relief home and distant signals at Basildon. The novel feature is that ordinary block working is maintained between Pangbourne and Goring, while the normal position of the signals is similar to all other running signals at danger. The new signals are the tubular post type, with upright rods inside and motor at the base, and are operated electrically by the signalman at the two stations. In the case of the section between his block post and the Basildon signal being clear, the signalman at either Goring or Pangbourne is able to start a train to proceed to Basildon, and he may, in case of the line being clear, operate the automatic signals at Basildon, and clear the section there. The engine of a train operates the starting and distant signals, and these are kept at "danger" until the train has passed over the track-circuited section in advance. During foggy weather or snowstorms, trains are not permitted to proceed from either end unless the entire section is clear. An indicator showing the state of the line up to a point 440 yds. in advance of the respective Basildon home signals is provided in the signal-boxes at Pangbourne and Goring. Immediately the train has passed the respective starting signals the indicator automatically records "Track Occupied," and is so held until the train has passed the clearing point, when "Track Clear" appears, the "Train Entering Section" signal must then be sent and the Basildon signal levers restored to their normal position.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906 %	DIVIDEND PAID. 1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£				
Bournemouth & Poole E. S. Co. Ltd.	10	7	5/-*	10½—11½	+½
Do. 4½% Cum. Pref.	10	4½	4½%*	10—11	
Do. 6% Cum. Second Pref.	10	6	6%	10½—10⅝	+⅛
Do. 4½% Debenture, Red.	Stock	4½	4½%	99—102	
Bromley (Kent) E.L.& Power Co., Ltd.	5	5½	2/-*	4⅜—4½	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	95—98	
Brompton & Kensington E. S. Co., Ltd.	5	10	4½%*	7—8	
Do. 7% Cum. Pref.	5	7	7%*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	97—100	
Ch. Cross, W. E. & City E. S. Co.	5	5	5%*	4½—5	
Do. 4½% Cum. Pref.	5	4½	2½%*	4½—5	
Do. 4% Deb. Red	Stock	4	4%	97—100	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	4½—4⅝	
Chelsea Electric Supply Co., Ltd.	5	4½	2/-*	3⅜—4½	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
City of London Elec. Lt. Co., Ltd.	10	6	5%*	10—11	
Do. 6% Cum. Pref.	10	6	6%*	11½—12½	+1¼
Do. 5% Deb. Red	Stock	5	5%	120—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	97—100	
City of Durham E. P. Dis. Co.	5	4	2/1%*	3½—4¼	
Do. 5% Pref.	5	5	5%*	4⅜—4⅞	
County of London Elect. Sup. Co. Ltd.	10	5	4%*	6¼—7⅛	
Do. 6% Cum. Pref.	10	6	6%*	10⅞—11⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	105—106	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	95—98	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅜—⅝	
Do. 6% Cum. Pref.	5	3½	—	¾—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	70—80 xd	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4½—5	
Do. 5% Cum. Pref.	5	5	2/6*	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97 xd	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6⅝—6⅞	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N't'ng Hill E.L. Cos. Db. Rd.	Stock	4	4%	99—103	
London Electric Supply Corporation	3	4	2/4½d*	1¼—1⅜	
Do. 6% Pref.	5	6	6%*	4½—5¼	+¼
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—94	
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	6—6½	+⅛
Do. 4½% Cum. Pref.	5	4½	4½%	4⅝—5⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	102—106	+1
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. Db.	100 & 500	4½	4½%	96—99	+1
Newcastle & Dist. E. L. Co., £9 paid	10	5	3/7½d.*	9½—10½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6½—6⅝	
Do. £2 Pm.	5	8	1/4½d*	6¼—6⅜	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5½	
Do. 10/- Pm.	5	5	1/4½d	5—5½	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	6%*	11¼—12½	
Oxford Electric Co., Ltd.	5	7	2/6*	5½—6	
Do. 4% Deb. Red.	Stock	4	4%	93—95 xd	
St. James and Pall Mall E. L. Co. Ltd.	5	10	5/-*	7⅝—8⅜	
Do. 7% Non-Cum. Pref.	5	7	3/6*	6½—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	½—1½	
Do. 4% Deb. Red	Stock	4	4/-*	71—75	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2½—3	
South Metropolitan E. L. & P. Co.	1	2½	6d*	⅜—½	
Do. 7% Cum. Pref.	1	7	8⅞d.*	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	101—104	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1½—2¼	
Do. 5% Cum. Pref.	5	5	2/6*	2—2½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	5%*	8½—9½	
Do. 4½% Cum. Pref.	5	4½	4½%	5—5½	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	87—90 xd	
Central London	Stock	4	3%	65—68	
Do. 4% Preferred	Stock	4	4%*	84—86	
Do. Deferred	Stock	4	—	43—46	
Do. 4% Debentures	Stock	4	4%	100—103 xd	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	73—76	
City and South London Cons.	Stock	2⅜	2½%	44—46	
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	116—119	
Do. 5% Perp. Pref. 1896	Stock	5	5%*	114—117	
Do. 5% Perp. Pref. 1901	Stock	5	5%*	113—116	
Great Northern & City Pref. "A"	10	4	11½d.	1¼—1⅜	
Gt. Northern, Piccadilly & Brompton	10	4	4/-*	4—5	
Do. 4% Perp. Deb.	Stock	4	4%	82—85	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1½%*	36½—37½	−3
Do. 3½% Preference	Stock	3½	3½%	87—90	
Do. 3½% "A" Pref.	Stock	3½	3½%*	77—80	
Do. 3½% Convertible Pref.	Stock	3½	3½%*	74—77	
Metropolitan District	Stock	nil	—	10—11	
Do. 6% Perp. Deb.	Stock	6	6%	105—110	
Do. 4% Pref. Deb.	Stock	4	4%	70—75	
Do. Extension Pref. (5%)	Stock	nil	—	18—23	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	—	47—52	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	36—40	
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	1⅛—1⅜	
Do. 5% Cum. Pref.	1	5	5%	1⅜—1⅝	
Do. 4½% Deb. Red.	Stock	4½	4½%	90—95	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	−⅛
Do. 6% Cum. Pref.	10	6	6%*	4⅜—5¼	−⅛
Do. 5% Perp. Deb.	Stock	5	5%	93—96	+1
Do. 4½% 2nd Deb.	Stock	4½	4½%	69—74	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4¼—4⅜	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	96—99	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906 %	DIVIDEND PAID. 1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£				
Dublin United Trams Co.	10	6	6%*	13—14	
Do. 6% Pref.	10	6	6%*	12⅝—13⅝	
Hastings & District E. Tr. Co. Do.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	⅞—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	92—95	
London Street Tramways Co.	4	4/9	2/-*	3—3½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7⅝—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—84	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	95—98	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	6d*	1⅜—1⅝	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	93—96	+2
National Elec. Construction Co. Ltd.	1	10	2/-	1⅛—1⅜	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	¾—1½	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—½	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9¾d*	⅞—1	
Do. 5% Cum. Pref.	1	5	5%*	¾—⅞	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4½—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)		—	6¾d.*	⅞—1⅛	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	60—70	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1½	
Do. 6% Cum. Pref.	5	nil	—	3½—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	+1
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	30/-	57—60	
Do. 6% Pref. Ord.	Stock	6	3%	102—104	+1
Do. Def. Ord.	Stock	1¾	—	17—17½	+½
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	80—84	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3½	
Do. 10% Cum. Pref.	5	10	5/-*	8¼—8⅝	
Do. 4½% Debs.	50	4½	4½%	97—100	
Direct United States Cable Co. Ltd.	20	4¼	4⅝%	13⅜—14½ xd	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12⅜—12⅝ xd	
Do. 4% Mort. Deb. Perp.	Stock	4	4%*	100—103	
Eastern Telegraph Co.	Stock	5¾	5%	130—135 xd	−1
Do. 3½% Pref.	Stock	3½	1¾%	82—85 xd	
Do. 4% Mort. Deb.	Stock	4	4%	99—102	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	30—32	
Indo-European Telegraph Co. Ltd.	25	13	65/-	52—55	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅝—1⅛	−⅛
National Telephone Co., Ltd., Pref.	6	6	6%*	110½—112½	
Do. Deferred	Stock	5½	6%*	110—112	+2½
Do. 6% Cum. 1st Pref.	10	6	6%*	11—13	
Do. 6% Cum. 2nd Pref.	10	6	6%*	10—12	
Do. 5% 3rd Pref.	5	5	5%*	5¼—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	96½—98½	+½
Do. 4% Deb. Red.	Stock	4	4%	99—101	
West African Telegraph Co. Ltd.	10	4	4/-	10—10½	
Western Telegraph Co., Ltd.	10	7	6%	13—13⅞	+⅛
Do. 4% Deb.	Stock	4	4%	98—101	+1
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	7¾d	⅝—1⅛	
Babcock & Wilcox, Ord.	1	20	1/7½*	3½—3⅝	
Do. 6% Pref.	1	6	7¾d	1⅞—1⅞	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6¾—7	+¼
Do. 6% Cum. Pref.	5	6	3/-*	5⅝—6¼	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	100—103	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%*	85—89	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅝—1	
Do. 4% Mort. Deb. Red.	Stock	4	4%	40—45	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅜	+⅛
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	83—86	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ltd.	5	15	15/-	9½—10½	
Do. 5% Cum. Pref.	5	5	5%	5½—5⅝	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	104—106	
Consolidated Electrical Co., Ltd.	1	3	8¾d*	⅞—1⅛	
Crompton & Co., Ltd.	3	5	5%	1⅛—1⅜	+⅛
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	94—97	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1⅜—1⅝	
Do. 6% Cum. Pref.	1	6	7¼d	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	99—102	
Edison & Swan United "A." £3 paid	5	4½	2/6	¾—1¼	
Do. do. (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	⅛—⅜	+⅛
Do. 7% Cum. Pref.	2	7	—	1¼—1⅜	+⅛
Do. 4% 1st Mort. Deb.	Stock	4	4%	64—66 xd	+2
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅞—8¼	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	10½—11½	
Do. 4½% Cum. Pref.	5	4½	2/3*	4⅝—5⅜	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	101½—106½	
I. R. & G. P. Co., Ltd.	10	10	10%	14½—15⅜	
Do. 4% Deb. Red.	100	4	4%*	98—100	+1
Tel. Const. & Maintenance Co.	12	15	5%*	28½—30½	
Do. 4% Deb. Bds. Red.	100	4	4%	100—103	+1
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3½—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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ELECTRICAL ENGINEERING

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SUMMARY

In two reports, the Highways Committee of the London County Council recommend the construction of tramways in the North and South of London at a cost aggregating £88,226. Messrs. Dick, Kerr & Co. are the successful tenderers for the reconstruction, on the conduit system, of the existing horse tramways from King's Cross to Holloway Road, and from Holloway Road to Finsbury Park. (Page 187.)

At a meeting of the Incorporated Municipal Electrical Association on Tuesday, a resolution was passed to the effect that the Association shall appear at the inquiry to be held by Mr. James Swinburne concerning the draft electrical regulations issued by the Home Office last year, in joint opposition with the Association of Municipal Corporations. At the same meeting resolutions were passed urging the Council of the Association to continue to make efforts to induce the Local Government Board to put the question of wages of permanent employees on a sound basis, and to petition the Board of Trade to introduce the Supply of Electricity Bill this session, with clauses permitting electricity supply undertakers to carry on the wiring of buildings, hiring of fittings and motors, &c. (Page 188.)

We publish some interesting statistics sent us by Mr. J. A. Robertson, on the use of electric power in some shipyards and large engineering works in the neighbourhood of Greenock. (Page 188.)

A Paper on the driving of rolling mills was read by Mr. G. Hooghwinkel recently before the Sheffield Society of Engineers and Metallurgists. The question of cost of power was dealt with, a description was given of various methods of electric driving, and a table of important rolling mill installations was included. A short discussion followed. (Page 189.)

The report of the Yorkshire Electric Power Co. shows that the gross profit for the half-year ended December 31st, 1907, was £836 10s. 5d., compared with a loss of £403 4s. 3d. for the preceding half-year. After payment of mortgage interest, the net revenue account shows a loss of £139 2s. 11d., compared with £1,211 3s. 9d. for the half-year ending June 30th, 1907. Agreements have now been entered into with consumers for a total of 5,548 kw., an increase of 2,426 kw. during the six months. (Page 191.)

A new generating station is under construction at Salt Lake City, the most notable features of which are the use of an unusual type of vertical water-tube boiler and the employment of some of the exhaust steam taken from the first stage of the Curtis turbines for heating purposes, while the remainder passes through a further stage to condensers in the usual way. (Page 192.)

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IN the discussion on a Paper by Mr. J. W. GORDON on the new Patents and Designs Act last week, Mr. H. FLETCHER MOULTON said that the Workmen's Compensation Act had provided a very deserving class with their living for some years past, and he trusted that the Patent Act would have the same effect. (Page 193.)

A CONSIDERABLE development of water power for electrical supply is taking place in South Carolina. One of the schemes, that of the Southern Power Co., includes a number of power-houses aggregating some 200,000 h.p. on the Catawba River. One of these stations is already at work, and contains eight 3,000 kw. alternators and two exciter sets. A feature of the installation is the provision for admitting carbonic acid gas into the transformer tanks in case of fire. (Page 195.)

A VERY complete electrical installation is to be found in the Stuyvesant Theatre, New York. The supply company's connections come through two sets of underground mains to the main switchboard, and a very complete arrangement of levers and gang shafts is adopted to actuate the switches and dimmers. Nearly all the lights in the auditorium are placed behind translucent glassware. (Page 196.)

A DESCRIPTION is given of the Berry Series System of alternating-current distribution, in which the heavy all-day losses in transformer substations are avoided by employing a small auxiliary transformer which takes the light load and an automatic switch to transfer the load to the main transformer when it rises above a certain value. (Page 197.)

A NEW form of arc lamp lowering gear is illustrated on page 200.

SOME electrically-driven coal spouts in which coal is conveyed by travelling bands have been installed by the North-Eastern Railway Co. at Tyne Dock, by which vessels can be coaled under all conditions of tide at the quayside. (Page 200.)

THE Paper by Mr. J. S. PECK on protective devices for high-tension circuits, which will be discussed at to-night's London meeting of the Institution of Electrical Engineers, was read before the Manchester Local Section on Tuesday. The author considered the nature of the "static" strains produced by lightning, switching, grounding, or by any occurrence which causes an abrupt change in static potential, which may appear as high pressure to earth or between wires, or as a concentration of potential upon a portion of the circuit. To relieve the high pressure between line and ground or between wires, lightning arresters are used. To protect apparatus from concentration of potential, choke coils may be placed in series with the apparatus to be protected. Lightning arresters usually consist of an air-grip in series with a current limiting and an arc suppressing device. Four types of lightning arresters are in general use—the horn, the multi-gap, the water-jet, and the electrolytic. (Page 201.)

MAJOR PRINGLE, in his Board of Trade report on the West Hampstead accident, finds that the collision was caused by forgetfulness in the first instance, and subsequently by some illegal manipulation of the electrical instruments or locking on the part of the signalman at West Hampstead, who should bear the full responsibility for his conduct. The opinion is expressed at the end of the report that automatic signalling is best adapted for conditions of high traffic frequency. (Page 205.)

A LETTER from Mr. H. L. WEBB calls attention to the development of the central battery telephone system and the message rate tariff on the Continent. (Page 206.)

THE advantages of electrical driving in textile cotton mills were dealt with in a Paper read by Mr. J. SHAW last Saturday before the Dundee Institute of Engineers. (Page 207.)

A NEW iron-clad switch, some new telephone designs, and a new metallic filament lamp are described on pages 207 and 208.

UNDER ELECTROCHEMISTRY AND ELECTROMETALLURGY a number of short notes are given upon various subjects, among them being reference to a patent for using calcium carbide anodes in the production of aluminium, a method for obtaining calcium carbide in cylindrical blocks, and the melting of refractory metals in vacuum by means of the arc. (Page 209.)

AN account of Prof. RUTHERFORD'S lecture last Friday at the Royal Institution appears under ELECTRICAL SCIENCE, together with a note on a new formula for the inductance of a circuit composed of two equal parallel wires. In the Papers abstracted in the Continental section DUFOUR describes another magneto-optic anomaly, which he takes to indicate the existence of positive electrons. MAX WIEN produces slightly damped oscillations by a new method of coupling, KLUPATHY proves the magnetic action of a beam of cathode rays, and LIGNANA describes an improved method of measuring energy in three-phase four-wire circuits. (Page 210.)

AMONGST the specifications published by the Patent Office last Thursday was one by BRUCE PEEBLES & Co. and LA COUR, for the conversion of single-phase currents into polyphase by means of a compensated converter. The ATELIERS-THOMSON-HOUSTON have one dealing with compensated dynamo machines in which the direction of rotation can be reversed. M. BROOKS and M. K. AKERS have an arrangement for regulating and equalising the loads on alternating-current generators. THE BRITISH WESTINGHOUSE ELECTRIC Co. have patented a means for neutralising and preventing disturbances to telephonic and telegraphic communication, due to proximity of the cables to high-tension alternating-power cables or overhead lines. The only expiring patent of electrical interest this week is one by F. TUDSBURY, relating to the method of attaching the collectors in such electric machines as the Wimshurst. (Page 211.)

THE Cardiff Tramway Manager estimates that there will be a profit of £15,000 from the tramway system at the end of the current financial year, compared with £4,000 last year. The Board of Trade refuses to intervene at present in the dispute between the various local authorities of the west of London concerning the alleged noise and nuisance from the tramcars of the London United Tramways Co. Intercommunication has been arranged between the National and municipal telephone systems at Hull. The Leyton District Council calls the attention of the Board of Trade to the delay in the construction of the North-East London Railway, authorised in 1905. The City Corporation is supporting other London authorities in objecting to the proposal by the Board of Trade to modify the existing audit of electric lighting accounts. The Hull Electricity Committee has decided to transfer the whole of the present reserve fund towards extinguishing the capital expended beyond the amount sanctioned by the Local Government Board. The Sunderland tramway returns show a considerable drop during the past year, and are still going down; the decrease is attributed to the extremely bad state of trade and the general distress in Sunderland. Some severe criticisms have been made by the Local Government Board auditor upon the accounts of the Walthamstow Electric Lighting and Light Railway departments, in which it is stated that had certain sums been charged to revenue instead of to capital, there would have been a loss instead of a substantial profit. In consequence of a disagreement between the Midland Electric Corporation for Power Distribution, and the Wednesbury Corporation, as to the terms upon which the present bulk supply shall be continued, the company has given notice to ter-

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minate the present agreement on March 31st, 1908, and notifies its intention to give a supply direct in future under the terms of its Provisional Order. A reply to the recent criticisms of Mr. Stephen Sellon upon the Dolter Surface Contact System in its application at Oxford, has been made by the engineer to the National Electric Construction Co. (Pages 213 and 214.)

The Ilford Corporation require a 1,000-kw. steam generating set, and a water-tube boiler; Aston Electric Supply Committee recommend the installation of a 2,000-kw. three-phase 6,600-volt turbo-generator; the Burnley Corporation propose to purchase a 750-kw. steam generator and a motor-driven centrifugal pump. Estimates have been prepared in connection with the proposed new generating station at Bury, the total expenditure being estimated at £39,881, £48,155, and £55,720, according to the initial capacity of the works. The Tramways Department of the Glasgow Corporation invite tenders for two movable bridges over the Clyde Canal. Stores are required by the Electricity or Tramways Department of the following authorities:—Blackburn, Gravesend, Halifax, Leeds, Bermondsey, Battersea, Hammersmith, Islington, Portsmouth, and Sheffield. Electric lighting installations are required by the Burnley Union, at a number of depots in Hornsey, and by the Hull Education Committee. (Pages 215 and 216.)

The report of the City & South-London Railway for the half-year ended December 31st shows a net profit of £49,619. The full dividend on the 5 per cent. preference shares is declared, and $1\frac{3}{4}$ per cent. upon the ordinary shares. The Great Northern & City Railway Co.'s accounts for the December half-year show a balance of £379, which it is recommended shall be carried forward. The net balance available for distribution by the Liverpool Overhead Railway Co. is £9,105, and dividends of 5 per cent. upon the preference shares, and $\frac{1}{2}$ per cent. on the ordinary shares, are declared. (Pages 217 and 218.)

The problem of diminishing the light load losses in alternating current transformer distribution systems has been before the electrical engineer ever since the transformer itself has been applied for electric lighting. It would, in fact, be interesting to know the exact amount of energy which has been employed in carrying the iron cores of transformers round their cycles of magnetisation, and has served no more useful purpose than to maintain a high sub-station temperature. It is evident that the problem of lessening this waste is a harder one than appears at first sight, for during the last ten or twelve years quite a number of attempts have been made with only limited success to construct a practical and reliable device for automatically switching transformers in and out of circuit according as the load increased or decreased. We are able to give a description this week, however, of a method introduced by Mr. A. F. Berry a few years ago, the use of which is spreading in a way which indicates suitability to its purpose. One of the interesting points in the system is the way in which, by connecting the small transformer, which is used at times of light load, in series with the main transformer, all actual breaking of the circuit by the automatic switch is rendered unnecessary, and at the same time the voltage surgings and consequent shocks to the insulation, which are apt to be produced when a transformer is suddenly thrown into circuit, are avoided. A further advantage of the periodic rests to which the transformers are subjected is that, not only are the circumstances more favourable as regards the life of the insulation, but the same transformer can be used for a higher maximum load than it would be suitable for if not allowed to cool at intervals. Another result attained is the improvement of the voltage regulation of the network. As we have said, the use of the Berry "series" transformer system is extending, but we believe that no complete description of it has yet been published, so that our readers will welcome the detailed article on the subject, which we are able to offer them this week.

We have awaited with much interest the publication of the report of the Board of Trade inquiry, conducted by Major Pringle, into the West Hampstead accident. It had been thought fit to withhold the report until the conclusion of the criminal proceedings, which resulted in the acquittal of the signalman on the charge of manslaughter, and it is striking to note how different is the firm tone of Major Pringle's pronouncement from the conclusion arrived at by the judge and jury. The Board of Trade inspecting officer has no hesitation in declaring that "the collision was caused by forgetfulness, in the first instance, and subsequently by some illegal manipulation of the electrical instruments or locking" on the part of the signalman, who "must bear the full responsibility for his conduct." It is distinctly to be regretted that, while the engineering and legal aspects of the occurrence had to be investigated by separate tribunals, some form of collaboration could not have been arranged. If Major Pringle's clear report and well-considered conclusion had been available to assist the judge in his summing up and the jury in their verdict in the manslaughter trial, they would not have given the negligent signalman the benefit of the doubt which the decisive pronouncement of the Government's railway expert would have dispelled.

Now that the session of Parliament has actually commenced, and the season of companies' meetings and reports is also upon us, more information is available with regard to the intentions of the London electricity supply authorities and the promoters of the electricity Bills which will soon come up for consideration in the House of Lords. It appears that the proposal that is being brought forward by a new company is attracting far more attention than it was a month ago, when the scheme to consolidate the London companies under one management, and to work them by a joint committee, seemed to be the one of leading importance. It is now known that the engineers to the London & District Electricity Supply Co. are Mr. H. F. Parshall and Mr. Robert Hammond, who were both experts retained by the London County Council last year on the London County Council Electric Power Bill. The engineering details of the scheme are, of course, not yet available for publication, but it is freely rumoured that the general technical lines of design will bear a marked similarity to those of last year. This is, in fact, to be anticipated, as one would naturally not expect a radical change in Mr. Parshall's and Mr. Hammond's views in twelve months. As in the case of Mr. Merz's famous Bill of 1905, the chief interest in the first instance centres around the low rates at which supply is to be provided. The price offered for untransformed high-pres-

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sure current supplied to authorised distributors is even less than in the London County Council Bill of last year, viz., £3 per annum per kw. of maximum demand, *plus* 0·25d. per unit, as against £3 15s. per kw., *plus* 0·22d. per unit. For transformed alternating current, £3 10s. per annum per kw., *plus* 0·3d. per unit, is set down, compared with £4 7s. per kw., *plus* 0·25d. of last year, and for direct current, £4 10s. per kw., *plus* 0·33d. per unit, instead of £5 12s. 6d., *plus* 0·27d. per unit. These prices may further be compared with the maximum of £5 per annum per kw., *plus* 0·5d. per unit, scheduled in the Bill proposing a combination of existing supply undertakers. As to supply to private consumers, there is a clause which will give rise to much discussion and opposition on behalf of the existing supply undertakers in London, and it will certainly puzzle the members of the Committee at the outset, unless it is very clearly interpreted to them. The company ask for power to supply any private consumer whose maximum demand is over 250 kw.; if the demand is less than 250 kw., they ask for power to supply, if they can do so, at a price lower by a certain percentage than that at which the authorised distributor is ready to supply. This percentage is 1 per cent. for every 10 kw. that the maximum demand is less than 250 kw. That is to say, that if the authorised distributor were willing to supply power to a consumer with a maximum demand of 50 kw. at a flat rate of 1¼d. per unit, the new company would be allowed to furnish the supply direct to the consumer at any price less than 1d. per unit.

The scheme to consolidate all the electricity supply companies under one management, known as the London Electric Supply (Joint Committee) Bill, will be the subject of opposition on the part of all the London Local Authorities, who apparently do not desire to avail themselves of the invitation to come into the Joint Committee which it is proposed to form. We are also in a position to state that a strong group of West-end companies, whose electric lighting business is likely to remain of far greater importance than their power load, is also opposed to the scheme. The companies who are promoting it are the Charing Cross Co., the City of London Co., the County of London Co., the London Electric Supply Corporation, the Metropolitan Electric Supply Co., and the South Metropolitan Electric Light & Power Co., and, in addition to these six companies, who will guarantee the interest on the capital of £1,000,000 that is to be issued if the Bill passes, two others, the Brompton & Kensington and the Chelsea companies, are also on the list of subscribers. As will be seen, the Kensington & Knightsbridge, Notting Hill, St. James's & Pall Mall, and Westminster Cos. (together with the Central Electric Supply Co.), are not taking active part in the scheme. It has been known for some time past that they are promoting a Bill of their own for a closer combination of their interests than is possible under their present Provisional Orders and Special Acts, but we believe that we are right in stating that they are actually opposed to the principle of the formation of a Joint Committee for the control of all of the London companies. It is easy to recognise that their interests are different to those of the larger companies operating further to the East and South, where the power load is of greater importance, but yet it is to be regretted that there is not a unanimity among all the companies working in London, for without that there will be little chance of any step being taken that will materially cheapen the cost of electricity supply in the Metropolis. That this supply is, on the whole, cheaper than in other large capitals we freely admit, but this is no reason why further economies could not be realised if the companies were placed in a more satisfactory position as regards ultimate purchase when their present concessions expire, for which probably they would be ready to guarantee a reduced tariff as a *quid pro quo*.

There is another element that has so far not been considered in the matter, viz., the attitude that will be taken by the Board of Trade. Mr. LLOYD GEORGE now knows more about electric lighting matters than when he made his statement of the Government policy with regard to the London County Council Electric Power Bill in 1906, and he has shown, in other directions, that, in matters in which the conciliation of conflicting interests is involved, he believes in the Board of Trade playing an active rather than a passive part. It would cause us no surprise, therefore, to learn that the question of electricity supply in the Metropolis will be relegated to a Royal Commission or Select Committee once more, or else that the present Bills are simply suspended to make way for a Government measure. In view of the new constitution of the London County Council, and the outlay which that body will incur on its new Municipal Building, the recommendation of the Hybrid Committee of 1906 to the effect that the Council should be the central electric supply company in London is hardly likely to be acted upon.

ARRANGEMENTS FOR THE WEEK

TO-DAY (THURSDAY), FEBRUARY 6TH.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at the Institution of Civil Engineers, Great George Street, Westminster. Paper to be read:—"Protective Devices for High-tension Transmission Circuits," by J. S. Peck.

Institution of Electrical Engineers: Leeds Local Section.

8 p.m. Smoking Concert at the Hotel Metropole, Leeds.

Röntgen Society.

8.15 p.m. Meeting at 20 Hanover Square, London. Paper to be read:—"The Present Position of X-Ray Measurements," with demonstration of apparatus, by Dr. Deane Butcher.

FRIDAY, FEBRUARY 7TH.

Institution of Civil Engineers: Students' Section.

8 p.m. Meeting at 25 Great George Street, Westminster. Paper to be read:—"Electric Hardening and Annealing Furnaces," by P. T. Steinthal. Mr. James Swinburne, F.R.S., will take the chair.

SATURDAY, FEBRUARY 8TH.

Junior Institution of Engineers.

6.30 for 7 p.m. Anniversary Dinner at the Hotel Cecil, London.

TUESDAY, FEBRUARY 11TH.

Physical Society.

7 p.m. Dinner at the Hotel Cecil, Strand.

Institution of Electrical Engineers: Manchester Students' Section.

7.30 p.m. Meeting in the Municipal School of Technology, Whitworth Street, Manchester. Paper to be read:—"Electrical Driving of Textile Mills," by W. Hanna.

Institution of Electrical Engineers: Glasgow Local Section.

8 p.m. Meeting at 207 Bath Street, Glasgow, when the discussion on Mr. J. F. C. Snell's Paper, "The Cost of Electric Power for Industrial Purposes," will be continued.

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WEDNESDAY, FERUARY 12TH.

Institution of Electrical Engineers: Birmingham Local Section.

7.30 p.m. Meeting at the Birmingham University. Papers to be read :—(1) "Experimental Determination of the Losses in Pole Shoes, due to Armature Teeth," by T. F. Wall and S. P. Smith; (2) "The Reluctance of the Air Gap in Dynamo Machines," by T. F. Wall.

Institution of Electrical Engineers: Students' Section.

7.30 p.m. Meeting at 92 Victoria Street, Westminster. Paper to be read:—"Train Lighting," by G. H. Nelson.

Association of Engineers-in-Charge.

8 p.m. Meeting at St. Bride's Institute, Bride Lane, Fleet Street, E.C. Paper to be read :—"Superheated Steam," by T. Sugden.

THURSDAY, FEBRUARY 13TH.

Rugby Engineering Society.

8 p.m. Ordinary Meeting. Paper to be read :—"Mechanically-propelled Commercial Vehicles, with Special Reference to the Petrol Electric System," by Bernard Hopps.

FRIDAY, FEBRUARY 14TH.

Northampton Institute Engineering Society.

5.45 p.m. Meeting at the Institute, Clerkenwell, E.C. Paper to be read :—"Some Problems of Electric Railway Operation," by E. V. Panell.

Physical Society.

8 p.m. Annual General Meeting at the Royal College of Science, Imperial Institute Road, South Kensington.

SATURDAY, FEBRUARY 15TH.

Institution of Electrical Engineers: Students' Section.

10.30 a.m. Visit to the National Physical Laboratory.

LONDON COUNTY COUNCIL TRAMWAYS

IN a report to the Council, the Highways Committee proposes to include among the tramway works to be put in hand during the year 1908-9 the electrification of the remainder of the London Southern Tramways system. This system was purchased by the Council from the London Southern Tramways Company by agreement as from October 2nd, 1906, and statutory authority for the conversion of the lines to electric traction is conferred upon the Council by the London County Council (Tramways and Improvements) Act, 1907. The reconstruction for electric conduit traction of a portion of the tramways, namely, the lines from Vauxhall to Brixton, is already in progress. The Act provides for the use of overhead electric traction on the remainder of the lines, and authorises the construction of certain single loop lines and the execution of street widenings along the route. The tramways are situated practically wholly in Lambeth, and the Act provides that the Lambeth Metropolitan Borough Council shall contribute one-third of the cost of the street widenings, but only on condition that the reconstruction of the tramways is completed by October 1st, 1909. It is, therefore, of importance that the remainder of the work should be proceeded with at as early a date as possible. The length of the tramways now proposed to be dealt with is about 1¼ route miles, and the estimated cost of the reconstruction and equipment of the lines for the overhead trolley system of electric traction is as follows :—Trackwork, &c., including special work and £4,600 for rails, £26,600; cables, cable-ducts, &c., £2,000; overhead equipment, £3,160; rolling stock, £3,150; total, £54,910. The Finance Committee, in agreeing to these proposals, point out that the cost per mile of single track for the trackwork and overhead equipment, viz., £11,904, is higher than in other cases of overhead construction, but special circumstances in connection with lowering roads under several railway bridges render this extra expenditure necessary. Under the Standing Orders, the consideration of this matter has been adjourned for a week.

In a further report the Highways Committee state that tenders have been received for the execution of the roadwork and platelaying, exclusive of the supply of rails and special trackwork, in connection with the reconstruction, for the underground conduit system of electric traction, of the existing horse tramways (i.) from King's Cross, *via* Caledonian Road and a short portion of Camden Road, to Holloway Road, and (ii.) from Holloway Road, *via* Seven Sisters Road, to Finsbury Park. The total length of line affected is about 2¾ miles of double track. The amounts of the tenders are as follows :—Dick, Kerr & Co., £53,516 15s. 10d.; Robert W. Blackwell & Co., £55,013 5s. 10d.; W. Manders, £56,684 7s. 4d.; J. G. White & Co., £58,249 14s. 3d.; John Mowlem & Co., £59,007; Edmund Nuttall & Co., £59,917 1s. 2d.; W. Underwood & Brother, £61,240 14s.; William Griffiths & Co., £62,041 16s. 7d.; William Muirhead & Co., £62,110 11s. 2d.; the National Electric Construction Co., £64,993 11s. 2d.; George Law, £68,489. The chief engineer's estimate, comparable with the tenders, is £58,986 16s. 2d.

The tender of Dick, Kerr & Co., Ltd., amounting to £53,516 15s. 10d., is recommended for acceptance, conditional upon their agreeing to give preference in employment on casual or unskilled labour required for the work to men *bona fide* resident in the county of London. Messrs. Dick, Kerr & Co. have intimated their willingness to adopt this course. A sum of £7,000 is included in the tender for alterations of pipes, mains, &c., the cost of which cannot be more accurately estimated beforehand, and also for any other contingencies which may arise. Messrs. Dick, Kerr & Co. are to be allowed to sublet to the undermentioned firms (or to such other persons or firms as may be approved by the chief engineer under the contract) the following portions of the work, namely (i.) to the Anderston Foundry Co., Ltd., or Wilson, Pease & Co., Ltd., the supply of the yokes; (ii.) to Doultons, Ltd., or Buller's, Ltd., the supply of the insulators; (iii.) to Bayliss, Jones & Bayliss, Ltd., the supply of the tie bars, bolts, &c.; and (iv.) to the Associated Portland Cement Manufacturers, Ltd., the supply of cement. The report was adopted at the meeting on Tuesday.

Cable Communication in the West Indies.—The Legislative Council of Trinidad has expressed its willingness to consider the advisability of increasing its subsidy for the Colony's cable service by £1,000 per annum in order to assist in procuring the establishment of an all-British cable communication from Great Britain, via Canada and Bermuda, to Barbadoes, Trinidad, and British Guiana, provided that the Legislatures of the Colonies of British Guiana and Barbadoes also express their willingness to do the same

Overhead Telegraph Wires in London.—On Tuesday last, in the King's Bench Division of the High Court, Mr. Justice A. J. Lawrence, the Hon. A. E. Gathorne-Hardy, and Sir James Woodhouse had before them the case of the Postmaster-General *v.* The Metropolitan Borough of Woolwich, which came up on an appeal from the award of the Stipendiary Magistrate for the Woolwich district. (*See* ELECTRICAL ENGINEERING, Vol. II., page 251.) Sir Robert Hunter, for the Postmaster-General, in presenting the case, explained that these wires were to be put up to connect alarms with fire brigade stations, but ultimately, no doubt, they would be used for telephone purposes. He estimated that were the work to be carried out in the manner proposed by the Borough Council, an excess in expenditure of £220 would be incurred. Mr. Thomas Edward Drucke, estate agent, said that iron poles did not deteriorate the selling value of the property. Mr. James R. Dickson, Borough Engineer, Woolwich, gave evidence as to the lasting value of an iron pole over that of a wooden pole. He was of the opinion that the work, if carried out according to the Postmaster-General's plans, would affect certain residential areas. Several other witnesses were heard, and the case was adjourned.

Preferential Charging Refused in Marylebone.—Sitting in the King's Bench Division of the High Court on Wednesday and Thursday last week, Mr. Justice Phillimore and Mr. Justice Walton heard an appeal against the decision of Judge Selfe in the Marylebone County Court in July last, in which certain Marylebone residents had failed to obtain a reduction of their electric lighting accounts in circumstances which certainly constituted a hardship. Messrs. Pemberton & Clark, a firm of auctioneers, occupied premises which were originally in the Hampstead electric lighting area, and in 1905 they entered into an agreement with the Hampstead Borough Council for the supply of electric light for a period of ten years at the rate of 4d. per unit. The Borough of St. Marylebone in March, 1906, advised Mr. Pemberton that, under the London Electric Lighting Areas Act, 1904, Messrs. Pemberton and Clark's premises had been transferred to the Marylebone lighting area, and they sent him a form to fill in whereby he would agree to pay for electric light at the increased rate of 8d. per unit for the first 200 hours of maximum demand per quarter, and 1d. per unit after. Mr. Pemberton declined to do this, and the Marylebone authority again wrote and asked him if it was his desire to be disconnected. He replied again that he wished to be supplied according to the terms of his contract with the Hampstead authority. The Marylebone Borough Council continued to supply him, however, and sent in accounts each quarter, made out on their basis of charge (8d. and 1d.), and in return a cheque was sent by Mr. Pemberton, not for the sum claimed, but for the amount due on the basis of 4d. per unit. Action was then taken by the Council for the recovery of the balance in the County Court. The Council had raised their meter rental, which was also in dispute. It was contended on behalf of the Marylebone Borough Council that they had simply charged according to the rates obtaining throughout the borough, and that no preference could be made. Similar applications to Messrs. Pemberton and Clark's were made by Mr. R. J. Knox, Messrs. Myring & Co., and Mr. Sobocuiski, all of whom were residents in Hampstead. After legal arguments by Mr. McMorran, K.C., and Mr. W. Cave on behalf of the Marylebone Borough Council, and Mr. Abinger for the consumers, judgment was given against the appeal, with costs.

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION

Draft Home Office Regulations

A SPECIAL general meeting of the Incorporated Municipal Electrical Association was held on Tuesday in London to receive a report from the Council upon the draft regulations issued by the Home Office under the Factory and Workshops Act, 1904, for the generation, transformation, distribution, and use of electrical energy.

Mr. S. L. PEARCE (Chief Electrical Engineer to the Manchester Corporation, and Senior Vice-President of the Association) presided in the absence of the President, Mr. H. Talbot (Nottingham), through illness. Mr. Pearce said that directly the Home Office issued the draft regulations above referred to, the Association was circularised, and the replies were dealt with at great length by a sub-committee, with the result that 41 formal objections had been lodged with the Home Office. The President (Mr. Talbot) and the honorary Secretary (Mr. Faraday Proctor) had had an interview with the Electrical Adviser to the Home Office, and although the result was satisfactory to a large extent, it was deemed necessary that some action should be taken towards being represented at the inquiry which was to be held by Mr. James Swinburne in March. Negotiations had been carried on with the Association of Municipal Corporations, and the question to be decided was whether the Incorporated Municipal Electrical Association should be represented at the inquiry independently or whether it should join forces with the Association of Municipal Corporations. In the first place, the following resolution would be put to the meeting: "That the Association of Municipal Corporations be informed that the Incorporated Municipal Electrical Association is willing to take joint action with them with regard to the employment of counsel and to tender expert evidence, it being understood that the objections raised by the Incorporated Municipal Electrical Association form part of the instructions to counsel." This resolution was proposed by Alderman Bruce (Sunderland), and seconded by Alderman A. Coates (Hanley), and carried unanimously.

Further resolutions were then put to the meeting, the Chairman explaining that they were contingent upon the first one, and were proposed in order to leave the Council absolutely prepared to meet any emergency.

(1) "That in the event of joint action by the Association of Municipal Corporations and the Incorporated Municipal Electrical Association not being arranged, the Incorporated Municipal Electrical Association proceed independently."

(2) "The President, the immediate past President, the senior Vice-President, the hon. Solicitor, and the hon. Secretary, form a sub-committee, with power to act, and to retain counsel if desirable."

Both these resolutions were carried unanimously.

After a short discussion, it was decided that any expense incurred should be provided by the municipalities forming the Association on the basis of gross annual revenue.

LOCAL GOVERNMENT BOARD LOANS.

The meeting then discussed the question of Local Government Board loans in relation to the payment of wages of permanent employees out of capital. It will be remembered that the Local Government Board has recently insisted that the wages of permanent employees engaged upon capital work should be provided out of revenue. The Chairman said he regretted that since the annual meeting last year very little progress had been made in this matter, nor had the Council been able to obtain an interview with the Local Government Board. The Council, however, did not intend to relax its efforts in this matter.

Mr. FARADAY PROCTOR (Bristol) mentioned that at Bristol, after a good deal of agitation, they had been allowed to pay certain wages of permanent workmen out of capital to the extent of something like £4,000.

Councillor SPENCER (Halifax) said that their experience at Halifax had been to the contrary, although they were still endeavouring to get reinstated a sum of £1,019 for wages.

A number of other speakers suggested that the members of Parliament for the respective boroughs should be approached with a view to appealing to the Board of Trade. Mr. R. Birkett (Southend), however, thought that harm was likely to be done by worrying a Government Department too much, for he was quite sure, from his experience, that the matter was not being put on one side by the Local Government Board. Mr. C. C. Atchison (Rochdale) suggested that the members of the Association should collect together reports of proceedings at Local Government Board inquiries upon this point, in order, if possible, to provide precedents to be produced when they themselves applied for loans. Mr. Faraday Proctor (honorary Secretary) said he would be pleased to have such information, and would tabulate it for the use of the members. Mr. F. M. Long (Norwich) said he had found the Local Government Board inspectors quite reasonable in this matter when he had explained exactly what he did in the allocation of workmen's wages.

At the conclusion of the discussion the Chairman stated that the Council would consider the various suggestions made, and would continue to press the matter until they had arrived at some satisfactory solution.

THE SUPPLY OF ELECTRICITY BILL.

A discussion then took place upon the desirability of urging the Board of Trade to introduce the Supply of Electricity Bill at as early a date as possible. The Chairman stated that the Council had no information to give to the meeting, as the Bill promised for this session had not yet been published, and therefore they could not discuss its provisions. Mr. A. C. Cramb (Croydon) spoke strongly as to the need for putting the law with regard to hiring out of motors and fittings, opening show-rooms, the stand-by clause, &c., on a more uniform basis. It was an expensive matter, he said, to have to secure these advantages by means of special Bills, and it was high time that such clauses were introduced into a general Bill, and it could very well be done in the Supply of Electricity Bill. During the subsequent discussion mention was made of the circular sent out by the Hastings Corporation on this point, and to the reply by the Board of Trade that in drafting the Supply of Electricity Bill this session, a clause of this nature would be introduced. Mr. A. H. Shaw, of Ilford, also pointed out that the Associated Municipal Electrical Engineers (Greater London) had been informed to the same effect by the Board of Trade. Subsequently Mr. Cramb proposed a resolution that the Council be asked to set out the various clauses referred to, and urge upon the Board of Trade that they should be included in the Supply of Electricity Bill to be promoted this session. At the same time Mr. Cramb expressed his doubts as to whether any such Bill would be passed. This was seconded, with the suggestion that a deputation should wait upon the Board of Trade. The resolution was then carried unanimously.

ELECTRIC POWER LOADS IN SOME LARGE SHIPYARDS AND ENGINEERING WORKS

IN the discussion in Glasgow on Mr. J. F. C. Snell's Paper on the cost of electric power supply, Mr. J. Robertson (Engineer-in-Chief to the Greenock Municipal Electricity Works) referred to some figures which he had with regard to the demand of shipyards and engineering works in his district, and at our request he has sent us the actual figures in tabulated form. They are appended below :—

	Nature of premises..	No. of motors.	Total H.P. installed.	No. of men.	Annual units.	Maximum load H.P.	Ratio of maximum H.P. to Total H.P.	H.P. per capita. (Total H.P. ÷ No. of men).	Units per capita.
1.	Shipyard	27	543	400	176,051	268	0·49	1·36	440·1
2.	Shipyard	43	1156	1150	376,000	536	0·463	1·005	326·95
3.	Engine works	30	647	730	279,439	234	0·36	0·886	382·8
4.	Engine and boiler works.	22	528	400	222,586	302	0·57	1·32	556·5
5.	Engine works	9	155	150	132,977	134	0·86	1·03	886·5

With the exception of No. 3, where a few small steam engines still exist, electricity is used throughout. This accounts for the difference noticed in Column H.P. *per capita*.

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ELECTRICAL DRIVING OF ROLLING MILLS

THE paper read by Mr. G. Hooghwinkel recently before the Sheffield Society of Engineers and Metallurgists on the driving of modern rolling mills was almost entirely devoted to electrical methods, although a few notes were given of direct driving by steam and gas engines for three high mills and reversing mills of the heaviest type, but it was remarked that all the smaller mills, such as small finishing mills and continuous rod-mills, could be better and more cheaply driven by electric motors, in most cases without an additional equaliser set, such as in the Ilgner, Westinghouse, or other systems.

The advantages and disadvantages which may be urged for and against electric driving for rolling mills were tabulated by the author as follows:—

Advantages.—(1) Constant and regular torque; (2) more reliable, less breakages of couplings, pinions, &c.; (3) less room, on account of absence of boilers, pipes, &c.; (4) easy adaption to mill; (5) easy and simple handling; (6) easy distribution by means of cables, instead of steam pipes or gas pipes; (7) advantages of centralising the power; (8) less labour; (9) lower fuel costs; (10) less oil and other stores; (11) use of gas engines of medium size in power station; (12) increased output due to higher speeds. *Disadvantages.*—(1) Less efficient, and wasteful speed regulation; (2) influence of the variations of the required power on generating station; (3) electric motors overload themselves until circuit breaks; (4) higher fuel costs than direct gas-engine drive; (5) high capital outlay.

A further advantage is the power control and checking, which is easily effected by means of the usual electrical instruments at any moment.

In dealing with the question of the power station, the author said that the power station supplying the mills might be gas or steam driven, and in the latter case coal or gas-fired boilers might be used; or the supply might be derived from a public supply station, which might be compared with the private station, except that it would have a better daily load factor, due to the influence of the diversity factor, and would generally be of somewhat larger capacity. The heavier capital charges, and charges for directorate, management, cables, &c., would, however, in his opinion be found to completely outbalance any advantages which might result from the better load factor and larger capacity.

Both with steam turbines and large gas engines, he continued, the economy does not increase proportionally after a certain output per unit is reached. The writer would put this economical limit at 2,000 kw. for steam turbines and 1,200 kw. for gas-engine sets. In both cases the price per unit will not be materially different, although in this country, as well as in Germany, the price per unit delivered to the mains is higher with the large power company than with large private power stations at collieries and steel works, and it is the writer's opinion that, as time goes on and the loads increase, the power companies will not be able to catch up with the private power plants at the works referred to.

On a recent tour in Germany the writer found that two large Westphalian power companies charged over 1d. per unit to the collieries in their district. Several large colliery power stations in Germany, and a few in this country (Powell Duffryn Company) produce their own power at from 0·3d. to 0·4d. per unit, including capital charges. As to the power stations using waste gases from blast furnaces, the first cost of the power station is at least 60 per cent. more. The cost of production, however, though lower than with coal-fired stations, is not as low as is generally put forward, on account of higher capital charges and special maintenance due to periodical cleaning, &c.

In some of the large South German gas-driven power stations the generating costs per unit are stated to be 0·25d. This figure may be taken as being perfectly well attainable. Much depends, of course, on the price of coal and the value placed on the waste gases. With coal at 6s. per ton, the writer has obtained 0·3d. per unit at a large colliery power station with a 40 per cent. load factor. Coal at steel works costs much more at the present time, and in view of the rising prices it is better to calculate with coal at 12s. per ton, and place a value of ¼d. per 1,000 cubic feet on the gases. This latter price is low, and only represents the price of cleaning, water, &c., and the capital charges on the cleaning plant, pipes, and cooling plant. The capital charges, however, are responsible for the second heaviest item in the generating costs, and in many cases it will be found to be nearly as economical to have a steam-driven power station with boilers fired with the waste gases, although the efficiency of the gas engine is over three times as great. With coal at a reasonable figure, a steam station of the outputs met with in large steel works is not so much less economical than a gas-engine station due to the smaller capital charges.

Some detailed estimates of the power cost for steam and gas-power stations were then entered into, from which it was contended that for medium size steel works power can be obtained at from 0·35d. as a maximum to 0·12d. as a minimum per unit, with 0·2d. as a fair average.

Mr. Hooghwinkel then passed on to a short description of various methods of electric driving. In the first installations with which the writer was connected, such as the Peine Steel Works, at Hanover, compound wound continuous current motors were used on account of speed variation and starting torque. The intermediate mills were driven by means of ropes or belts, and the motors, as a rule, were direct-coupled to the finishing mill, which requires most power. A high speed (300–400 r.p.m.), and therefore cheap, motor could be used, having a heavy flywheel pulley. Rolling mill motors, however, require a double speed regulation. Firstly, various standard speeds for rolling various materials; and secondly, a drop in speed is required in order to make the flywheel do its duty and give up stored energy with increasing load on the motor. The first condition is met by a shunt motor, but with this class of motor the maximum drop in speed is only 2 to 3 per cent., quite insufficient to induce the flywheel masses to give up their stored energy. A series winding is therefore added to produce this effect. Continuous current motors are still considered to have some advantages over three-phase motors, especially in connection with the auxiliary plant, such as cranes, rolls, &c. In later installations, however, especially in works where a large central station with power transmission existed, three-phase motors are being more extensively used because of their simpler and more compact construction. The speed variation for both purposes, which in this case is obtained by means of a resistance in the rotor circuit, however, causes losses proportional to the percentage of the speed variation. But it is also possible to vary the speed without losses by changing the pole connections. A third method is by the use of two motors each for a standard speed, assuring high efficiency for each speed. This latter method has been adopted at one of the new roughing mills at the Hildegarde Works, which are rope-driven from one end.

To direct-coupled motors for heavy bar or plate mills, separate flywheels are added by means of flexible couplings. The dimensions of these flywheels depend on the number of passes at the same time, and the duration of each pass. Heavy flywheels will therefore be found on mills where the material passes but once, or with short passes. In order to obtain efficient flywheel masses, mills of this kind, *i.e.*, plate mills requiring 1,000 h.p. normal, are driven by high-speed motors (200 r.p.m.) and rope-driven, the motor being coupled to a solid cast-steel flywheel, allowing peripheral speeds of 150 feet per second. A considerable number of mills have been equipped on this principle, and have been very satisfactory, both from the point of view of power consumption and equalising in the central station. If further equalising is required, *i.e.*, when rolling mills are on a power company circuit, the by now well-known Ilgner flywheel sets have to be added. This is, however, a costly addition, and, moreover, precludes the use of three-phase rolling-mill motors. Lately, however, the writer has been interested in a modified system of this kind, which allows of slightly smaller flywheel sets, which are in parallel with the principal motor. This allows of the equaliser being uncoupled in the case of defects in this part of the plant, so that the three-phase high-tension mill motor can be run directly from the mains. An electrical winding engine on this principle is being erected at a South Wales colliery on the writer's advice, so that further particulars as to the results will shortly be available. Generally speaking, the writer is of opinion that for continuous mills no separate flywheel sets will be required. However, on account of the higher peripheral speeds (over 250 ft. per second), it may in some cases be more advantageous to run two or more mills from one flywheel set, instead of installing a number of heavy flywheels (on account of lower speed) on each mill. An additional advantage in this case is the efficient speed regulation by means of variations in the generator field, doing away with all starting losses.

Rolling-mill motors have to be constructed in accordance with the very heavy demands made upon them. They must have a

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reasonable clearance, and, in any case, substantial bearings. Their maximum load is, as a rule, two or three times the normal rating—more often three times. Their speed variation is, of course, governed by the requirements of the material to be rolled. The heavy duty of these motors, due to their exposure to sudden jerks, was at first considered a serious bar to their introduction by the steel works' managers, but it has been proved in actual practice that these jerks do not inconvenience the motor (if properly constructed and designed) more than the steam engine. As a matter of fact, these jerks do more harm to the mills themselves, and the usual safety device which protects the mill also protects the motor. It is, however, necessary to give especial attention to the insulation and mechanical protection of the rotor windings, and especially the end connections, in the same way as is now being done in turbo-generator work, for these jerks are nothing more than speed retardations in a very short time, and the resultant forces act directly on the revolving windings. The greater number of the continuous mill motors at present installed are of about 500 h.p. normal capacity, but some of the heavier plate mills call for much more powerful motors—ranging in some cases up to 5,000 h.p. The heavier and more modern mills are nearly all driven by three-phase high-tension motors. The two-motor equipment is advantageous when two or more fundamental rolling speeds are required, but the system of driving required in each particular case depends on so many additional circumstances, and each case should be considered on its own merits on competent electrical expert advice.

As to the financial results of the electrical driving of continuous rolling mills, it may be assumed that in most cases, with electric power at sufficiently low figures, as is now being obtained from large power supply companies and steel works power stations, including 12 per cent. for interest and depreciation, electric driving will prove to be the cheaper. Results published from time to time, *i.e.*, lately by the Dillinger Iron Works, in Luxemburg, have confirmed this forecast, just the same as electric driving for pumping, endless rope hauling, and other continuous and non-reversible processes prove cheaper if properly designed and executed. These last points have in many cases not been kept sufficiently in view, and the several failures can nearly always be traced to one of these causes. A great deal depends, however, on the price paid for the electrical power. The writer is of opinion, however, that reversing mills will even pay better if electrically equipped than non-reversing mills, because the steam drive for any reversing plant is much less economical. The writer has been closely connected with the development of the electric winding engine, which is more or less on a par with the reversing mill, although not nearly as difficult a problem, and holds that it pays better to wind by electricity than to drive a fan if power costs anything like 0·25d. per unit. As, however, this question of costs has been most frequently attacked with reference to reversing plant, the writer proposes to give a detailed estimate with costs in connection with the reversing rolling-mill drive. The best proof of the commercial success of electric driving of all non-reversing rolling mills is the number of installations. In Europe alone, the number of motors installed for medium and heavy mill work is 230, with a normal capacity of 190,000 h.p., and a maximum capacity of 410,000 h.p. Over 60 per cent. of this number are repeat orders.

The two principal points to consider in the design of electrical equipments for reversing mills are the quick starting and retardation of the rolls. In order to obtain this it is essential to reduce the forces due to the inertia of the revolving masses. In the first equipments, which are all on the direct-current system, the motor had to be divided into two or three units in order to obtain broader and more compact construction with less flywheel effect. A good steam rolling-mill engine can be brought up to speed in 1½ to 2 seconds. The electric motors at Hildegarde, although calculated to take four seconds, performed this duty in 2½ seconds. This difference is so small that, even with eight reversals per minute, the time lost is

Electrically-driven Reversing Mills running and ordered in Europe.

Works.	Type of Mill.	Product of Mill.					Capacity per hour.	Rolls.			Mill Motor.							Flywheel Set						Power Station			
		Finished Product.	Weight.	Original Section.	Elongation.	Number of Passes.		Diameter.	Revs. per minute.	Type of Coupling.	No. of Armatures in Series.	Voltage per Armature.	Maximum Torque in Ft. Tons.	Maximum Speed. Full Excitation.	Maximum Speed. Low Excitation.	Maximum Load in H.P.	No. of Generators in Series	Voltage per Armature.	Type of Motor.	Maximum Speed per minute.	No and Weight of Fly Wheels.	Normal Motor Load.	Primary Power.	Pressure of Supply.	Distance to Flywheel Set.	Distance from Mill to Flywheel
			T.	Sq. Inch	Times		T	Inch													Tons	H.P.			Y	Y
*Hildegarde Steel Works	Cogging, Roughing, Finishing.	70lb. Rails, 18 inch Girders.	2	15×15	43	23	15	30	110 to 140	direct coupld	3	330	255	110	140	9000	2	500	3-phase	375	2 at 26	2500	Steam Turbine	3000 v., 50 a.	130	11
*Resicsa Steel Works	Same. 4 Stands. Billets 1st.	Same, Bars, 2×2 inch.	1·6 3·5	10×9 24×20	20 4·75	21 19	20 30/35	30 38	110 to 150 35	Girder Mill direct other 2:1	2	550	255	110	150	9000	2	550	3-phase	417	2 at 26	2000	Gas Engine	5200 v 20 a	615	190
*Resicsa Steel Works . . .	Plate Mill, 1 Stand. Universal, 1 Stand.	6 m/m. Plates. Loco. Frames.	3·5 3·5	16×32 max 16×40	19 15	29 27	30 —	34 30	55 to 150 150 110	Plate M. 2:1 other direct	2	550	255	110	150	9000	2	550	3-phase	417	2 at 26	2000	Gas Engine	5200 v., 20 8 a.	615	190
*Rombach Steel Works	Bar Mill 2 Stands	2×2 inch Bars, Ties.	2·1	9×7	16	13	60/70	32	120 to 160	Direct	2	550	295	120	160	12500	2	550	3-phase	300	4 at 25	2800	1 Steam Turbine 2 Gas Engines	5500 v 50 a.	327	16
Hirstener Steel Works	Plate Mill 2 Stands	Plates, 700 m/m by 4 m/m.	1·25	—	—	17	20	30	120 to 160	Direct	1	800	147	120	160	6250	2	400	Continuous Current	405	2 at 26	1500	Gas Engine	500 v	327	16
Firming Steel Works	Cogging Mill, 5 Stands. Armour Plate Mill.	Bars, 2×2 inch, 8 in. Plate.	0·5	12×12	36	21	4	28 44	40 to 54	Gearing 2:6:1	1	500	131	110	140	3750	1	500	Continuous Current	400	2 at 20	800	Steam Engine	220 v.	272	13
†Dorman, Long & Co.	Girders, Rails. 2 Stands.	6in. Girders Angles and T Sections.	0·35	6×6	24	—	10	16	110 to 160	Direct	1	400	105	110	160	3000	1	400	3-phase	400	2 at 20	950	P Supply Co. with Steam Turbine	2750 v., 40 a	—	13
Georg Maria Steel Works	Cogging Mill, 1 Stand.	Billets.	2·5	16×16 to 20×20	15	17	50	36	90	Direct	2	750	278	60	90	7000	3	500	Continuous Current	450	1 at 35	1300	Gas Engine	500 v.	545	54
Rheinische Stahlwerke	Cogging Mill, 1 Stand.	Billets.	2·5 to 3·2	19×19	13	15	75	44	60	Direct	2	635	492	40	60	8400	2	650	Continuous Current	450	1 at 38	1600	Gas Engine	500 v	0	196
*Grille, Funke & Co.	Tube Mill.			—	—	—	—	—	50	Gearing 5:1	1	500	48	250	—	800	1	500	3-phase	500	1 at 5	800	Westphalian Power Co	5000 v. 50 a	—	—
*Georg Tugmayer & Sons	Copper Rolling Mill.	Billets.	3	64×6	—	80	3	33	24	Gearing 5:1	1	550	17	120	—	900	1	—	Water Turbine, belt driven	750	1 at 5	—	Water Turbine	—	0	11
Hungarian Steel Works	Cogging Mill. 1 Stand.	Billets. Rails.	3 1·5	22×22 5×5	21 14	— —	36 18	40 30	94 140	Gearing 5:1 Direct	1	1000	262	80	140	9000	2	500	3-phase	375	2 at 35	1800	Steam Turbine	8000 v 50 a.	223	21

• Running. † Second one on order in England.

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not considerable. At the Illinois Steel Works, where a 30 in. two-high mill is driven by two 2,000 h.p. motors at 0 to 150 revs., reversing every four seconds, the average station load is only 30 per cent. of the maximum load of the mill motors.

The Ilgner method of combining flywheel compensation and Ward Leonard control is so well known by now that it is not necessary to go into details. Recently the writer had the opportunity of applying another method on much the same principles, but in parallel and not in series with the main motors, to an electrical winding engine. The results are, however, not yet obtainable, but the arrangement, which consists of a rotary convertor and separate flywheel generator in parallel, present the advantage of allowing the use of three-phase mill motors, and the possibility of cutting out the equaliser set in case of break down, without stopping the mill, and a power factor of unity. These advantages may or may not counteract the disadvantages of greater power consumption due to starting losses, but the results from the winding plant will soon give the necessary data in order to come to a conclusion on this point. In most cases, but by no means in all, the addition of an equalising system will be required, but the cost of such a system will be many times repaid by the smaller power consumption in the power station, and the lower first cost of the prime movers, which need only produce the average load (about 25 to 30 per cent.), instead of being calculated to take the maximum power requirements. The ideal facility of control without loss is perhaps the most striking advantage of the Ilgner system. This system requires, however, direct-current motors, which are limited to a certain extent, owing to commutation difficulties, inertia of the revolving masses, &c. The first drawback can be overcome by the use of commutating poles and compensating coils, and the second by the subdivision into two or three motors. The first plant had three motors, but in all the later installations two motors have been found to be better. The excitation is either compound or shunt. The same remarks apply to the construction of the flywheel dynamo, which is subdivided for the same reasons. The broad design of the driving motors and their relatively small diameters brings the inertia moments down to about the same as that of the steel gear wheels between steam engine and mill. The absence of this gear is one of the advantages of the electric drive. In addition to what has been said with reference to the non-reversible motors, extraordinary stresses and jerks in the direction of the shaft have to be provided against. The frame and bearings of such motors are therefore often made of cast steel.

In conclusion, the author gave some comparative estimates for a steam and electrically driven mill of large size which went to show that with about the same capital expenditure an annual saving of about £3,000 per annum could be obtained by the adoption of electrical methods. The table opposite gives details of some important rolling-mill installations.

DISCUSSION.

The discussion was opened by Mr. S. E. FEDDEN (Chief Electrical Engineer, Sheffield Corporation), who complimented the lecturer on his Paper, which was full of practical and common sense information. He was generally in agreement with what had been said, and considered the figures had been given in a conservative spirit. Sheffield manufacturers had already grasped the fact that smaller plants could be more cheaply driven by electro-motors. Where 500 to 800 h.p. is required it would pay to put down plant and have a competent man specially told off to look after it, and make him responsible for the costs. Referring to driving by large gas engines, he was very much surprised at the amount of labour required to look after them in some of the Continental works, the cleaning also was a laborious and costly business. Twin-engines should always be used, as mentioned by the author. He was firmly of the opinion it would be more economical to put down an electrical power house and have only one spare set. He was in agreement with the author in advising the use of polyphase motors, and he did not consider high-tension motors any more dangerous than the ordinary transformers used in house lighting.

Mr. J. S. PECK (Westinghouse Co.) hoped the steel manufacturers would take some of the truths to heart and not let the Germans get ahead of them. He emphasised the fact that by electrical driving it was possible to know exactly what power was required and was being taken by any particular class of work. In driving three high mills it is necessary to slow down and this can easily be done with induction motors by inserting resistances in the rotor circuit.

Mr. ECKMANN (Manchester) criticised the author's figures with regard to the cost of the gas for driving gas engines, considering it too low. He also did not consider it a fair comparison when burning the blast furnace gases under the boilers; the proper place was in the engine. Referring to the advantages of electric driving, he agreed that a very important one was being able to know exactly how much power was being taken for each billet, as it was then possible to calculate the costs very closely and quote accordingly.

Mr. HOOGHWINKEL, in replying, was sorry the discussion had been so meagre. He had particularly desired to read the Paper in the heart of the steel industry, so that the subject might be fully discussed by those more intimately interested. He prided himself with only having quoted figures which could be fully substantiated by actual practice. Replying to a remark by Mr. Fedden, the load factor in a modern steel works was about 40 per cent., and in a colliery with which he was connected it was as high as 49 per cent. The actual works costs in some of the German works were from 0·25d. to 0·2d. per unit. The advantages of high-tension motors were largely in the superior construction of the switch gear and the smaller cables required.

YORKSHIRE ELECTRIC POWER CO.

THE report of the directors for the half-year ending December 31st, 1907, states that the company's business shows a steady and progressive improvement. The profit on the revenue account for the half-year amounts to £836 10s. 5d., as against a loss of £403 4s. 3d. for the preceding half-year. After payment of mortgage interest, the net revenue account shows a loss on the half-year of £139 2s. 11d., as against a loss of £1,211 3s. 9d. for the half-year ending June 30th, 1907. The loss made in the half-year occurred during the earlier part of that period; during the last three months the receipts have not only met all current expenses, but have been more than sufficient to cover mortgage interest in addition. The demand for energy from the company's mains is steadily increasing, and the directors anticipate with confidence profitable and continuous progress of the company's business for the year 1908. Up to December 31st last, agreements had been entered into with consumers for a total of 5,548 kw., being an increase of 2,426 kw. during the six months, which is a considerably larger increase than in any previous half-year. Amongst these new agreements is one with the "British Carbide Factories, Ltd.," who have leased for a number of years a portion of the company's land in close proximity to the generating station, and are now erecting buildings thereon in which calcium carbide will be manufactured on a large scale for the first time in Great Britain. They have contracted to take their supply of current from the company, and will be important consumers. A supply of energy is now being given to "Electrical Distribution of Yorkshire, Ltd.," in Farsley, Gomersal, Horsforth, and Liversedge, and a supply will also be given to the company in Calverley at an early date. During the half-year the Ravensthorpe Urban District Council have commenced to take a bulk supply of energy. The agreement with that Council, as in the case of the agreements with the Pudsey Corporation and the Mirfield Urban District Council, provides that the company may give a supply for power purposes direct to large power users. Terms have been arranged with the Brighouse Corporation by which they will close down their present generating station and will take their energy for tramway, power, and lighting services direct from this company. As the company has now reached the position of meeting expenditure out of revenue, the directors suggest that in future the general custom of electrical and industrial companies shall be followed and the report and statement of accounts issued to the shareholders yearly instead of half-yearly as hitherto. A resolution to this effect will be submitted for the consideration of shareholders at the meeting on the 18th inst.

The revenue account shows that generation and distribution expenses amount to £5,190 11s. 2d., made up as follows:—Coal and coal handling, £1,740 15s. 10d.; oil, water, and engine-room stores, £55 3s.; proportion of salaries of engineers and officers, shift wages, &c., £1,075 0s. 2d.; maintenance and repairs, cost of work done for consumers, and sundry expenses, £2.321 12s. 2d.; managements and general expenses amount to £1.266 11s. 10d., the items being rents and wayleaves, £36 13s. 9d.; rates and taxes, £55 15s. 1d.; directors' fees (travelling expenses), £15 9s.; salaries and managing engineer, secretary, clerks, canvassers, &c., £629 12s. 10d.; stationery, printing, and advertising, £128 1s. 9d.; telephones, postages, and general establishment expenses, £181 2s. 4d.; auditors of company, £10 10s.; law expenses, £160 9s. 10d.; insurances, £48 17s. 3d. The total expenditure is therefore £6.457 3s. The receipts amount to £7.293 15s. 5d., viz.:—Sale of energy, £4.836 10s. 7d.; rentals of meters and other apparatus, £43 6s. 6d.; work done for consumers, £2,331 14s. 3d.; transfer fees, 15s.; sundry receipts, £81 7s. 1d., leaving a balance to be carried to net revenue account of £836 10s. 5d. The interest

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on mortgage amounts to £973 13s. 4d., making the loss already referred to of £139 2s. 11d.

The total capital expenditure during the half-year was £3,746 2s. 6d., as follows :—Buildings, £47 7s. 2d.; machinery, £126 6s.; mains, £1,331 19s. 9d.; transformers and motors, and meters and installations on consumers' premises, £2,203 19s. 1d.; electrical instruments, £11 18s. 5d.; furniture, fixtures, utensils, &c., £214 12s. 1d. The total expenditure to December 31st, 1907, is :—Land, £6,773 16s. 0d.; buildings, £21,296 9s. 1d.; machinery, £71,413 13s. 7d.; mains, £90,999 0s. 4d.; transformers and motors, and meters and installations on consumers' premises, £18,014 18s. 7d.; electrical instruments, £8,165 8s. 11d.; furniture, fixtures, utensils, &c., £1,327; making a total of £217,987 6s. 6d. To this is added the sum of £67,522 4s. 1d., costs of promoting special Act and formation and preliminary expenses incurred by the Yorkshire Electric Power Syndicate, Ltd., and allotment of 2,000 fully paid shares in consideration of services rendered as per agreement, making a total of £285,509 10s. 7d. The total capital issued to date is £298,750, consisting of 25,875 ordinary £10 shares and £40,000 mortgage, leaving a balance of capital account of £13,240 9s. 5d.

NEW POWER STATION AT SALT LAKE CITY

A DESCRIPTION of a new steam-driven generating station under construction at Salt Lake City, Utah, U.S.A., which will form an auxiliary to a group of four water power stations, is given in the *Western Electrician* (Chicago). The plant is designed for a capacity of 6,000 kilowatts in six units—four of 1,250 kilowatts each and two of 500 kilowatts each. A plan of the station is given in Fig. 1.

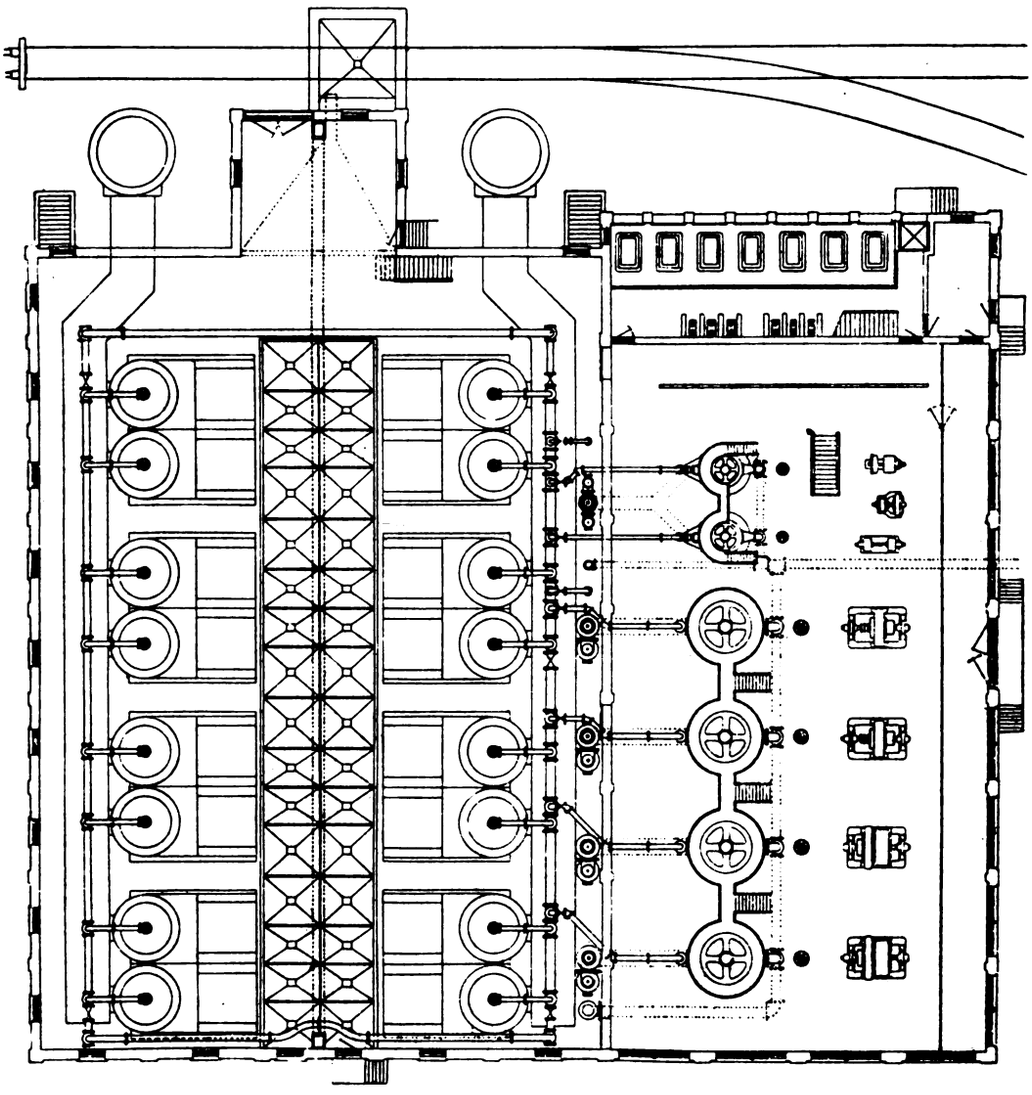


FIG. 1.—PLAN OF THE GENERATING STATION.

The boilers are of the Wickes water-tube type, which is a somewhat unusual pattern, with long, vertical straight tubes, set in two rows of eight boilers each, with two boilers in a battery. The rated capacity per boiler is 400 horse-power. Each boiler is equipped with a Murphy automatic furnace, and each battery is driven by a separate stoker engine. Natural draught is obtained by two reinforced concrete stacks, 200 ft. high. Each stack will accommodate one row of boilers, although they will be cross-connected for convenience in cleaning, &c. Each row of boilers is being equipped with its own feed-water heater and pumps, and when complete the heaters and pumps will be cross-connected, so as to obtain greatest flexibility. Space is left in rear of boilers for economisers, to be installed later. The boilers are designed for a working pressure of 175 pounds. On account of the company doing a public-heating business, the ratio of boiler horse-power per kilowatt is somewhat large, and also allows for the absence of superheating surface. The condensers are of the barometric type, and ordinarily supplied by steam pumps placed in the basement over cisterns into which are connected artesian wells.

A section showing the arrangement of the boiler is given in Fig. 2.

The present installation in the turbine room consists of a pair of 500-kilowatt, two-stage Curtis turbines, equipped with one motor-driven exciter and one turbo-exciter. One or two of the larger generators will follow immediately. For the direct-current power load a rotary converter will be installed, which, with compensator, will supply the 440-220 direct current. The generators are wound for 2,300 volts, three-phase, 60 cycles, and will run at a speed of 1,800 revolutions per minute.

The turbines are specially designed to operate in connection

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with central-station heating, and will furnish exhaust steam at the required pressure from the first stage. The second stage is regularly equipped with condensers. The pressure from first stage leading to heating mains will be controlled with a special automatic reducing valve. The second stages of the 500-kilowatt turbines will be connected to a twin condenser of the Baragwanath manufacture. The first stages are connected into a common exhaust header, so arranged that the feed-water heater will float with the heating mains, and into this same header all the auxiliaries will discharge their exhaust. A combination back-pressure and relief valve is provided, both in first and second-stage exhaust lines.

The main switchboard, situated on the turbine-room floor, will consist of the regular generator, exciter, and feeder panels, together with the panels for receiving the current from the hydro-electric plants.

After leaving the switchboard, the feeder wires lead directly to a tunnel for general distribution, and the lines leading to high-tension apparatus lead directly through fireproof wall into special compartments. These compartments will contain seven 1,000-kilowatt, 33,000-volt transformers, the necessary oil switches for both the high and low sides of transformers, lightning arresters, disconnecting switches, coils, and a complete bus-bar arrangement for either one or two three-phase, 33,000-volt incoming circuits on either one or both banks of transformers. One spare transformer will be in readiness to throw into the circuit at any time without undue interruption in service.

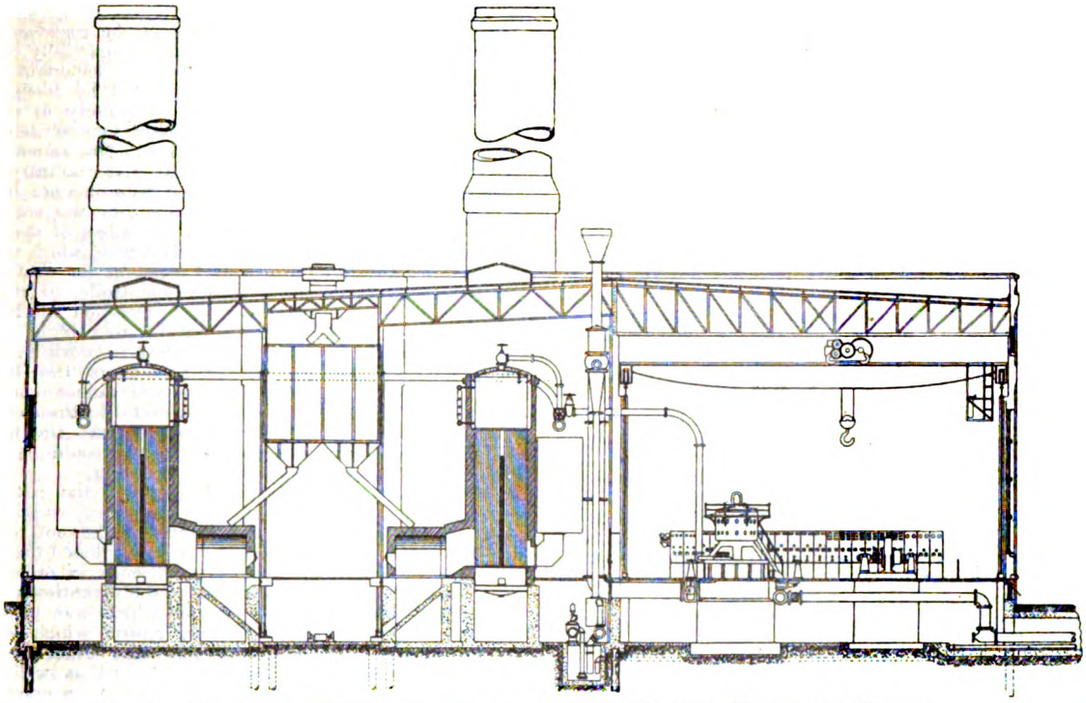


FIG. 2.—SECTION OF GENERATING STATION SHOWING VERTICAL WATER-TUBE BOILERS.

THE NEW PATENT LAW

MR. J. W. GORDON read a Paper on the new Patents and Designs Act before the Royal Society of Arts last week. He expressed the opinion that the language of the clause in the Act enabling procedure to be instituted for the revocation of a patent if it was not worked in this country was ambiguous if taken by itself. Thus he gives as an example the patent originally granted for the telephone and phonograph: "In these days the two instruments would probably be held to be different inventions, but when both were new the telephone, naturally enough, was regarded as a phonograph worked by electricity, and the phonograph as a mechanical telephone. Both instruments were comprised in one patent grant, but they gave rise to totally distinct manufactures. Would the fact that the one instrument might be mainly manufactured within the realm in such a case be held sufficient compliance with the Act, even although the other—the really important manufacture, suppose—was carried on exclusively abroad? If not, must the rule be applied distributively to all the separate claims made under a patent, and the patentee called on to show that his invention, in every separate application of it, is carried on mainly within the realm?"

"It is very difficult to see," the author continued, "if the language of the Act alone be considered, how this question should be decided. But when we know that the demand for legislation in obedience to which this Act was passed was a demand that every patentee should be required, subject to certain allowances, to perform the duty of introducing his patented improvement into the manufactures of this country, it becomes easy to decide between the two views. The real question, then, is not whether the major part of the work connected with the carrying out of a patented improvement has been done here or there, but whether the improvement itself in its entirety has or has not been fairly introduced into this country. If a patentee who by manufacture elsewhere has demonstrated his ability to bring his invention into use, shirks his responsibility so far as this country is concerned, that will be a good ground of revocation. While thus the principle may be identified with some confidence, it must be admitted that the Act will probably be a very difficult one to work. The criterion indicated—that of the preponderance of the manufacture carried on abroad—is one which affords but a very imperfect test of the matter which is essentially in question. There are very many manufactures, and with the spread of industrial enterprise over the whole world their number is daily increasing, in which it is impossible for this country to have a main share of the industry. Let me take by way of illustration the printing trade. That is one which is carried on by very elaborate mechanical appliances to the perfection of which a great deal of inventive industry has been recently applied and is being applied at the present time. Take the case of some valuable invention in connection with type setting or printing machinery. There is, of course, an enormous market for such an invention in this country; there is a market still larger in America; there is, it may be, a market larger yet on the Continent of Europe. Now, if the supposed invention is of sufficient importance and sufficient merit to make its way in all these different countries, it is not to be supposed that it could be mainly carried on within the United Kingdom. No patentee could be expected to bring about such a result as that."

No review of the New Patent Act would be complete without a reference to the question of compulsory licences, although, as is pointed out in the Paper, they were recognised in the Act of 1902, and the present Act only facilitates procedure in obtaining them. "The only tribunal," the author said, "which is favourably circumstanced for deciding upon the question of granting a compulsory licence in the High Court. The question of a compulsory licence invariably arises in connection with the question of the infringement of some specific patent. Now, as a rule, the manufacturer or dealer, as the case may be, proceeds

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about his ordinary business in happy ignorance of the patent rights of other people. The small manufacturer cannot afford to spend the time necessary to make himself personally acquainted with the Patent Office file, nor can he afford the expense of keeping an expert staff at work upon the file for his information. He must, therefore, take his chance in patent cases, and he does. Every now and again it happens that he gets a threat of proceedings, and is warned to desist from some manufacture in which he is actually engaged. It is then that the question of compulsory licence arises in an acute form. It may very well happen that the manufacture which is the object of attack, is the result entirely of his own industry and invention. The effect which our law gives to patent rights, enables a patentee, in many cases, to exercise control over not only the industry which he may himself have created, but also, by means of what is known as a master patent, to enjoy rights in the tributary inventions and manufactures of other people. In the aggregate these tributary inventions, sometimes improvements upon a patented invention, sometimes themselves wholly independent inventions, form a very important branch of our manufacturing industry."

The author does not expect, however, that the chief effect of the provision relating to compulsory licences will be made manifest by actual litigation. The knowledge that such a remedy exists will incline both patentees and manufacturers to agree with one another, and to do by voluntary arrangement what they can be compelled to do by process of law.

The author next expressed the opinion that the clauses of the Act designed to prevent the imposition of oppressive conditions in the terms of licences had been drafted with very special care, and set out with great fulness and exactitude the precise intentions of the Legislature. At the same time, he added, an operation, even though skilfully performed upon so delicate an organism as the contractual relations of tradesmen and manufacturers with one another, must always be attended with risks, and perhaps the most it was possible to say at the moment about this provision was that it had been very carefully elaborated, with the object of preventing a very formidable mischief, and that both its practical importance and its theoretical interest would make the working of the system an object, for many years to come, of lively interest to all who are concerned in the working of our Patent law.

Dealing with the power to award costs, now for the first time conferred upon the Comptroller, Mr. Gordon pointed out that it was a new departure from the settled policy of former Statutes, and he criticises it for the following reason:—Opposition to the grant of a patent or amendment of a specification is based not usually on grounds of right, but on grounds of technical propriety. The patentee, for instance, who opposes a subsequent grant on the ground of a grant previously made to himself, does not by the result of his opposition, even if successful, in any way increase his own rights. On the other hand his action in a proper case does enable the Patent Office to exercise its powers with better discrimination than would be possible without such assistance. It is a public duty which the opponent fulfils, although he is usually animated in the performance of that duty by the expectation of securing some private advantage in the result. Now, it may indeed be said that it is quite right that a man performing a public duty should be secured against expense in doing so. But it is not equally easy to make out the proposition that the indemnity to him should be paid not out of public moneys but out of the private purse of the applicant for a patent. It is, of course, obvious that if the applicant is seeking some advantage to which he is not entitled, it would be reasonably fair that the necessary expense of restricting his claims to what is properly allowable should be charged to himself, but, on the other hand, he pays a sealing fee which is sufficient, on an average, to defray the expense of all the proceedings considered necessary at the Patent Office to secure the proper limitation of a patentee's claims.

Consideration of this question led the author to the matter of the search for anticipation instituted by the Patent Office, which, he said, resulted in the cost of a British patent being greatly less than that of obtaining a disputed patent in any other considerable country in the world. Patents of addition, however, were criticised, and the author found it difficult to understand their purpose.

DISCUSSION.

The CHAIRMAN (Sir William Preece) said that the Act did not meet the case where an applicant for a patent was bothered by some vexatious claim by somebody with an imaginary anticipation. There was a class of cranks, well known to patent agents, whose sole object appeared to be to lodge claims for priority on absolutely no justification whatever. They delayed the issue of the patent, and caused a great deal of trouble, as well as expense. If such people were promptly mulcted in costs, he thought the number of those vexatious appeals would be diminished.

Mr. WALTER F. REID, F.I.C., pointed out that very great power had been put into the hands of the Comptroller, and he hoped it would not be used in such a way as to countenance objections. It was well known, however, that some of the objections in the Patent Office to trade marks were absolutely childish, and if that sort of thing was to happen with regard to patents, the sooner another Act was passed doing away with the control of the Comptroller the better it would be. The author had, to illustrate one of his points, mentioned the utilisation of water-power for the fixation of the nitrogen of the air. It might interest him to know that water-power had not such a monopoly of the industry as had hitherto been supposed, because a large company would shortly be at work which would utilise coal for the same purpose, in the confident belief that coal, under certain conditions, could commercially compete with water-power. There was one extremely important reason why such a patent should not be controlled by foreign countries, but that the working should be compulsory in this country, viz., that England was at the present time entirely dependent for its explosives on foreign countries. Not an ounce of explosives could be made in England under the ordinary commercial conditions without using nitrate of soda obtained from abroad.

Mr. J. F. ISELIN said he was afraid he was not in harmony with the previous speakers as to the effect of the Act, which contained two important points. The first, which was the most important, was the forfeiture of a patent for want of working, and the second, the power of the Comptroller to refuse a patent altogether. A man who made an invention which was useful only to one manufacturer might be told if he went to the manufacturer, "You have no capital to work this invention; why should I pay for it? In four years' time the invention will fall into my hands, because you cannot work it in this country." Or, if the invention was useful to three or four manufacturers, they could form a ring against the inventor. He believed that exactly the same benefits could be obtained by means of a system of compulsory licensing.

Mr. H. FLETCHER MOULTON said, like the last speaker, he was considerably afraid of the compulsory working proposals, not because he thought the patents ought not to be worked in this country, but because the Act abandoned the very obvious and proper system of compulsory licence in order to try and force the starting of the working of the invention simultaneously in all the countries of the world, which was in most cases a practical impossibility. The only reason which could be suggested for such a procedure was that other countries were trying it, and that England might just as well be forward in the race; but it was perfectly impossible in practice to expect that a complicated invention, like the linotype machine, for instance, could be manufactured in three or four years in a dozen different countries. He very much regretted that, instead of trying to improve the machinery of the compulsory licence, it had been pushed to the background. The same remark applied to the clause dealing with restrictive covenants. The introducer of the Bill did not seem to realise that he was handicapping, not so much the patentee, as the person who wanted to get a licence under it, by saying that no licenses should be granted on the terms that all the machinery was to be taken from one particular man. He heard the Act described by Sir Joseph Lawrence at the Imperial Industries' Club as a layman's Act. The author and many others present remembered with gratitude other laymen's Acts, such as the Workman's Compensation Act, which had provided a very deserving class with their living for some years past, and he trusted the new Patent Act would have the same effect.

Cellulose Acetate as Insulation for Wires.—An article by Mr. R. Fleming in the *General Electric Review*, abstracted in the *Iron and Coal Trades Review*, deals with the suitability of cellulose acetate as an insulating covering for wires. The new material is claimed to have a high degree of elasticity and high specific resistance, and it is said that very even coatings can be applied to fine wires. It is particularly suitable for wires from No. 35 to No. 40 B & S gauge, and has been used with success for the windings of meter armatures. The thinness of the coatings, which for 0·003 in. diam. wire need not exceed 0·0005 in., as compared with cotton or silk insulation, renders a much better space factor obtainable. Another great advantage of acetate wire is that it is not affected by ordinary atmospheric conditions. Complete drying and impregnating processes are necessary for fibrous insulations, if long life is to be expected of them. In the Lynn acetate wire-coating machines the solution automatically passes from the mixing reservoirs to the coating portion of the apparatus. Here, by a system of transfer wheels, the solution is applied to the revolving coating roll, which, in turn, deposits it on the moving wire. The quantity of solution placed on the wire must be adjusted to a nicety; therefore, mechanical scrapers are employed, which remove the excess and leave just the proper amount to be deposited. After receiving its coating of solution, the wire passes through the oven at the rate of several hundred feet per minute. The volatile solvent is here driven off and the coating hardened, after which the process is repeated until numerous coatings have been applied. This method insures an even distribution of the film over the whole surface of the wire. To keep the fine wire moving at such a high rate of speed a very delicate adjustment of the moving parts is required, for the slightest unevenness of motion is sure to break the wire. This is prevented by friction drives and friction tension devices, which insure a uniform motion.

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WATER-POWER STATIONS OF THE SOUTHERN POWER CO., OF AMERICA

IN a short note in ELECTRICAL ENGINEERING, January 2nd, page 24, entitled "Power Developments in South Carolina," we referred to the large water power scheme of the Southern Power Company being pushed forward in that district, partly to cope with the growing demand for electrical energy for textile factory driving in what is known as the Piedmont region. Some further particulars of the companies' undertaking are given in the *Electrical World* (New York). Electrical energy is now distributed to Charlotte, N.C., the company's headquarters, from the Catawba River, eighteen miles away, for operating street railways and for feeding lamp and motor circuits. Other towns in the vicinity where energy from the same source is available are Concord, Rock Hill, Kanapolis, and Statesville. The company charges $20 per horse-power per year for energy used 11 hours a day six days a week. Steam power, under most favourable conditions, is stated to cost about twice as much.

The Southern Power Company already has in operation two large electric plants, one called "Catawba" is rated at 10,000 horse-power, and the other, known as the Great Falls Plant, has a rated output of 40,000 horse-power. The company is now carrying out plans for the development of 200,000 horse-power. It controls nine separate sites in the Piedmont section, where rapids occur between the head waters and the lowlands over a distance of 110 miles in all, and with an aggregate fall of nearly 1,000 ft. A new plant, rated at 40,000 horse-power, is building at Rocky Creek, and another rated at 24,000 horse-power, is building at Ninety-Nine Island, near Spartanburg. Similar developments are planned at other points in the river.

Of the different power sites, controlled by the company, the one known as the "Great Falls" of the Catawba River offered the best opportunity for the initial development; so the work was begun here first. A railroad twelve miles in length was built to connect the Great Falls site with the railway centres of the State, and to furnish transportation facilities for material of construction.

Before development, the Great Falls comprised a series of falls and shoals having a total head of 176 ft. over a distance of eight miles, for the full utilisation of which three separate developments will be required. The middle one, with a head of 72 ft., and receiving the run off from a drainage area of 4,200 square miles, is known as the Great Falls Station, and has just been placed in service. It is located on one side of an island, known as Mountain Island. A low spillway dam was erected across the river at the head of the island to deflect the entire volume of the river into the western channel. Across the western channel near the foot of the island is built a 30-ft. spillway dam, this dam deflecting the water into an almost natural canal which carries it about 1¼ miles, at which point is located an enormous retaining wall across the natural valley. Built into this retaining wall are eight 5,200-h.p. hydraulic turbines of the twin horizontal type, enclosed in steel cases 15 ft. in diameter by 19 ft. long. Steel feeder pipes of 7-16 in. plate are encased in the retaining wall, these feeder pipes being elliptical in form at the intake; dimensions, 16 ft. × 18 ft., gradually narrowing down to 15 ft. in diameter where the feeder enters the wheel case. The draft tubes are also built of 7-16-in. sheet steel, and are 11 ft. in diameter at the wheel case, gradually increasing to the point of discharge, where they are elliptical in shape, 11 ft. × 18 ft. A special feature in this construction is a tunnel extending the entire length of the power house through the retaining wall and behind the turbine cases. By this method of construction the usual outboard water bearing is replaced by an oil bearing, which may be easily got at and inspected. This tunnel also makes it much easier to get at any part of the wheels when necessary. Both bearings are rigidly connected to the head, the outer bearing being designed to take up the end thrust of the wheels. The gates are of the swivel type, and so designed as to give the maximum efficiency at approximately three-quarter gate, which represents full load on the generators.

The two turbines for operating the exciters are similar in construction, and are rated at 700 horse-power at 450 r.p.m. under a working head of 72 ft. At the intake the feeders for the exciter turbines are 6 ft. × 9 ft., gradually tapering to 6 ft. in diameter at the wheel case. All feeder pipes are equipped with manholes and vent pipes. The draft tubes are 5 ft. 6 in. in diameter at the case, flaring out to 10 ft. in width at the discharge end.

The 5,200-h.p. turbines are direct connected to 3,000-kw., 60-cycle, three-phase, 2,300-volt generators and the two exciter turbines to 400-kw., 240-volt direct-current generators.

The switchboard is mounted on a gallery which stands about 6 ft. above the main station floor, thus giving ample space below for all cables, which are placed in racks on either side, the direct-current cables being on one side and the alternating-current cables on the opposite side. Behind the switchboard is the transformer house in which are placed four banks of transformers, each bank consisting of three 2,000-kw. oil-insulated, water-cooled transformers, which step up the potential to 44,000 volts. The transformer casings are designed to withstand a pressure of 150 lb. per square inch, and are equipped with relief valves connected to a vent discharging outside of the building. The transformers are mounted on flanged wheels, and stand in their respective compartments on rails supported on concrete pedestals. A pipe system through which carbon dioxide may be admitted in case of fire connects all the tanks. The gas generator and pressure tank are placed in the basement, and in addition to the transformer connections a pipe extends to the second storey so that any apparatus on this floor may also be deluged in carbonic acid gas in case of necessity. The oil for the transformers may be supplied by gravity feed or by a pressure feed from a tank outside. By reversing the direction of rotation of the pump the oil may be withdrawn from the transformers and, after passing through a filter, returned to the storage tank. Connections are also provided for discharging the oil into the tail race. An electrically-driven triplex pump supplies oil to the high-tension apparatus on the second floor of the transformer house through two pipe leads terminating in hose bibs in floor boxes.

Each generator is controlled through an instrument post and switch pedestal. Each post is equipped with an ammeter, voltmeter, wattmeter, and field ammeter, and in addition there are two synchronisers, two frequency indicators, and four bus-bar voltmeters distributed among the several posts. Each control pedestal is equipped with a remote-control switch for operating an oil circuit-breaker, one field switch, a rheostat hand wheel, an eight-point voltmeter receptacle, a meter shunt, and a lamp reflector.

The main switchboard contains two transformer panels, two double-circuit feeder panels, one station panel, and two blank panels. Concrete slabs are used in the low-tension bus-bar and oil switch structure, the cells in the sub-structure containing the oil switches and the busbars being housed in compartments above these. The bus-bars are cut into two sections by an oil circuit-breaker; and each section may be further divided by means of selector switches.

The high-tension transformer leads are taken through wells in the floor of the second storey, and connect through oil switches to the high-tension busses or feed direct to the line. The current for operating the high-tension circuit-breakers is obtained from oil-insulated series transformers. Oil-insulated choke coils are placed between the transformers and the oil switches to relieve the former of the strains due to surges in the line. Lightning arresters of the single-pole, low-equivalent type are installed.

Four sets of outgoing lines are used for distributing the energy, a double steel tower being used for supporting this line.

Besides the Great Falls station, the Southern Power Company has ordered six 5,200-h.p. and one 700-h.p. twin horizontal turbines, which will be exact duplicates of the Great Falls turbines for the new Ninety-Nine Island station. This station will be located on the Broad River nine miles above Blacksburg, S.C. Work is now being pushed on this development, and everything will be rushed as rapidly as possible to completion. The other developments will be taken up in order and completed as rapidly as possible. It is stated that when all of the developments of this company are completed they will have carried out not only the largest power scheme in the Southern States, but one of the largest in the world.

Electric Heater.—A new form of water-heater is described in the *Electrical World* (New York). The water circulates between two cylindrical carbon electrodes, the gap between which is from 1-8 in. to 3-32 in. The electrical energy is thus converted into heat energy directly in the water, and radiation and conduction losses are reduced to a minimum. When applied to a bath or wash-basin, the handle which turns off the water also opens the circuit. This form of heater has been successfully used in conjunction with hot-water radiators for heating purposes. The heater is made in various sizes, the largest being for 20 amperes at 220 volts, and the smallest for 4 amperes at 110 volts.

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ELECTRICAL EQUIPMENT OF THE STUYVESANT THEATRE, NEW YORK

ONE of the most complete electrical equipments ever built for a modern playhouse has been installed in the Stuyvesant Theatre, New York. The interior illumination has been carried out in accordance with suggestions from Mr. Belasco, and is described in the *Electrical World* (New York) as restful and pleasing.

The stage is equipped with 84 arc and incandescent pockets, each of which is rated at 50 amperes. The pockets are placed in the stage floor, and in the floor of the spot-light gallery, erected for this particular purpose.

The entire lighting is controlled from a special stage switchboard, arranged so that all the switches can be controlled individually, collectively, or in any desired combination at will. The board is of slate, with the various operating levers, gang shafts, and sectional shafts mounted thereon. It is supported on a heavy, angle-iron frame about 2 ft. from the proscenium wall on the lighting bridge. The switchboard platform consists of a large slab of white marble, and is 12 ft. from the floor.

The dimmer handles and shafts are mounted directly above the board and can be manipulated similar to the switchboard section. The dimmers are of the Ward Leonard type, mounted above the stage switchboard, and are operated by means of steel rod drives.

A large distribution box is installed directly underneath the marble switchboard floor. It is divided into sections and provided with doors for the purpose of easily getting at the wiring. The wires in this box are tagged and numbered for convenience in making repairs quickly. The centre of distribution for the auditorium and stage lamps is under this box, so that should a fuse in any section or circuit blow, another can be easily inserted.

The stage arc lamp pockets are of the most recent type. A three-wire circuit is run to the main centre of distribution from each pocket and this circuit is protected by a 50-ampere fuse. The incandescent lamp pockets are similar in construction and wiring and are arranged with dimmers on each outside wire, so that one half of the section may be separately dimmed from the other half.

The lighting bridge is a special novelty, and on each side of the stage there are mounted eight 50-ampere arc lamp pockets, making a total of 16 for both sides, for the purpose of concentrating a powerful illumination upon the stage.

There are five borders, each consisting of 72 white, 60 red, 60 blue, and 65 amber incandescent lamps, all of 32 candle-power. There is also a large panorama border of 220 32-c.p. lamps, arranged in a semicircle. The border lamps are fed from a 48-strand flexible border cable carried in conduit from the main centre of distribution to the gridiron, whence the wires drop directly over each border, terminating in a splicing and pull box. Near the end of the pull box, each border cable is securely fastened on the steel border cable by means of a 2½-in. split wire grip laced in the centre so that it is impossible to pull the cable away from the splicing box. Specially designed sheave wheels are also provided for the purpose of having the slack constantly taken up, so that the raising and lowering of the cable will not in any way interfere with the scenery. This also guards the cable against mechanical injury. The borders are suspended from four large strain bolt insulators, secured to steel cables running up to the gridiron, so that they are perfectly insulated.

The double border strips have wires with slow-burning insulation. The wiring is so arranged that each border is divided in two sections. Consequently one half can be operated from the stage switchboard separately from the other half, in order to get the lighting effect desired.

The footlights are made up of four rows of coloured lamps, the number of which is approximately the same as in each border. Instead of the usual galvanised metal gutter, the lamps are wired in conduit with iron boxes, and so arranged that each circuit runs down to the apron of the wiring gutter which is about 32 ft. long, and is arranged with sliding covers for the purpose of getting at the different circuits, so that should a wire break through accident, or a short circuit be caused by mechanical injury, repairs can be made in a very short time. All circuits from this wiring gutter built in the apron of the stage terminate in the centre of distribution, and the main leads run to the main switchboard through dimmers, and are controlled in sections or all together. To the left of the board there is a five-compartment signal cabinet and the wiring is arranged so that when a push button is pressed underneath each lamp compartment, a lamp will flash at a distant point, and at the same time will indicate on the signal cabinet that the signal has been received, at the stage, each fly gallery, rigging loft, on the opposite side of the stage, or in the musicians' pit, as the case might be.

In addition there are speaking tubes and buzzers running to each of the above-mentioned points, should the signal cabinet fail to work. There are also mounted on the signal cabinet 24 buzzers for signals to the occupants of the dressing-rooms, and six chimebells distributed throughout the auditorium, lobby, &c., for the purpose of notifying persons there that the curtain is about to rise. The bell and telephone system is supplied by a motor-generator situated in the chief electrician's room, where the main meter and distribution board is also placed. The latter is a large marbleised slab switchboard with angle-iron frame and enclosed with steel sides and doors, and with a rolling shutter in front. There are five meters, eight motor-switches, and nine three-pole lighting switches mounted thereon. There are two 1,500-ampere main feeder switches, for the control of the entire circuits throughout the building, each of which is connected to a separate service from the illuminating company's mains. The 1,500,000-circ. mil feeder leading to the theatre board runs in iron conduit underneath the auditorium floor to the main centre of distribution behind the stage, where it connects with two sets of bus-bars. The "front-of-house" board controls 38 circuits for all exit, stairs, lobby, and front-of-house lighting, and this panel is supplied by a separate connection from the Edison company's service.

Perhaps the most novel and pleasing feature of the lighting scheme is found in the auditorium dome. There are approximately 400 incandescent lamps installed behind octagon-shaped art glass panels in the ceiling of the auditorium, the light being diffused through these panels.

The other lighting fixtures are for the main part of the concealed type, and in no case are the lamps visible in the auditorium. There are eight special column caps of glass in the auditorium of antique design, which have 36 32-c.p. lamps concealed in each. All balcony and box lamps are concealed in bowl-shaped fixtures of glassware of novel design.

The theatre is also equipped with inter-communicating telephones wired in iron conduit, with 34-strand special telphone cable.

In the basement of the theatre is installed a triplex, direct-connected, 25-h.p. fire pump, and a switchboard is installed for the automatic control of the motor. The motor is also provided with a hand starter, speed regulator, and a pressure regulator which starts the motor as soon as the pressure is below the requirements of the fire department; besides this there is a fire alarm system directly connected to the city fire-engine house.

For the heating and ventilating system there are installed an 84-in. blower which forces the hot or cold air to the auditorium, and a large exhaust fan in the dome of the auditorium, for the purpose of ventilating the entire house. The fans are direct-connected to motors of the enclosed type. In the centre of the stage is a large electric elevator for lowering all properties to the basement and sub-basement for storage. The elevator is equipped with controlling devices, and is provided with a mechanical safety clutch. The total travel is 32 feet.

Government Control of Niagara Electric Power.—It is stated that Mr. Steele, President of the Toronto Chamber of Commerce, has agreed to start a movement having for its object the Government ownership of the electric power plant at Niagara. It is claimed that the Falls would be safeguarded by such an arrangement, and that a better management of the plant in the public interests would also result.

The Indian Electricity Act.—We understand from an Indian correspondent that, owing to difficulties having arisen regarding the grant of powers to certain companies wishing to supply energy in bulk in India, a committee was formed in 1907 to make suggestions for the necessary amendment of the Indian Electricity Act, 1903. The committee found that in various other points the Act had either shown itself to be defective or would in course of time do so, and suggested a number of other amendments; and they also suggested that in place of the Act being administered by the local governments of the various provinces and administrations—over a dozen—it should, for the present, be entirely administered by the Governor-General in Council. Under the existing Act anomalies occur owing to a reservation regarding places in military occupation, which can only be licensed by the Government of India, whereas such areas may, and often do, exist in the middle of a town where a licence has been granted by a Local Government. Confusion is bound to occur in cases like this, and those who put money into the undertakings are apt to become alarmed. The various proposals of the Committee of Amendment have been submitted to Local Governments and Chambers of Commerce, and, so far as information is available in the Press, have met with very general acceptance.

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THE BERRY SERIES TRANSFORMER SWITCH FOR SAVING LIGHT LOAD LOSSES

A NUMBER of attempts have been made from time to time to improve the overall efficiency of alternating-current distribution systems with transformer sub-stations, owing to the heavy "light-load" losses entailed by the all-day use of transformers of sufficient size to deal with the maximum or "peak" load, especially in the case of a purely lighting load. A method which has obviated some of the difficulties met with in earlier attempts, and has met with a good deal of success in this direction, is the "series system" designed by Mr. A. F. Berry. Although primarily devised with the object of minimising light-load losses, the use of the apparatus introduces, as we shall see hereafter, other advantages in the directions of improved voltage regulation, and the possibility of employing transformers of not only better design, but even smaller size for the same work than would be otherwise required. The conditions under which the transformers work are also more conducive to their long life.

Briefly, the general principle of the system is the provision in a sub-station of a small auxiliary transformer, so arranged with its primary and secondary windings in series with those of main transformer that it takes practically the whole of the load when light, but is cut out by an automatic switch when the load rises above a certain value. The scheme in its simplest form is shown diagrammatically in Fig. 1. This represents a sub-station with a single main 100-kw. transformer for 2,000/200 volts, and an auxiliary 10-kw. transformer. A little reflection will enable one to see that when the two are in series with the switches P and S open—as shown in the diagram—practically the whole of the voltage will be across the terminals of the smaller unit, owing to the relative impedances of the windings of the two. In such circumstances, therefore, the magnetisation cycles of the large transformer will be in that region of its curve below the steep part where hysteresis is practically non-existent. The small transformer will be taking such load as there is, and the magnetising current, which the station is called upon to supply, is only that corresponding to the 10-kw. transformer instead of, as would otherwise be the case, the 100-kw. unit.

When the load increases to an amount for which the capacity of the small transformer is insufficient, the relay solenoid, A, which, for convenience, is shown in two places in the diagram, in order to indicate its position both electrically in the primary circuit, and mechanically in the control apparatus, comes into action. It draws down the lever arm and causes the lower carbon contact, C_2, to close. This energises the lower coil, K_2, of the actuating magnet, M, so that the movable armature is raised, and the switches, S and P, closed, thereby short-circuiting the primary and secondary of the small transformer simultaneously. The whole load is then taken by the large unit in the usual way. As will be seen, the mechanical construction of the switch is such that, when once on, no further force is required to keep it closed, so that the current can be cut off from the operating coil as soon as the switch, S, is closed. For this purpose a rocking lever, R, is provided, carrying a carbon contact at each end. When the plunger rises, the left-hand contact shown closed in the diagram opens and breaks the circuit of the lower operating coil, while the right-hand contact switches in the circuit of the upper operating coil, ready for use when the time comes to open the switches. When the load falls to a value which the small transformer can deal with, the relay arm rises and closes C, energising the upper operating coil so that the switches S and P are pulled off. As soon as this is done, current is cut off from the coil by the lever, R, as before. It will be seen that, as the current is not kept on to the operating coil more than momentarily, a pretty strong current can be used without appreciable losses, so that the forces dealt with can be large, and the construction of the apparatus robust.

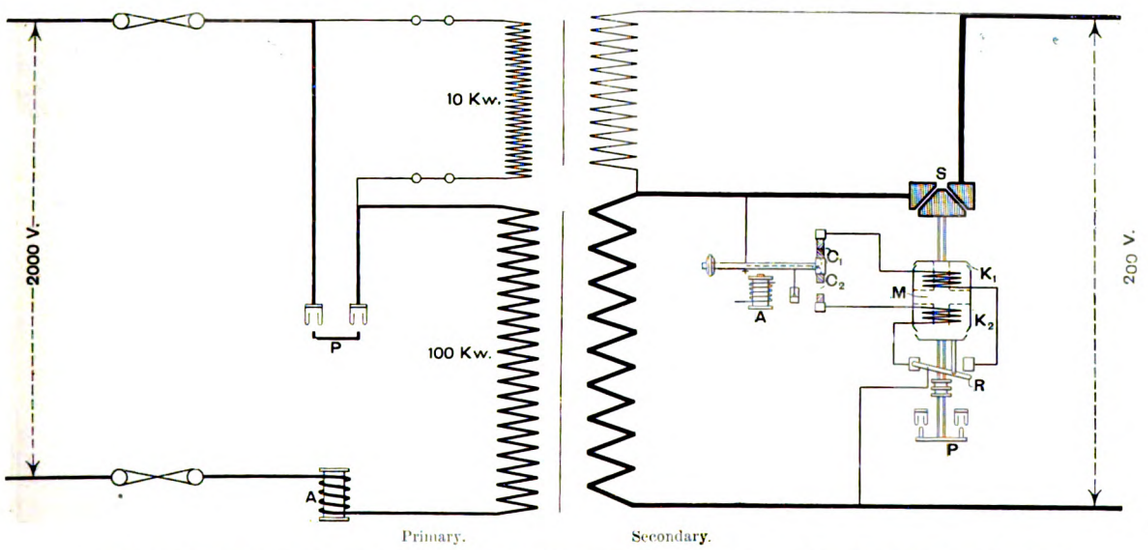


Fig. 1.—Diagram of Connections: Berry Series System for Two-wire Single-phase Circuit.

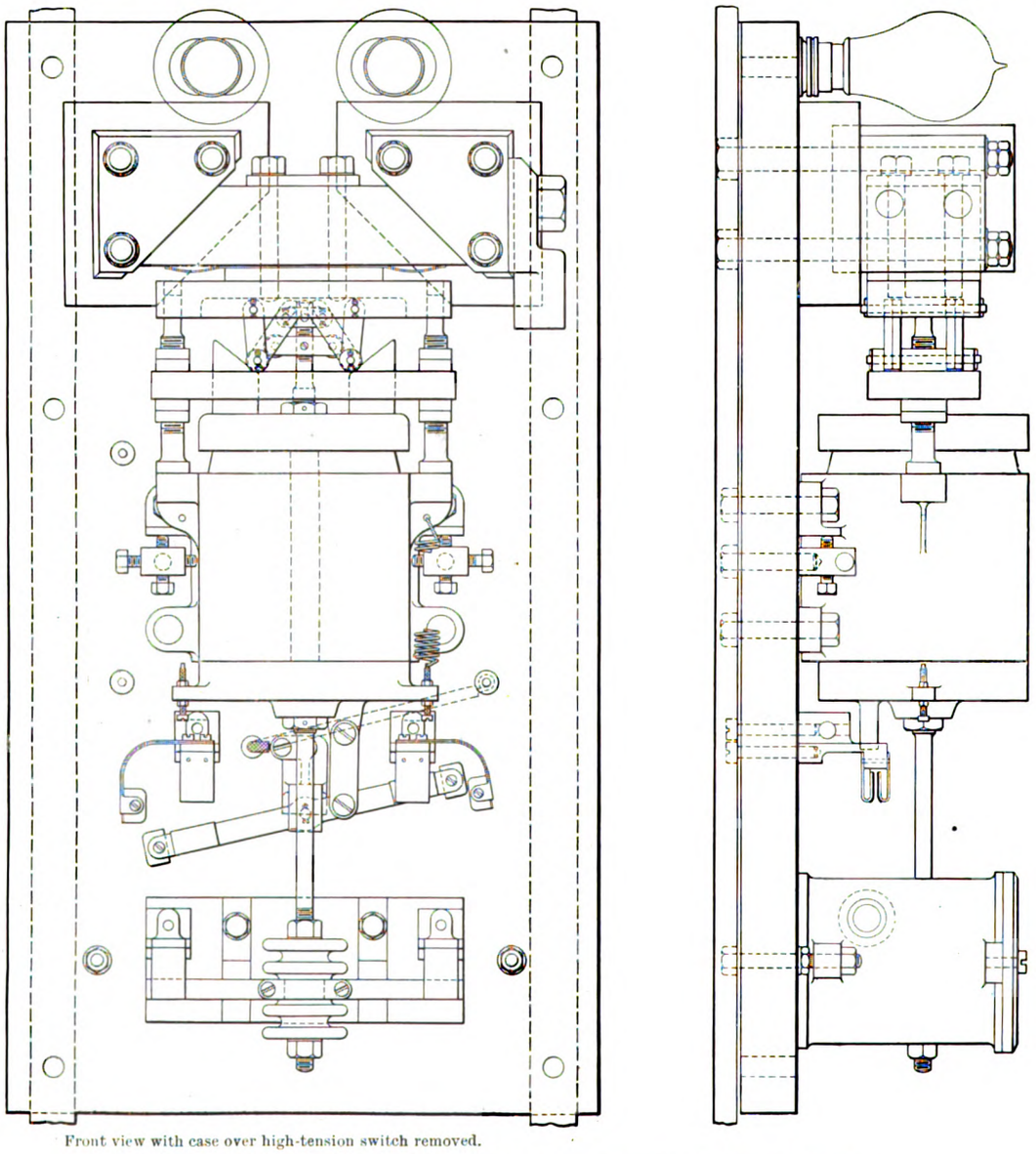
The representation of the control apparatus in Fig. 1 is, of course, only diagrammatic, but the form taken by the different parts of controlling gear is seen in Figs. 2, 3, and 4, which show respectively the details of a switch for an ordinary two-wire system, and control equipments for three-phase and single-phase three-wire circuits. In the latest form of the standard arrangement the switch mechanism is mounted on one panel, and the relay and fuses for the small transformer on another panel, which may or may not be placed alongside. The three-phase gear only differs from the single-phase form of the apparatus in having a three-pole

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primary switch. In the three-wire pattern the secondary switch at the top is divided into two parts, but otherwise the arrangement is similar to the ordinary two-wire type.

There are several points in design of the apparatus to which attention should be directed. The form of the heavy current secondary switch at the top is particularly well adapted to its purpose; the fixed contact piece to which the cables are attached are of solid metal, and the moving bridge is laminated and of a form which makes a good wedge-like contact. It must be realised that this switch, although of large carrying capacity, is never called upon to break the circuit, so that not only is there no liability to arcing or burning of the surfaces, but only a very small travel is required. The arrangement of levers, &c., by which the switch only moves through a small fraction of the travel of the plunger, and a correspondingly large force is obtained on the contacts, is clearly shown in Fig. 2, and is most ingenious. By means of the action of the levers, the switch, when on or off, is firmly locked, so that not only is it unnecessary, as already stated, to keep the current on the coils continuously, but it is impossible for vibration to loosen the switch. The pull is obtained from a pair of iron-clad magnets of the "pot" type, back to back, with separate coils, and attracting armatures at either end. In the older designs the magnet cores were solid, but a magnet with radial laminations, somewhat similar to those of the core of the Berry type of transformer, is being introduced. The construction of the high-tension switch and of the switch which breaks the control circuit is simple, as can be seen from the illustrations.

The relay arm is provided with carbon contacts and an adjustable balance weight. A dash-pot is fitted, so that its action in causing the opening of the switch is not too rapid. This prevents oscillation of the load in the neighbourhood of the critical value, causing continual opening and closing of the switch. The terminals of the relay coil are entirely enclosed in porcelain covers. Above the relay are the fuses in the primary circuit of the small transformer. A very neat device is adopted to ensure the immediate transference of the load to the large transformer in event of a breakdown of the small transformer. These fuses, which are of a special type, are so arranged that should either of them blow, or even become overheated, a thin, varnished silk cord, hanging so that it just touches the fuse strips, will burn through and cause a weight to drop on the lever arm of the relay, so that the small transformer is immediately switched out. Very little attention is required in actual working beyond occasionally renewing the oil



Front view with case over high-tension switch removed.

FIG. 2.—DETAILS OF TWO-WIRE CONTROL PANEL FOR BERRY SERIES SYSTEM.

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in the dash-pot and inspection of the carbon contacts, which should be trued from time to time by drawing a piece of fine emery cloth between them.

One object of the system is the reduction of the "all day" losses; the exact amount of saving in this respect, of course, depends on the "peakiness" of the

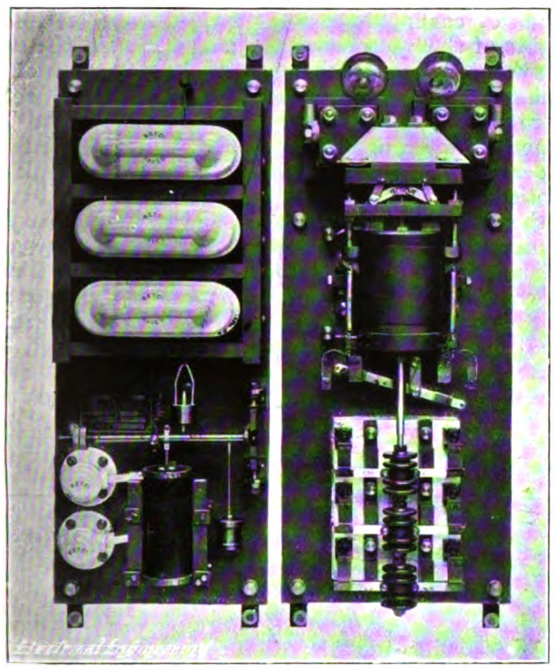


Fig. 3.—Three-phase Control Gear.

load, but under such conditions as an ordinary lighting load the reduction of losses claimed is such as to increase the all day efficiency of distribution from 70 to 90 per cent. The main transformer can be designed with lower copper losses, as it is not so necessary to cut down the iron losses. The result is that not only

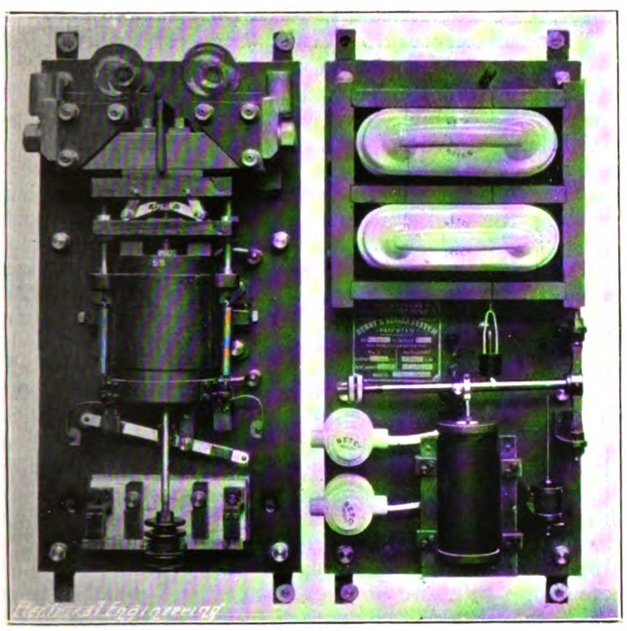


Fig. 4.—Single-phase Three-wire Control Gear.

at light load are the iron losses enormously reduced, but at heavy loads the copper losses, which in any case then predominate, are less serious; so that in both ways better overall efficiency is produced. It is also interesting to inquire into the effect upon the voltage regulation of the introduction of the system. At light loads the drop will be greater than before, as only the small transformer is in use, but when the large transformer is switched in, less drop than before will be obtained on account of the lower copper losses of the type of large transformer employed, and of the fact that, generally speaking, it will be cooler.

The effect upon the sub-station temperature is very marked. For example, in a sub-station in Hammersmith the temperature on one occasion was reduced to 68° F., when under similar circumstances before the series gear was introduced it had been 96° F. With regard to the conditions under which the transformers work, the fact that they are allowed to cool every day, and are cool when called upon to take up the load, is very greatly in their favour; and the intermittent nature of the heating of the core enables a smaller size of transformer to be used than would be the case with the ordinary arrangement. Another point which should be noticed is the fact that the cutting in and out of the transformers cannot occasion the deleterious voltage surgings and shock which are often produced by putting a transformer suddenly on to a circuit, as when the voltage is applied to the primary of the large transformer the core is already magnetically "in step."

The first equipment was installed about three years ago in a sub-station in Ealing, which formerly con-

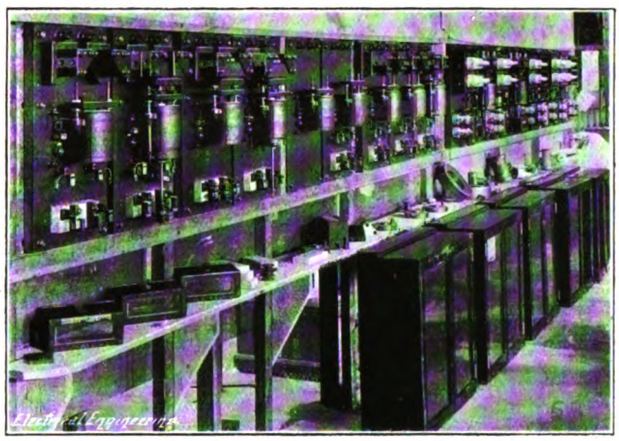


Fig. 5.—Group of Control Boards in Course of Erection.

tained a single 100 kw. transformer which had an all-day magnetising current of 0·7 amperes of 2,000 volts. This has been replaced by a transformer rated at 50 kw., which, owing to the intermittent nature of the work, is quite sufficient for the load under the new conditions, and a 10 kw. transformer for the day load with a magnetising current of less than 0·1 amperes. Similar outfits are in use at Hammersmith, Croydon, Reading, Scarborough, Wakefield, Bradford, Newcastle, and several other places both in this country and abroad.

The apparatus is made entirely at the works of the British Electric Transformer Co., at Hayes, Middlesex, which is the place of manufacture of the well-known Berry transformers. The control-boards are assembled together in batches. A group in a more or less finished stage is shown in Fig. 5 in course of erection. At the time of our visit to the works a large batch of completed boards were ready for dispatch to Shanghai. A rather ingenious arrangement is used for testing the relays and switches. A small bucket is attached to the relay lever, and gradually filled with water. The increased weight causes the lever to drop, but the bucket when full tilts up and empties itself, enabling the lever to rise again. The switch is, therefore, made to open and close periodically, and this is continued until the apparatus has been subjected to the equivalent of one or two months' regular work.

Looking round the works, we saw a large number of

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transformers in progress of the oil-cooled and air-cooled Berry types of all sizes. Another speciality is an alternating-current booster, consisting of a small transformer with a number of tappings connected to a multiple-contact regulating switch, with two arms connected together by a choking coil to prevent interrupting the circuit or short-circuiting a section when passing from one step to another.

In conclusion, we wish to express our thanks to Mr. A. F. Berry for having afforded us facilities for examining the details of his interesting system.

ARC LAMP LOWERING GEAR

ON one or two occasions we have referred to forms of arc-lamp lowering gear made for special purposes by the London Electric Firm, of Croydon. A recent addition to their series is shown in the accompanying illustration, which represents three arc lamps mounted on special brackets at the Hammersmith station of the Metropolitan District Railway.

The gear consists of one of the firm's contact devices arranged



SPECIAL ARC LAMP SUSPENSION AT HAMMERSMITH STATION.

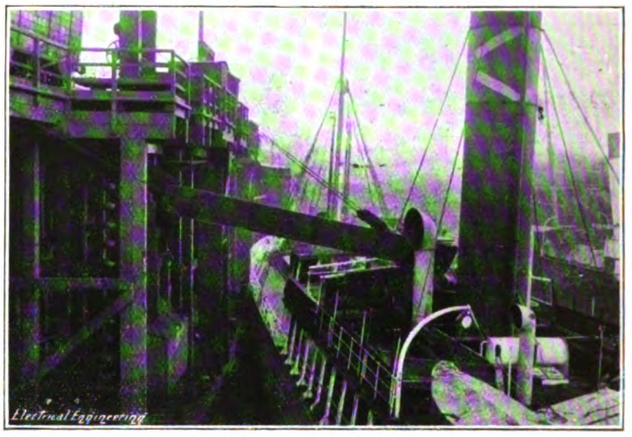
with the fixed part secured to the bracket, and the movable part to the upper end of the tube carrying the lamp. A flexible wire rope draws up this tube, telescoping it through the fixed part of the contact, and when the lamp is sufficiently high, it is swung round over the roof for trimming. The contact device is an adaptation of the firm's patent "one working part" type; and when the lamp is in its normal position the weight is entirely off the rope. The winch used is of the self-sustaining type without ratchets or gear wheels, so that the danger of running back is avoided.

Institution of Electrical Engineers, Dublin Section.—It has been arranged to hold the annual dinner, which was postponed from December 19th, owing to the death of Lord Kelvin, on Saturday evening, February 29th, at the Gresham Hotel, at 7 p.m. The charge for each member will be 5s., exclusive of wine. Members can invite any number of guests they may desire at the same rate per head.

ELECTRICITY IN COALING OPERATIONS

THE Tyne is one of the principal coaling centres of the world, and the magnitude of the operations carried out there render an indication of the means and methods whereby electricity is applied to the coaling of ships especially interesting.

It is a comparatively easy thing to arrange suitable means of coaling a vessel, provided that the relative heights of the vessel and the wharf remain the same, but this condition does not obtain in most of the coaling stations of the world, owing to tidal action. There are therefore found on the banks of the Tyne immense staiths or coaling jetties, whereby the trucks of coal can be taken right out from the bank and emptied into hoppers which discharge into the bunkers of the vessel. Where, however, it is necessary for engineering reasons to coal from the low quay edge, difficulty often arises from the fact that the level of the vessel's deck is higher than that of the quay, and in order to overcome this the North-Eastern Railway Company have included in their installation at Tyne Dock, electrically-driven coaling spouts, which render operations independent of gravity. These spouts for the shipment of coal at the staiths are of an effective length out from the quay edge of from 19 to 28 feet,



ELECTRICALLY-WORKED COALING SPOUT ON THE TYNE.

the distance varying according to the angle from the horizontal to which they are set. In these spouts, which have a width of 4 ft., travelling bands run, which carry the coal into vessels whose decks are at such a height from the water that in ordinary gravitation working the coal would not flow down the usual spout. As a matter of fact, these electrically-driven spouts will admit of coal being carried upwards to the bunkers of the vessel up to an angle of 18° above the horizontal line of the spout, thus giving a considerably greater range to the class and size of the vessel which can be coaled from the quayside.

The working capacity of the spouts is from 500 to 600 tons per hour, and the illustration gives a general idea of their appearance in operation. The drive is from electric motors of the three-phase type, thoroughly enclosed in order to protect the gear from flying coal dust, and the supply is taken from the mains of the County of Durham Electric Power Supply Co. The electrically-driven coaling spouts, which have been for some time in continuous operation, and which during the recent sustained pressure of foreign orders have been subjected to considerable pressure of work, have shown themselves capable of dealing with the demands placed upon them in a satisfactory manner.

The Royal Society of Arts.—His Majesty the King, who is patron of the Society of Arts, has granted permission to the society to prefix to its title the term "Royal," and the society will consequently in future be known as the "Royal Society of Arts."

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PROTECTIVE DEVICES FOR HIGH-TENSION CIRCUITS

THE Paper by Mr. J. S. Peck on the above subject, which is to be discussed to-night at the London meeting of the Institution of Electrical Engineers, was read before the Manchester Local Section of the Institution on Tuesday last. The author in the introductory portion of the Paper pointed out that the question of protective apparatus for high-voltage transmission systems had not up to now received much attention in this country owing to the scarcity of high-tension overhead lines and the rarer occurrence of severe thunderstorms as compared with the Continent and America. Static disturbances were, however, sometimes due to other causes than lightning, and underground cable systems of large capacity were particularly liable to such disturbances.

In dealing with the "static" disturbances produced by switching, short-circuiting, grounding, and lightning, or in any other way which produces a very abrupt change in potential, he referred to their distinguishing features of oscillatory nature and extreme suddenness of action. One of the best-known effects due to static is the concentration of potential upon the outer turns of the windings of electrical apparatus. For example, each turn of the high-tension winding of a transformer has a static capacity to the low-tension winding and to ground. Each turn also has a certain amount of inductance. Consider the case of switching such a transformer into circuit; before the switch is closed both windings are at zero potential. When it is nearly closed a spark passes from the line at the instant of maximum line voltage. This outermost turn is immediately brought up to line potential; the next turns in order follow it rapidly, but no turn can reach full potential until the capacity connected to it is fully charged.

This effect is produced by any action which causes a very abrupt change in potential of the end turns of a transformer, and may occur in a high-voltage motor or generator in exactly the same way. It has no tendency to cause a breakdown to earth, but tends to produce short-circuits between adjacent turns. It is one of the most frequent sources of trouble in high-voltage apparatus.

The phenomenon of reflected waves of potential was explained as follows:—If a condenser is fully charged and then

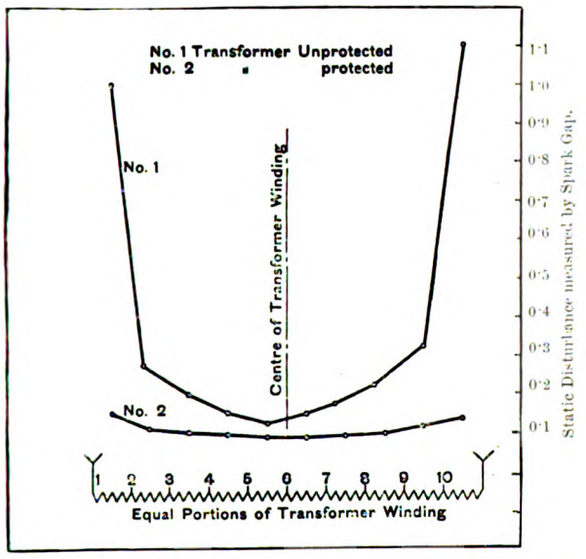


FIG. 1.—CURVE SHOWING PROTECTION AFFORDED BY CHOKE COILS.

discharged through a reactance, the current will increase until the condenser is entirely discharged, when the whole of the energy will be stored in the reactance; but the energy cannot remain thus stored, and the reactance begins to discharge into the condenser, which is charged to its original potential, but in the opposite direction. The condenser cannot remain charged, but again discharges into the reactance, so that the charge oscillates between reactance and condenser until it is used up in ohmic loss and leakage. If a condenser is without charge, and we charge it from a constant potential line through a reactance, current flows into the condenser through the reactance at an increasing rate, which reaches a maximum when the condenser reaches line pressure. The current through the reactance cannot stop, however, but continues to flow into the condenser until it is charged to double-line pressure. The condenser, however, cannot remain at double potential, but discharges through the reactance into the line, and continues to oscillate between zero and double-line pressure until it finally comes to rest at line pressure. Thus it is possible to obtain double the original pressure on a condenser when charging it through reactance. A transmission line is made up of condensers and reactances in series. If an unloaded line is connected at one end to a constant potential source, a charge passes into the line and advances at a certain rate depending upon the constants of the line. When it reaches the open end of the line it can go no further, but on account of the inductance of the circuit the charge is increased until approximately double potential is reached at the end of the line, but the end of the line cannot remain at double potential, and the charge is reflected back along the line, bringing it to double potential. The next wave reduces it to line potential, and the reflected wave to zero potential. Thus the line oscillates from zero to double-line potential until it finally comes to rest at line potential.

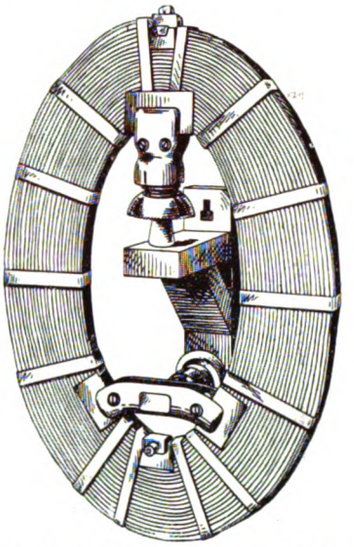


FIG. 2.—CHOKE COIL FOR ALTERNATING-CURRENT CIRCUITS.

It is not necessary that the line should be open-circuited in order to obtain a reflected wave and a potential rise, for if there is a branch line at the end of the main line, and the branch has less capacity than the main line, it will be unable to absorb the charge as rapidly as it arrives at the junction, and a rise in potential will occur. Every line has a natural period of oscillation, and if the frequency of the generator is such as to increase the magnitude of the oscillation, resonance occurs, and there is practically no limit to the voltage which may result. Fortunately, the frequency of oscillation of a transmission line is so high that there is very little chance of resonance with the generator frequency. On very long lines there is, however, the possibility that there may be resonance with some of the higher harmonics, and for this reason it is desirable that the generator should deliver an E.M.F. wave which has as nearly as possible a sine-form.

The static disturbances described above may be said to be caused by internal workings, but the most severe strains to which apparatus is subjected are due to lightning. It is evident from what has been said that, regardless of the source of the static disturbance, there are at least two dangers to electrical apparatus on transmission systems:—(1) Concentration of potential on the end windings, causing shorts between adjacent turns; and (2) excessive voltage between wires and ground, causing breakdowns to ground over insulators, bushings, or through the insulation of the windings.

In order to prevent trouble from the first cause, two courses are open—(*a*) To insulate the end windings so that they will withstand the strains. This method is often used, but it is always expensive, and on certain types of apparatus very difficult to apply. (*b*) To prevent the windings being subjected to the abrupt change of potential. In the case of switching, danger may be prevented by closing the circuit through a resistance or adopting certain other means, but the most effective

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remedy, and one which is good for practically all cases, is to place choke coils between the apparatus and the lines from which the static disturbance comes. With this arrangement the shock is taken by the choke coils, which can be heavily insulated to withstand it, and if the coils should break down they are readily repaired or replaced. The use of a choke coil may be said to be the same (so far as the static strains are concerned) as placing the end turns outside the apparatus, where there is plenty of room for insulation. The effect of a choke coil in reducing strains on the end windings of a transformer is shown in Fig. 1, where the voltages across different numbers of turns near the line are measured with and without a choke coil. A type of choke coil for this purpose is shown in Fig. 2.

In order to prevent trouble from the second cause, that is, high voltage to earth, the lightning arrester is used to afford a path to earth for static discharges of lower resistance than that offered by the insulation of the transmission line or of the apparatus connected to it. The requirements for a good arrester are conflicting. It must offer an easy path to earth, yet must be able to hold back the line voltage, and when a discharge occurs it must be able to interrupt or suppress the arc which follows the discharge. All arresters, except the water-jet type, consist of at least one air-gap in series with an

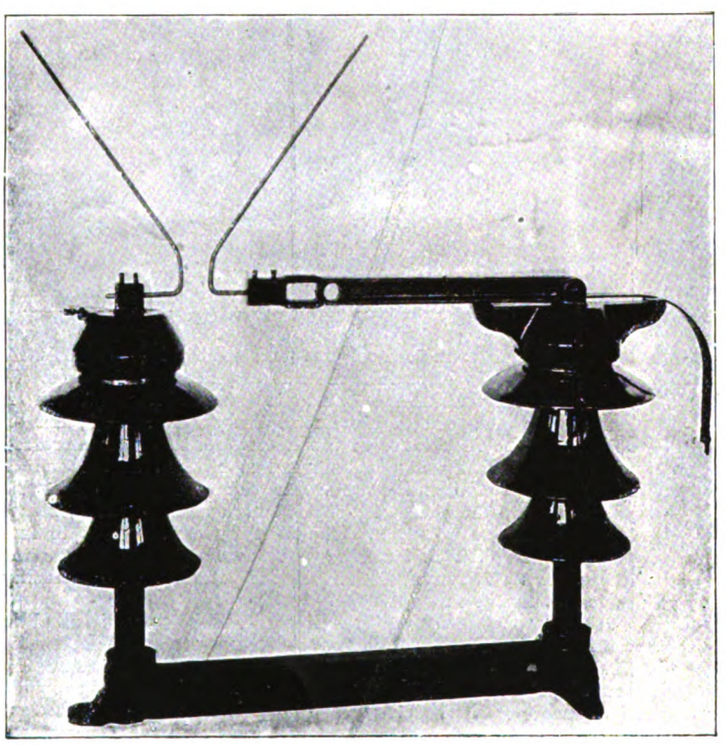


FIG. 3.—HORN TYPE LIGHTNING ARRESTER.

arc-suppressing device. In the case of alternate-current arresters there are often a very large number of gaps in series.

Horn-type Arrester.—This consists of two wires, or rods, each bent at an acute angle, the two being placed in such a position that the air-gap is small at the bottom, but increases rapidly from bottom to top. One horn of the arrester is connected to line and the other to ground, and the arrester so adjusted that the gap at the bottom is just large enough to withstand normal or slight increases above normal voltage. When there is an excess voltage an arc passes across the small part of the gap, and due to its heat rises until it is drawn out so long that it is ruptured. The advantage of this type of arrester is that it is cheap and can be installed out of doors. The objections are that the arc takes a long time to break, and, since it constitutes a short-circuit on the system, will throw synchronous apparatus out of step. It is now customary to instal a high resistance in series with this arrester in order to limit the current which flows on short-circuit, but this resistance retards the static discharge. This arrester requires a much higher resistance in series with it than certain other types. This form of arrester is shown in Fig. 3.

Non-arcing Multi-gap Arresters.—It was discovered by Wurts that certain metals had the property of suppressing alternating arcs. The non-arcing multi-gap arrester consists of a number of small metal cylinders separated by air-gaps of approximately $\frac{1}{32}$ in. (Fig. 4). The number of gaps between line and ground is made great enough to suppress any arcing which occurs after a static discharge. This arrester proved a great success on

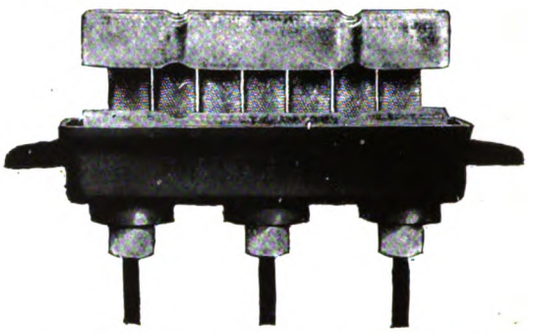


FIG. 4.—NON-ARCING METAL ARRESTER UNIT.

circuits of 2,000 volts, and was used to some extent on voltages as high as 15,000 and 20,000. It was found, however, that on large generating systems, and particularly with high voltages, the arresters did not always retain their non-arcing quality, or else that an enormous number of gaps were required. Thomas discovered that in order that an arrester should be non-arcing it was necessary to limit the amount of current which flowed after the arrester discharged. This at once suggested an ohmic resistance in series with the gaps, but on high potential circuits the insertion of sufficient resistance to render the arrester non-arcing increased greatly the resistance which the arrester offered to static discharges. He found, however, that the resistance of the arrester to static discharges could be greatly reduced by using a large number of gaps and comparatively small series resistance, and shunting part of the gaps with an ohmic resistance. This he called a low equivalent arrester; the general arrangement is shown in Fig. 5. The action of the arrester is as follows:—Approximately twice as many gap units are taken as are required to hold back the line voltage. Approximately one-half of the gaps are shunted with an ohmic resistance. When no discharge occurs the ground potential is brought up to the middle of the series. Thus there are between line and ground only one-half the total number of gaps. When there is an excessive potential on the line, the non-shunted gaps break down first, so that full potential is thrown across the shunted gaps, and they also break down. The arc through the shunted gaps is, however, very unstable and quickly drops out, the current passing through the shunt resistance, but the non-shunted gaps now have in series with them the shunt resistance and the series resistance, so that the current passing through them is very small and the arc is quickly suppressed. Although the two series of gaps do not break down simultaneously, the whole action is, of course, very sudden and appears instantaneous. This arrester has been very successful, and the principle with various modifications is now used on practically all arresters of the multi-gap type.

One objection to the multi-gap arrester is that on high voltages an increase in the number of gaps out of all proportion to the increase in voltage is required in order to hold back the line voltage and to make the arrester non-arcing. It was

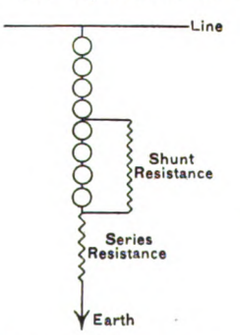


FIG. 5.—ARRANGEMENT OF "LOW EQUIVALENT" ARRESTER.



FIG. 6.—ARRESTER UNITS WITH EARTH SHIELD.

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found also that the number of gaps varied greatly on different circuits, and this difference was finally traced to the position of the arrester with reference to grounded objects. The explanation of the phenomena is believed to be as follows :—

When ground potential is brought near the arrester, the potential gradient across the gaps near the line becomes so high



Fig. 7.—Water Column Lightning Arrester.

that the air between the cylinders becomes ionised, and the line potential is gradually moved towards the grounded end of the arrester until there are not sufficient gaps to hold back the line voltage and a discharge occurs. When the arrester is well removed from grounded objects, *i.e.*, from the walls of buildings, &c., the total potential strain from line to ground is divided more equally between the cylinders, consequently the arrester will stand a higher potential, or a smaller number of gaps are required for holding back the same potential.

With high-potential arresters a hissing sound is often noticeable. This is caused by static sparks which pass continuously from the line wire to the cylinders which are adjacent to them. The closer the arrester is to grounded objects, the further will this display extend downward toward the ground from the line terminal. To overcome this unequal distribution of potential across the gaps, a metallic ground shield connected to the line is placed adjacent to a portion of the gaps furthest from the ground, thus the line potential is brought near to these gaps, and the excessive potential gradient removed. This arrangement is shown diagrammatically in Fig. 6. It is found in practice that the use of the shield often permits a great reduction in the number of gaps to be made.

Mutiplex Arrester.—While the lightning arrester is intended primarily to afford an easy path to earth for static discharges, it has been found that a high static potential sometimes exists between the different wires of a transmission circuit. To take care of this, the General Electric Company of America brought out the multiplex arrester. In this arrester, which is of the multi-gap type, an ohmic resistance is connected from about the middle point of the series of gaps in one phase to the corresponding point of the arrester in the next phase. Thus all the arresters are connected together by a high ohmic resistance at approximately their middle points. and it is possible for a static discharge to pass half-way through one arrester, through the ohmic resistance, and through half the number of gaps in the other arrester to the opposite side of the circuit.

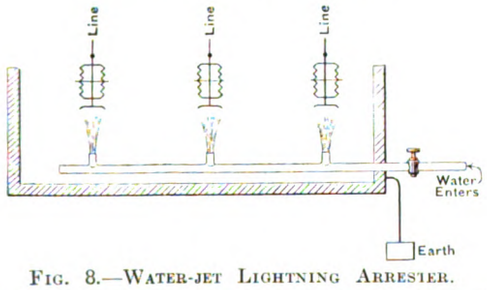


Fig. 8.—Water-jet Lightning Arrester.
The Water sprays upwards and strikes against the Plates which are connected to the Line Wires.

Water-jet Arresters.—On the Continent an arrester, consisting of jets of water playing upon the wires, has been used to some extent. The chief objection to this type is that it causes a leakage of current to earth which represents a loss of power, and if the resistance is sufficiently high to prevent serious loss due to leakage, it may offer considerable resistance to static discharges. It is, however, comparatively cheap, and appears to have given satisfactory protection, and there is no reason why an air-gap should not be placed between the line and the jet, though this would increase the resistance to the discharge. Its use is limited to places where there is a supply of water, unless pumping is resorted to. There are a number of different forms of this arrester, two are shown in Figs. 7 and 8.

Arresters in Parallel.—Much discussion has taken place regarding the effect of series resistances in lightning arresters in retarding static discharges. The static charge is represented by a certain current at a certain voltage. If the resistance of the arrester is low enough, so that the voltage of the charge can force the current through the arrester resistance as fast as it arrives at the arrester, then there will be no further rise in potential, but if the resistance cannot pass the current at this rate, there will be reflection and a rise in potential. To overcome this difficulty a number of arresters may be installed in parallel, the arresters having different gaps and different resistances. The arrester with a minimum gap has the maximum resistance, and the arrester with a maximum gap has the minimum resistance. The theory of the operation is as follows :—

When a discharge occurs it will jump the smallest gap, and if the current is not too large for the resistance there will be no rise in potential, but if the current is too large there will be a rise in potential, and the next larger gap will break down. With a very high rise the largest gap with minimum series resistance will break down. On some transmission systems arresters have been installed which consist simply of a horn-gap in series with a fuse. The gap is set so high that it will be broken down only with a very high rise in potential. This arrester, which offers a direct path to earth, is probably as good a means as any yet devised for taking care of a direct lightning stroke. Several of these arresters are connected in parallel, and usually only one discharges at a time, so that the line is not left unprotected, and arrangements are made for replacing fuses quickly.

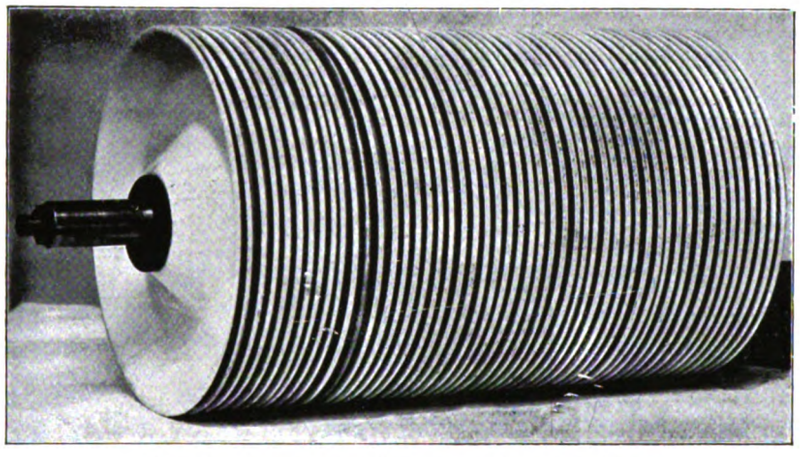


Fig. 9.—Electrolytic Lightning Arrester Unit.

The Electrolytic Arrester.—It has been found that aluminium in certain electrolytes forms a non-conductive film on its surface. This film, although extremely thin, will withstand about 400 volts. At higher voltage the film is punctured with countless small holes, and a large current is permitted to pass, but when the voltage drops below the critical value the film is reformed and prevents further passage of current. A sufficient number of these cells may be placed in series to withstand almost any voltage desired. It is evident that the aluminium cell possesses almost ideal characteristics for a lightning arrester, as it permits very little current to pass at normal voltage, but breaks down at higher voltage and re-seals itself as soon as the high voltage has passed and the line has been relieved. When voltage is applied to the aluminium cell, a small current, partly capacity and partly leakage current, flows through it, and for a lightning arrester it is desirable to use a gap in series with the cell in order to prevent this current flow.

In order to obtain a large number of cells in series, the aluminium plates are pressed into tray form. These trays are set one inside the other (Fig. 9), and separated by suitable insulating washers. They may thus be built up into a column comprising a large number of cells in series. The columns are

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enclosed in suitable earthenware jars, and the trays filled with the electrolyte. This is done by filling the top tray and letting the electrolyte run over into those below. After the trays have been filled, the jar is tipped slightly, so that a small amount of the electrolyte runs out of each tray, and a small amount of transformer oil is then poured into the top tray, and permitted to run over into those below. This oil prevents evaporation of the electrolyte. A number of jars may be mounted

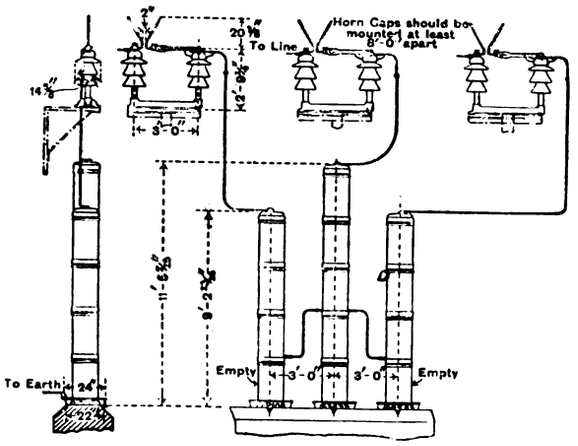


FIG. 10.—OUTLINE OF ELECTROLYTIC LIGHTNING ARRESTER FOR 53,000 TO 66,000-VOLT THREE-PHASE CIRCUITS WITH UNDERGROUND NEUTRAL.

one above the other for high voltages, and as the edges of the trays do not touch the jars, current must pass from tray to tray.

For voltages not exceeding 13,500, a gap consisting of the usual non-arcing metal cylinders is placed between the line and the electrolytic unit. For higher voltages the horn-type gap is used. The gap used must have sufficient power to suppress the arc which exists after the static disturbance has passed. The cur-

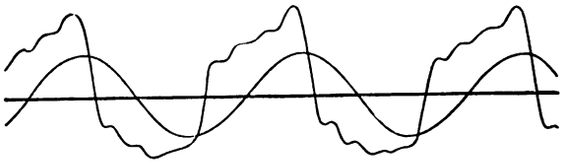


FIG. 11.—OSCILLOGRAPH SHOWING CURRENT AND VOLTAGE ON ELECTROLYTIC UNIT, 12,500 VOLTS, 25 CYCLES, 0·41 AMPERE.

rent in this arc is quite small. It is not advisable to use a horn-type gap on the lower voltages, as it must be set so close that the arc does not rise properly and extinguish itself.

A diagram of the arrangement of this arrester is shown in Fig. 10, and oscillograph curves showing current and voltages on an electrolytic unit are shown in Fig. 11.

Ground Wire.—The concensus of opinion seems to be that one of the best methods of protecting a transmission line from

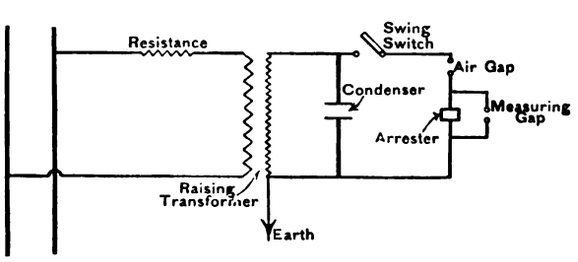


FIG. 12.—DIAGRAM OF CONNECTIONS FOR METHOD OF TESTING LIGHTNING ARRESTERS.

lightning is to string a wire above the transmission line, this wire being grounded at frequent intervals. Three wires, one above and one at each side of the transmission circuit, are recommended as affording very complete protection. It is the general practice, however, to instal lightning arresters at the ends of the line, whether ground wires are used or not.

Testing Lightning Arresters.—Before concluding this Paper, a few words were said regarding the methods of testing the protective power of lightning arresters. Fig. 12 shows one system of connections which is used. A condenser is charged to a high potential from a raising transformer. This condenser is discharged by means of a swing switch through a spark-gap in series with the arrester. In shunt to the arrester is an adjustable spark-gap, which affords an alternative path for the discharge. The gap is adjusted until the great majority of the discharges, say 95 per cent., pass through the arrester instead of over the gap. The length of the gap under this condition is called the equivalent spark-gap of the arrester, and means an air-gap of such a length that a slightly higher pressure is required to break it down than is required to break down the arrester. Obviously, the lower the equivalent gap the greater is the protective power of the arrester, as the gap represents somewhat less than the minimum insulation strength which the arrester will protect. In order to test the non-arcing power of the arrester, the adjustable spark-gap may be replaced by connections to the power circuit. When a discharge passes through the arrester, the arc which follows from the power circuit should be quickly suppressed.

The International Telegraph Conference.—It is announced that China will be represented for the first time at the coming telegraph conference at Lisbon in the person of Mr. Dresing, foreign adviser to the Chinese telegraph service.

New Telephone Charges.—An action is down for hearing in the City of London Court on February 13th, which is taken by the Postmaster-General against the London Paper Supply Co., in connection with what is alleged to be persistent over-charging by the Post Office for telephone service upon the message rate system. The London Paper Supply Co. allege that they have been charged for calls not made to the extent of £1 16s. 6d., and they claimed the return of this amount from the Postmaster-General. In this they were unsuccessful, and after their telephone connection was cut off, they refused to return the instruments. It is to recover the instruments that the Postmaster-General is taking the action in question. The action will raise the whole question of the accuracy of the Post Office methods of registering calls under the new message rate system of charging.

Breach of Contract for Electricity Supply.—In the King's Bench Division of the High Court, on Wednesday and Thursday last week, Mr. Justice Ridley and a special jury heard the action of Bourne and Another *v.* The Marylebone Borough Council, in which the plaintiffs, who are drapers, of Oxford Street, claimed damages against the defendants for alleged breach of contract. It appears that a contract was made between the parties, under which the defendants agreed to supply electric light to plaintiffs' premises, newly opened in Berners Street, at 240 volts by the first week in September of 1905. It was alleged on the part of the plaintiffs, however, that the defendants failed to supply by that date, and no supply was given until October 9th, 1905. A temporary supply was agreed upon at 200 volts, but the plaintiffs did not get the light within the time specified in the new contract. It was pleaded on the part of the defendants that their representatives had no authority from the defendants to enter into any of the contracts, and that neither of the alleged contracts had the seal of the Corporation. Evidence having been heard, the jury found for the plaintiffs on all the points, but before judgment would be entered it was arranged that the case should stand over for legal argument as to the defendants' liability. On this point the case came before Mr. Justice Ridley on Friday, when his lordship reserved judgment.

Nuisance from Brighton Corporation Motor Generator Station.—This action, in which the Rev. Edward Heath, Colonel Grove-Morris, and Mr. Frank Harold claimed an injunction to restrain the Brighton Corporation from working their North-road Electric Works so as to cause a nuisance to the worshippers of St. Mary and St. Mary Magdalene Church, in Bread-street, Brighton, was continued before Mr. Justice Joyce in the Chancery Division of the High Courts on Thursday. The evidence was completed at the previous sitting, and was reported in our last issue. Mr. Astbury, K.C., addressing the Court, submitted on behalf of the Corporation that the evidence of the plaintiff clearly established that no possible legal nuisance existed. It was, he said, impossible to deal with the case seriously; so infinitesimal was the noise, no words of the English language could express the character of the sound. The Corporation had done everything possible to meet the plaintiffs, but as trustees of the ratepayers there must be a limit to their kindness and charity. If this case went against the Corporation there would be hundreds of blackmailing actions. If the plaintiffs agreed to the action being dismissed the Corporation would not press for costs, but beyond that the Corporation would not go. The hearing was continued on Friday, and after the Court had been addressed on behalf of the plaintiffs his Lordship reserved judgment, remarking that he might visit Brighton personally in order to satisfy himself respecting the alleged nuisance, or send an expert to report on the matter.

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THE WEST HAMPSTEAD ACCIDENT

THE full report of Major J. W. Pringle of the Board of Trade inquiry into the accident which occurred between two electric trains at West Hampstead Station of the Metropolitan Railway, under circumstances already reported in ELECTRICAL ENGINEERING (Vol. II., pages 672, 685, 770, and 829, and January 16th, page 70), has now been issued. It will be remembered that the down train from Baker Street to Willesden Green was standing at the platform in the station waiting for the signal to proceed, and the following train was admitted into the station under all proper signals during the prevalence of a thick fog, and struck the rear of the standing train. Three passengers were killed. The constitution of the trains and the damage done are set forth in the report, and full details, with a plan of the scene of the collision, are given, together with a description of the working of the Spagnoletti electric lock and block system of signalling in use on the part of the line in question. Briefly, the electrical interlocking ensures that the passage of a train over a treadle in front of the home signal at West Hampstead releases the instrument, which allows the signalman at West Hampstead to free the lever working the down starting signal at Finchley Road. Again, the passage of a train over a treadle in front of the down starting signal at West Hampstead releases the disc instrument which permits the signalman at West Hampstead to free the lever working his own down home signal. It must be noted that this disc instrument is only released if the treadle in front of the down starting signal is operated whilst the starting signal lever is in the safety position. If the signal lever is at danger when the treadle contact is made the instrument will not be released. Lock indicators are provided in the signal-box behind each signal lever, which is electrically controlled. These visually indicate whether the lock is "on" or "off." In case of a failure of the electrical releasing arrangements, or when a train arrives at the station, but does not proceed further, it is necessary to provide means whereby the signalman can release his disc instruments and his lever locks. For this purpose there are fixed in the signal-box a number of small release boxes with glass fronts. These contain release springs, which, when operated by hand, release the disc instruments.

After detailing the evidence before the inquiry, the report proceeds to the conclusions and deals first with the accepted facts, about which there is no conflict of evidence, and finds that in the circumstances no blame or responsibility for the collision can be attributed to either motorman Smith, the guards of the Neasden train, or to fog-signalman Tomes.

In dealing with the discrepancies between the evidence of signalman Hollis, of West Hampstead, and others, Hollis's own account of his dealings with these two trains is summarised as follows:—His usual practice was to offer a down train to Kilburn, when it had arrived at West Hampstead. Contrary to this usual custom, he offered the Willesden Green train, had it accepted, and lowered his down starting signal very soon after he had accepted the train from Finchley Road, and some time therefore before the train arrived at West Hampstead. He estimates that the approximate time for this action was 7.45½ a.m. He then proceeded to enter in his train register book the timings of several up and down trains. Whilst so engaged he heard the noise of a train approaching, and judged it was the Willesden Green train. He therefore entered in the train book the arrival and departure of this train as 7.46 and 7.46½, and at the same time, in accordance with his general practice, he bocked the time of the receipt from Kilburn of the clearance signal for the train as 7.48. Shortly afterwards, turning towards the lever frame, he saw that the discs of his down "Kilburn" and down "additional" instruments were both showing "Line clear." This would indicate that the Willesden train had arrived at Kilburn, if all was correct. He had not then cleared back to Finchley Road for this Willesden train, and all his down line signals were standing at "Clear." He therefore replaced all his down line signals at danger, and cleared back to Finchley Road on the bell instrument. Therefore, when the Neasden train was offered him, he accepted it, released his down home signal lock in the usual manner, by working the tapper of his down additional disc instrument, and lowered the down home and distant signals, so that the train shortly afterwards entered the station, and the collision took place.

Signalman Boggis at Kilburn absolutely denies that he received any signal for the Willesden Green train at or about 7.45½. He did not, therefore, accept it, or release the starting signal at West Hampstead. He further asserts that no down line signal was sent to him from 7.43 until 7.52 a.m. If this be true Hollis could not have lowered his down starting signal between these named times.

This statement of signalman Boggis is corroborated by ganger Coleman, who was on the platform at West Hampstead when the collision occurred, and a few seconds later ran into the signal-box. He declares that he saw Hollis go to the Kilburn bell instrument and ring a train on, and afterwards pull off the down starting signal. He also heard an acknowledgment received on the bell instrument. If Coleman's evidence is believed, the time, 7.52, given by Boggis for the receipt of a bell signal from West Hampstead, is substantiated. Hollis denies having sent any signal at 7.52 a.m. Again, there is overwhelming testimony that the down starting signal was not lowered from the moment when the Willesden train arrived until after the collision.

The evidence being overwhelming on the point that the down starting signal was at "Danger" the whole time during which the Willesden Green train was standing in the station, it follows that if his statement is to be credited, Hollis must have replaced his down line signals at danger after the Willesden Green train had passed the down home signal—otherwise motorman Spittle would have found that signal at danger when he passed it—but before the train had arrived at the platform. It is difficult to understand, continues the report, how he could have been so foolish, unless he was inattentive to his duties, as to place his starting signal at danger at the moment when the train was passing his signal-box and entering the station. But if his statement is believed, that he offered the Willesden Green train to Kilburn, and lowered the starting signal before the collision took place, this is what must have happened. He declares that when he put his signals to danger both his discs showed "Line clear." As he had not cleared back for the Willesden Green train to Finchley Road, the disc of his down Finchley Road instrument must have been either swinging in the neutral position, or showing "Train on line." He evidently refers, therefore, to the discs of the down additional and down Kilburn instruments. Now, if these two discs showed "Line clear," and the Willesden Green train had been properly offered and accepted, as Hollis declares, there must have been a failure of the electrical locking with both these instruments, for the Willesden Green train was still standing in the station, and had not operated the two treadles which release these instruments. Taking first the down Kilburn instrument. Any failure of the locking with this instrument would have been duplicated in the corresponding instrument at Kilburn, and must have been noticed by signalman Boggis. No failure of any kind was noted either before or after the accident. Moreover, such a failure would set the disc swinging in the neutral position, and would not expose the "Line clear" disc. There is in addition the emphatic statement of signalman Boggis to the effect that no train was offered to him between 7.43 and 7.52, and that he was not called upon to release the lock on the down starting signal at West Hampstead until 7.52. Since there was no failure of the electrical locking of the down Kilburn instrument at West Hampstead, Hollis could not have offered the Willesden Green train to Kilburn, and could not, therefore, have lowered his down starting signal, either before or after the train arrived at the station. In these circumstances, whilst the Willesden Green train was waiting for the starting signal to be lowered, the proper and normal position of the disc of the down Kilburn instrument was "Line clear," as Hollis describes. But if "Line clear" was the position of this instrument when Hollis put back his starting signal to danger, we must believe signalman Boggis's statement as corroborated by ganger Coleman's evidence, that Hollis offered him a train at 7.52 a.m., and that this train was accepted, otherwise the disc of the down Kilburn instrument at West Hampstead would not, after the accident, have showed "Train on line," as described by signalman Shepherd, but "Line clear." Two further conclusions most naturally follow. First, that the bell signal sent at 7.52 a.m. was intended for the Neasden train, and consisted, therefore, of one bell only, as Boggis asserts. Secondly, that when the starting signal was lowered in accordance with the evidence of Spittle and Coleman, very shortly after the collision, it was intended by Hollis for the Neasden train.

The case of the down additional instrument has now to be considered. The disc of this instrument should have been showing "Train on line," and the instrument should have been locked until the Willesden Green train passed over the treadle, situated about 107 yards in advance of the down starting signal. Until this treadle had been actuated by the train, it ought not to have been possible, with proper working, for Hollis to release the lock, and pull over the lever of the down home signal, in order to admit the Neasden train into the station. Hollis asserts that something went wrong with the electrical arrangements, which resulted in the wrong disc being displayed, and further permitted him to release the lock on the down home signal in the proper manner by working the tapper of the instrument. On the battery circuit for the additional disc instrument there are two breaks—not one only—where contact has to be made before the circuit is complete, and the operating current can pass. Contact in one case is made by the depression of the rail, under the weight of the train, against the lever arm of the treadle. When this lever arm, which is enclosed in a metal case, is in proper adjustment, it requires a weight of from five to six tons upon the rail to make contact. The second contact is made in the signal-box by the lever which works the down starting signal being pulled over in the lever frame to its furthest extent.

It is acknowledged by various witnesses that instances have in past years occurred where, owing to some movement in the

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permanent way, or to want of adjustment in the treadle lever, the lock of one of these "additional" instruments has been released, after the starting signal had been pulled over, but before the train had operated the treadle.

An examination of the condition of the apparatus after the accident lead to the conclusion expressed in the report as follows :—

"As regards the down additional instrument, therefore, I hold that a failure causing an improper release did not take place, as Hollis asserts, and that when the Neasden train was signalled to him, the 'Train on line' disc must have been showing, and the instrument must have been locked."

The question remains, continues the report, how was the additional instrument unlocked? The spring contacts and keys are enclosed in small glass-faced boxes. These boxes are kept locked. Only a stationmaster, or station foreman, is authorised to open any of these boxes with the key. Where a release is required for the purposes of ordinary working, *e.g.*, for cancelling a train, signalmen are authorised to break the glass face of the release box. They are ordered to report all such breakages, and the station foreman or stationmaster is alone authorised to replace the glass from a store in his possession. It is necessary to open the case of the release box by means of the key in order to replace the glass. The lock of these release boxes is of the lever pattern, and the key, which has five tumblers, is not of a complicated description. If Hollis owned a key of this pattern, he could have opened the box, pressed the spring, and thus made it possible for himself to release the lock on the down home signal. There is no evidence of any description to show that he had such a key in his possession at the time of the accident; and as no one was in the signal-box with him, it cannot be directly proved that he opened one of the release boxes on this occasion. But without breaking a glass, or opening a box with a key, I do not think, says Major Pringle, it would have been possible to obtain a release of the down home signal lever.

Some points connected with the neglect of certain rules, &c., which have a bearing on this accident are then dealt with, and the conclusions are given as follows :—

1. That the first (Willesden Green) train was not, on arrival at West Hampstead, put into block to Kilburn, and that the starting signal was consequently not lowered. The result was that the train was kept standing at the platform for five or six minutes before the collision happened.

2. That, in all probability, owing to the thick fog, the train, as it stood at the platform, was out of sight of the signalman; but nothing was done in accordance with the company's rules to remind him of the position of the train.

3. That the electrical and mechanical signalling arrangements were in working order, and that it was not possible, with proper usage, and in accordance with the regulations, to lower the down home and distant signals for the second (Neasden) train to enter the station, until the first train had left the station.

I find, therefore, that the collision was caused by forgetfulness in the first instance, and subsequently by some illegal manipulation of the electrical instruments or locking on the part of signalman Hollis. He must bear the full responsibility for his conduct. Further, I find that the collision might, in all probability, have been prevented, if motorman Spittle and guard Sills had carried out general rule No. 55 (*a*), which is applicable on the company's system to trains standing within station limits. To some extent responsibility falls upon these men for not carrying out this rule. Station foreman Fitch failed to act in accordance with Rule 61 (A) and appoint a ground fog-signalman, or detail one of the station staff, to assist Hollis. It is evident he has not properly supervised the manner in which the signalmen perform their duties, or observed the company's rules regarding the use of the release key-boxes. Signalman Boggis was wrong in accepting a train when he thought it had been improperly signalled. But having regard to the time the signal was received, *i.e.*, after the collision, as the evidence shows, this error was not a contributory cause of the accident.

The report concludes with the following remarks :—

It is generally recognised that an automatic system of signalling is best adapted for a railway where block sections are very short and traffic of high frequency. The company's system of "lock and block" signalling has done excellent service in the past. This is proved by the fact that, from the opening of the railway in 1863 until the date of this unfortunate collision, some three thousand millions of passengers have been carried without the loss of one life in a train accident. The maximum number of trains dealt with during the winter at West Hampstead, in one signalman's tour of duty—eight hours—is 226, an average of 28·25 per hour. During the summer months the average is sometimes as high as 36 per hour. Having regard to the number of movements involved in passing so large a traffic on the "lock and block" system, a machine-like regularity of action is necessary, which can best be supplied by an automatic method of working. The company have for some time past been experimenting with a system of train-controlled signalling, with a view to adopting it on their lines. But every detail must be thoroughly proved by long and continuous tests under working conditions before the method can be accepted. Some time, therefore, must elapse before any complete change in the signalling arrangements can be carried out.

CORRESPONDENCE

TELEPHONE PROGRESS ON THE CONTINENT.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—There has recently been much discussion of what is known as the measured rate tariff for telephone service, and a few months ago a statement went the round of the Press to the effect that in Germany, Belgium, and France telephone rates for unlimited service were materially lower than those in force in this country. Also, there have been efforts to discredit the technical policy of the National Telephone Company and the Post Office in the important matter of the adoption of the central battery system of working large telephone exchanges.

I have just returned from a tour on the Continent devoted exclusively—barring one week in the Engadine devoted exclusively to more alluring affairs—to the study of telephone conditions. I visited Antwerp, Brussels, Rotterdam, The Hague, Amsterdam, Hamburg, Berlin, Vienna, Munich, and Paris, and in each place conferred with the principal telephone authorities, visited the chief exchanges, and was made fully acquainted with recent progress and future plans, both technical and administrative. Well, everywhere I find that measured rates and central battery equipment are the order of the day. I talked with perhaps fifty telephone officials, administrators, engineers, and executives, ranging from an Under-Secretary of State down to an exchange manager, and, among them all, Belgian, Dutch, German, Austrian, and French, there was no difference of opinion as to the correctness of the measured rate tariff for telephone service, and as to the efficiency of the central battery system of working large telephone exchanges.

Practice is following precept with more or less rapidity. Germany, which contains about half the total telephones in use on the Continent, is about to abolish the unlimited rate entirely, and in a short time all telephone subscribers in the German Empire will pay for their service at measured rates. An interesting detail is that in the new German tariff the lowest rate at which calls will be sold to the large user is exactly the same as the corresponding figure in the National Telephone Company's tariff, viz., 0·48d. per call. Austria abolished unlimited rates last year, and all Austrian telephone subscribers now pay measured rates. There was much opposition to the new tariff, especially from the large users in Vienna, but common sense has prevailed, and the Austrian Administration is now enjoying a rapid increase of subscribers, particularly among private houses and small users generally, owing to the much more elastic tariff which the measured rate scheme provides.

In Belgium a measured rate tariff is under discussion, and the responsible Minister has announced that a new scale of telephone rates will shortly be introduced. In France the leading officials of the Telegraph Department have long been convinced of the correctness of the measured rate principle, and a committee is about to be appointed to prepare a new tariff.

Therefore, whereas it has recently been represented in the British Press that telephone service is supplied in the principal Continental countries at absurdly low figures for unlimited service, the facts are that measured rates are either actually in force or about to be adopted. And when a change of this sort is made by a Government Administration on the Continent it is not done in the gradual and genial way adopted here by the National Telephone Company and the Post Office, who allow old subscribers to retain their existing arrangements until convinced of the superiority of newer methods. The Continental subscriber finds his contract changed for him, whether he likes it or not.

As with measured rates, so with the central battery system. This would hardly be worth mention were it not for the efforts of those connected with the defunct municipal telephone movement to discredit modern telephone work, for among serious telephone engineers there is no difference of opinion as to the superior efficiency of central battery working. Everywhere on the Continent new central battery exchanges are coming into use, and old local battery systems are being abandoned and replaced by central battery plants. The reconstruction of the Berlin system with central battery plant for 100,000 lines is nearly complete, similar work at Hamburg is in course of execution, while many of the smaller systems in Germany have already been converted. In Belgium, Holland, and Austria new exchanges are all central battery, and old ones are gradually being rebuilt on the same lines, while the French Administration is now engaged in converting the entire Paris system to central battery working.

The extent to which both the administrative and the technical conditions of the telephone business on the Continent have been misrepresented by contributors to the Press, and the general interest in "the telephone question" at the present time are my excuse for the length of this letter, for which I trust you will be able to find space.

I am, &c.,
HERBERT LAWS WEBB.

35 OLD QUEEN STREET, WESTMINSTER, S.W.,
Jan. 31*st*, 1908.

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ELECTRIC DRIVING OF TEXTILE FACTORIES

A PAPER on the development of textile electric driving was read before the Dundee Institute of Engineers last Saturday by Mr. J. Shaw (Mill Engineer of the British Thomson-Houston Co.). In looking back upon the history of electrically-driven textile mills, the author called attention to the fact that five years ago the United Kingdom did not contain a single textile mill driven electrically, either from its own generating plant or from outside supply. Two years afterwards, in February, 1905, contracts were entered into to erect the first new textile mill in the United Kingdom to be electrically driven. One mill only, in the meantime, had completely replaced its old gear-transmission by electric-transmission. There are to-day in operation in the British Isles electrically-driven mills aggregating about 26,000 b.h.p. in motors. This amount is being added to every day. Since the first completely electrically-driven mill in the world was equipped (viz., the Columbia Mill, in South Carolina, equipped in 1894), 70,000 b.h.p. in motors had been installed in America. There is, to-day, a total of about 225,000 h.p. in that country. Electrical-driving has therefore progressed during the last five years 26,000 b.h.p. in the United Kingdom, and some 155,000 b.h.p. in the States. The progress on the Continent has been equally remarkable.

He said that electrical-driving in this country was now in relation to rope-driving, in the same position the latter occupied 20 years ago in relation to gear-driving. The same strenuous opposition which was offered to rope-driving had been experienced against electrical-driving. Rope-driving had demonstrated its practical utility and was accepted as better than gear. Electrical-driving was forcing itself into recognition as strongly as rope-driving forced itself 20 years ago. The experience of the last few years had done much to dispel the opposition originally experienced, and it was not too much to say that ultimately electrical transmission would be universally adopted.

The advantages to be gained by electrical-driving were classified as follows, and those coming under each heading were discussed at length :—

(*a*) Maximum steadiness and uniformity of speed, resulting in improved quality and greater quantity of production in a given time. (*b*) Elimination of rope race, shafting, belts, ropes, and gears, reducing power-transmitting devices to an absolute minimum. (*c*) Less wear and tear on driven machinery, due to steadier speed. (*d*) Flexibility and facilities for independent operation and extensions. (*e*) Allocation of correct proportion of power costs to each department. (*f*) Facility for tracing and eliminating sources of undue absorption of power. (*g*) Centralisation of power generating plant.

The steadiness of the steam turbine as a source of power was emphasised, and the following advantages of taking current from central power-stations rather than isolated plants were discussed :—(*a*) Continuity of supply and freedom from stoppage. (*b*) Reduction of original capital outlay. (*c*) Extensions can be carried out at the smallest expense. (*d*) Specialisation of mill management in textile work alone. (*e*) Freedom from engine, boiler, and gearing troubles.

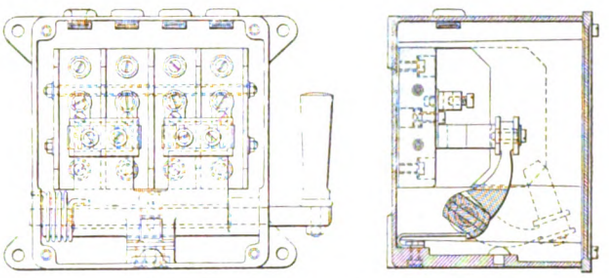
It was pointed out that of the total amount of textile electrical-driving now running in Lancashire and Yorkshire, more than one-third is driven from the mains of power supply companies or municipal corporations, and the present tendency appears to be to further development on these lines.

In dealing with the question of the probability of stoppage of supply under different conditions, Mr. Shaw gives an example from a record of the first cotton mill in the United Kingdom to be driven in this manner. The mill is supplied from a power-station, in which all the plant was new and untried. The mains, sub-station plant, and mill equipment were also new. In other words, the whole of the plant was new, and it could scarcely be expected that hitches might not occur. During the first six months' run the total stoppage in the mill amounted to 5 hours 57 minutes. Of this amount, faults at the power-station and on the mains and substation accounted for 3 hours and 27 minutes. Stoppages on the mill equipment amounted to 2½ hours. During the same period, in another mill of similar size, owned by the same authority, but driven by means of rope-transmission, the total stoppages amounted to 41 hours, and the average stoppages for the five previous half-years in this mill amounted to 11¼ hr. The total stoppages from all causes during the 12 months run, ending December 31st, 1907, of the electrically-driven mill, amounted to only three hours. This record speaks for itself.

A NEW IRONCLAD SWITCH

THE accompanying drawing shows details of a new switch which has been recently introduced by Messrs. A. Reyrolle & Co. with the object of meeting the demand for a flame-proof, rain-proof, double-break, quick-release switch of substantial construction for use in exposed positions, mines, factories, &c.

With regard to the construction of this, it should be noticed that the arms carrying the switch blades are all cast in one piece integral with the sleeve *A*, which is loose on the shaft. The cam *B* is pinned to the spindle, and in putting the switch to the "on" position it engages with the sleeve at the point *C*. On



DOUBLE-POLE IRONCLAD SWITCH.
Scale : ⅛th full size.

the sleeve *A* there are also two projections shown at *D* which are engaged by the spring *E* in the "full on" position only. In switching off, the cam *B* depresses the spring *E*, thus releasing the catch, then engages the sleeve at the point *F* and starts withdrawing the blades, after which the spring *G* takes charge, giving a very quick break. The wearing parts of this switch are built up from small pieces, which are very easily renewable, with the result that the necessary spare parts, for even a large installation, would cost a very small sum only. Having in view the ease with which the parts may be renewed, it was not thought necessary to embody sparking contacts in the design. The switch, which is rated at 25 amps., is also made in the three-pole type.

SOME NEW TELEPHONE DESIGNS

THE General Electric Co.'s new telephone catalogue (the tenth edition), published last week, shows that several interesting modifications in detail have been made in the company's designs. Among the more interesting of these is the development that has been made in the employment of "concealed" terminals. Not only in the case of the best exchange

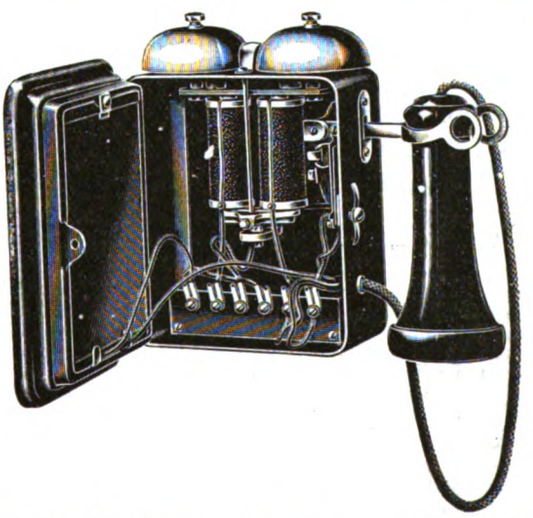


FIG. 1.—C.B. EXCHANGE INSTRUMENT IN STEEL CASE AND WITH CONCEALED TERMINALS.

instruments, but also in some of the cheaper house telephones a hinged back-board is provided, and the terminals are within. A central battery exchange instrument of this type is shown in Fig. 1, which also embodies another new feature, namely, a case made of enamelled mild steel instead of wood.

We also illustrate a new portable telephone for use in tramway feeder pillars. Fig. 2 shows box, fitted with a pair of jacks, which is fixed in the pillar, and Figs. 3 and 4 the hand combination telephone, which is carried by the tram

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conductor. The tabs at the end of the cord are joined permanently to a two-pin plug, which is pushed into the jack. The case of the instrument is of aluminium. The terminals of the "plug-box," connected to the jack, are fitted with small locking screws, preventing the nuts from being completely removed and lost. These, together with the jacks themselves,

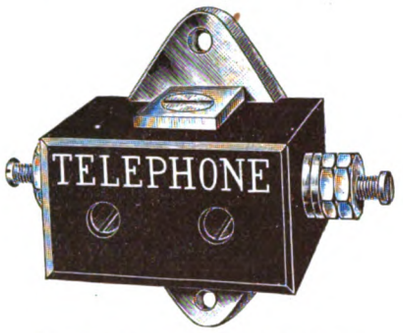


FIG. 2.—PLUG-BOX FOR TRAMWAY FEEDER PILLARS.

are mounted in a solid ebonite block, which is fixed to a cast-iron base. Several other types of tramway telephone and accessories are listed, and the catalogue also includes varieties of water-tight instruments for mining, ships, and engine-house use, telephones for rifle ranges, military telephones, as well as affording an embarrassingly rich choice of instruments for domestic installations and exchange service. We also notice a

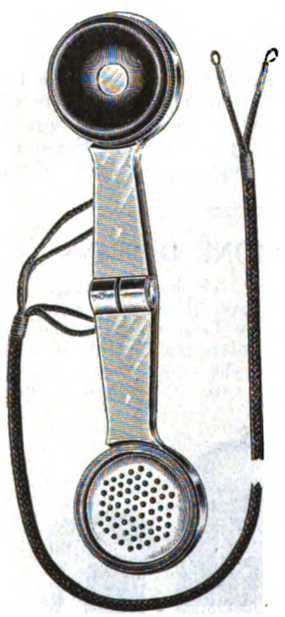


FIG. 3.—ALUMINIUM TRAMWAY TELEPHONE, OPEN.

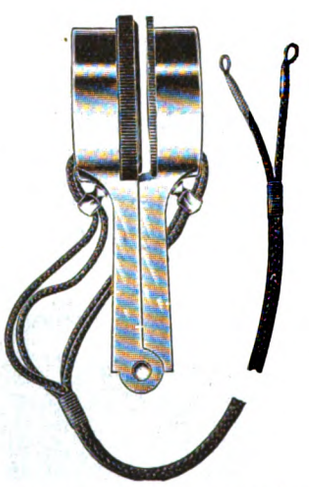


FIG. 4.—ALUMINIUM TRAMWAY TELEPHONE, CLOSED.

thermostat for fire-alarm purposes designed by Lieut.-Col. Fox, of the Salvage Corps. The company inform us that they are prepared to manufacture and erect complete central battery exchange switchboard equipments, and some designs are illustrated in the list. The General Electric Co. have always been famed for the completeness of their catalogues, and this new telephone catalogue fully maintains their reputation in this respect.

A New Metallic Filament Lamp.—The International Electric Co., of 55 Redcross Street, London, E.C., are to-day placing a new metallic filament lamp, the "Orieco," on the market. This lamp is supplied in sizes of from 32 to 50 c.p. at 70 to 130 volts. The efficiency is 1¼ watts per British candle-power, and it is claimed that during an average life of 1,000 hours there is no falling off of efficiency. The lamp may be employed both on continuous and alternating currents. Its price is 4s. As in the case of the majority of other metallic filament lamps, the lamp must be hung in a vertical position. In connection with the supply of the lamps, an interesting fact to be noted is that the suppliers, while paying carriage in the case of consignments of over 50, and making no extra charge for packing, undertake to give credit for breakages if they are notified at once, and the damaged lamps returned forthwith.

CATALOGUES AND PAMPHLETS RECEIVED

ADVERTISING SIGNS.—The Sun Electrical Co., of Charing Cross Road, illustrate a number of effective new patterns of illuminated signs, including their patent kaleidoscope colour-changing sign, and a novelty which immediately attracts attention known as the "winking pup," consisting of an effigy of a particularly knowing yellow puppy, with a lamp in the interior of his head which is connected with a thermoblink flasher, so that he winks his left eye. A very simple form of thermal flasher is listed as well as motor-driven flashes for more complicated effects.

A leaflet received from the Technical Art Co., of Newcastle, whose sole selling agents are Messrs. Jarvis Bros., Ltd., of Middlesbrough, describes a circular sign with a conical back containing the lamps and flashing apparatus. A "duplex" arrangement can be fitted so that different lettering is lighted up alternately.

ENGINEERING SPECIALITIES.—The new catalogue issued by Messrs. Michael Pal & Co., of Parliament Mansions, Victoria Street, S.W., gives particulars of quite a large variety of machinery and appliances of use to engineers. The oil-saving and waste-cleaning apparatus includes separating, washing, and drying machines for oily waste and cloths and oil filters. Fans driven by diminutive steam turbines and water power, which may be useful where electric power is not available, are also listed. Other appliances comprise turbine type boiler-tube cleaners and steam soot and dust blowers. A useful item is an electromagnetic lamp holder, which can be made to adhere to any iron or steel object. Lubricating rotary pumps and automatic chain valves are also dealt with, and illustrations given of dynamos and motors, for full particulars of which reference must be made to a separate list. Attention should also be called to a particularly compact form of pillar type electrically-driven grinding and polishing machines, fitted with twist drill attachment and a pendulum swinging holder, which allows a steady universal movement to be given to the tool while grinding.

INCANDESCENT LAMPS.—A coloured folding card is to hand from "Cryselco, Ltd.," with a representation of an incandescent lamp and a holder on the two halves of the card, so arranged that the collar of the lamp fits into the holder in a very realistic manner.

LIGHTING, POWER, AND HEATING APPARATUS.—The newest batch of leaflets issued by the Electric and Ordnance Accessories Co., Ltd., of "Stellite" Works, Birmingham, cover a considerable range of electrical apparatus. Taking first those dealing with arc lamps, we find a description of the "Victor" flame arc lamp, which has a remarkably simple mechanism consisting of clutches with separate coils for each carbon, so that there are actually only two moving parts. Special care is taken to ensure that fumes are excluded from the interior of the lamp. Other leaflets contain details and coloured illustrations of standard enclosed and miniature "Victor" arc lamps. The lists of Stellite dynamos and motors cover four pole semi-enclosed machines up to about 20 kw. The most attractive of the set of leaflets, from an artistic point of view, are those devoted to electric heaters, which contain some well-executed examples of colour-printing. A large number of designs of "Eclipse" heaters of the induced draught type are illustrated, in which a current of heated air rises from perforations at the top of the case as well as radiators of the lamp type.

MOTOR TESTING BRAKES.—A revised list from Messrs. Morris and Lister, of Coventry, describes the latest pattern of their eddy current testing brake. As compared with the earlier forms of this mechanical construction has been simplified, and at the same time the apparatus has been made more suitable for continuous working without overheating. This has been effected by doing away with the outer pole rings and substituting a disc of iron, attached to each copper disc itself, on which is mounted a series of vanes which promote radiation from the heated disc and at the same time induce a current of air to circulate round the exciting coils. For high-speed work the brake is frequently fitted with ball bearings. The sizes listed range from 3 to 35 h.p. on continuous rating. Special control panels are also included in the list.

PORTABLE AND SEMI-PORTABLE ENGINES.—A magnificently printed illustrated catalogue of portable and semi-portable engines of high class, complete with boilers, and arranged for superheated steam, has been issued by Mr. R. Wolf, who has made a speciality of machinery of this class. A feature of the boilers, which are of the fire-tube type, is that the whole tube system and superheater can be easily taken out and replaced, so that the removal of scale is much facilitated. The arrangement of the superheater immediately at the end of the tubes in the smoke-box ensures a very good efficiency. It is impossible to recapitulate here the features of all the types listed, but a good idea of the economy of the sets can be obtained from the following figures of coal consumption:—Single-cylinder engine of 24 B.H.P., 2·12 lb. of coal per B.H.P. hour; compound condensing engine of 100 B.H.P., 1·37 lb. per B.H.P. hour;

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tandem compound condensing engine with two superheaters of 55 B.H.P., 1·23 lb. per B.H.P. hour. We are also informed that the same makers have recently obtained a figure of 1·11 lb. per B.H.P. hour for a 500 h.p. tandem compound semi-portable set. These engines are particularly suitable for temporary generating stations and extensions, and their variation in speed is guaranteed to be within 1 in 150.

STANDARDISING AND TESTING INSTRUMENTS.—Messrs. R. W. Paul's new instrument catalogue takes the useful form of a number of separate sheets bound together in a cover, so that they can easily be added to. A very large variety of resistance boxes, slide wire resistances, and bridges, variable carbon and other rheostats, are listed, in addition to moving coil "single pivot" galvanometers and measuring instruments. Further forms of galvanometer include the well-known Ayrton-Mather moving coil type, Mr. A. Campbell's standard galvanometer, and Paul's marine galvanometer. Another group of instruments is the series of Duddell-Mather standard wattmeter and anti-capacity gauge resistances. The special instruments for alternating current work include Cohens barretter, the Ayrton-Mather electrostatic voltmeters, and Campbell's vibration galvanometer, and standards of mutual induction.

STEAM TURBINES.—We have received a pamphlet from Messrs. Willans & Robinson, Ltd., describing their system of "mixed pressure" turbines, in which, by specially arranged valves and governor gear, the same turbine can act either as an exhaust steam turbine or as a combination between the two when the supply of exhaust steam falls below the normal.

TELEPHONES.—The Sterling Telephone and Electric Co. have sent us the seventh edition of their long list of telephones and accessories, fire alarms, mining bells, and exploders, &c.

WATER SUPPLY, PUMPS AND ACCESSORIES.—A collection of leaflets from Arnold Goodwin & Sons, of Southwark, deal with their compressed-air system of pumping water, and announce the opening of new departments for hydraulic and general engineering repair work. Other specialities are the "Beatall" patent piston rings, and a series of self-restraining worm-geared lifting blocks and "suspended lift-ways."

ELECTROCHEMISTRY AND ELECTROMETALLURGY

IN the *Comptes rendus de l'Académie des Sciences*, 1907, 645, C. Matignon describes the preparation of aluminium carbide, C_3Al_4. A mixture of fine aluminium powder and lamp black is placed in a Perrot electric furnace and strongly heated; the reaction between the metal and carbon takes place quite smoothly. The heating can also be carried out with an acetylene-oxygen flame. Another method for preparing the carbide is to heat hexachlorobenzene, C_6H_6, in a sealed tube with aluminium to 225°. The carbide gives off methane when acted upon by hydrochloric acid,

$$C_3Al_4+12HCl=3CH_4+4AlCl_3.$$

Time after time patents containing processes for the electroplating of aluminium have been published. but we seem to get very little nearer a successful process for plating upon this

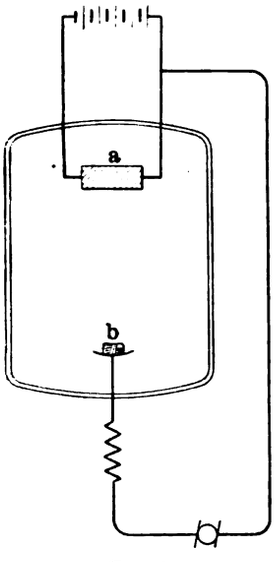


FIG. 1.

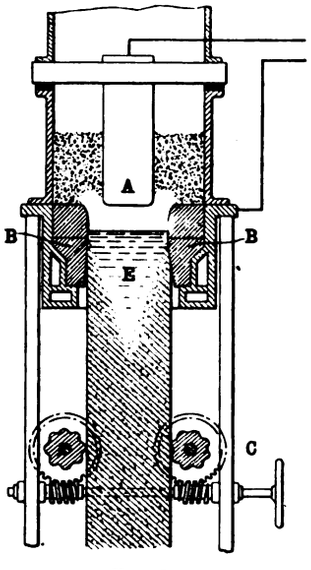


FIG. 2.

metal. According to the *Electrochemische Zeitschrift* of January, the well-known firm of Langbein-Pfanhauser in Leipzig have now worked out a process which is entirely successful. Unfortunately, what the process is is kept a secret.

In the electrolytic production of aluminium by the electrolysis of alumina dissolved in fused cryolite, the electrodes employed are of carbon. In the *American Patent* 872,985 (3/12/07), Henry Spencer protects the use of electrodes of calcium or other carbide. According to Spencer, both the cryolite and alumina take part in the electrolysis, and the electrode is therefore consumed in the following manner:—

$$2AlF_3+2Al_2O_3+3CaC_2=6Al+3CaF_2+6CO.$$

It is usually accepted that in the process as at present worked, only the alumina is decomposed by the current, and that the corrosion of the electrode is entirely due to the action of the liberated oxygen; indeed, great care is taken in the regulation of the voltage in order to prevent the liberation of fluorine. If when calcium carbide electrodes are employed the reaction takes place as above formulated, there seems no reason why the bath should not be started with fused calcium fluoride, since unless cryolite were continually charged in, after a time the bath would become rich in calcium fluoride. Furthermore, as the aluminium fluoride became used up, the alumina alone would take part in the electrolysis. If alumina only took part in the electrolysis, then the electrode would be oxidised as follows:—

$$Al_2O_3+CaC_2=CaO+2CO+2Al.$$

The bath would therefore become choked up with lime, and the resistance would increase. On the other hand, it would hardly pay to continually charge in cryolite, whether artificial or natural.

Up to the present, in order to form reguline masses or filaments of very refractory metals, such as tantalum, it has been customary to compress the powdered metal, and then to cause adherence of the particles by passing an electric current through the compressed mass in an indifferent atmosphere. In the *American Patent*, 873,958 (17/12/07), M. V. Pirani describes a new method of melting the metal in vacuum. An oxide, such as barium oxide, is strongly heated in a vacuum, so that it becomes ionised, there is then no difficulty in striking an arc between it and the substance to be melted. The method of carrying out the operation is shown by the sketch, Fig. 1. *A* is the barium oxide, which can be brought to a high temperature in the vacuum by heating it with the current from the battery *b*. As soon as this has taken place an arc readily springs between the metal to be melted at *a* and the oxide. On a 100-volt circuit the arc can be induced when the oxide and metal are separated by some centimetres, with 50 amperes the metal is very rapidly melted. Either a direct or an an alternating current can be employed.

Calcium carbide is always contaminated with more or less unreduced lime and carbon, and consequently does not yield the same quantity of acetylene as if it were quite pure. J. C. King, in the *American Patent*, 872,351 (3/12/07), describes a furnace for remelting the carbide, and thus getting rid of at any rate a portion of the impurities, and for obtaining it in homogeneous blocks or cylinders. Fig. 2 gives an idea of the furnace which is employed. *A* is the one electrode, and *BB* the other; they both consist of graphite or other form of carbon. The broken carbide is charged in and the current passed. The carbide between *A* and *B* sets up a powerful resistance, and thus becomes strongly heated and plastic. It consequently passes out below *A*, and as it solidifies is drawn continually away by the ratchet arrangement at *C*. For some purposes it certainly would be a great advantage to have the carbide in the form of cylindrical blocks. It would be convenient for packing, and there would be no difficulty in breaking it up as required. The second melting should certainly have a purifying effect.

O. Thallner contributes an interesting, but rather diffuse, article to *Stahl und Eisén*, November 20th and 27th, upon the "Manufacture of High-grade Steel in the Electric Furnace." He considers that the electrode furnace of Héroult is of great use for desulphurising, dephosphorising, and deoxidising. Great credit is due to Héroult, Eichhoff, and Lindenberg, for recognising the possibility of purifying iron and steel by careful manipulation of the slag, and of realising the importance of using pure slags. The electric furnace is generally compared to the crucible furnace but Dr. Thallner considers it as being quite apart from the crucible furnace, where the metal remains molten over long periods. The process in the Héroult furnace consists practically of three stages. In the first place the phosphorus is removed, and the sulphur content reduced; also the carbon is reduced in quantity to about 0·1 per cent. Over-

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oxidation may take place, and manganese and silicon are removed. The second stage is one of deoxidation, and the third stage is a reduction process. The slag is deoxidised by the formation of calcium and silicon carbide, the iron is thus reduced from the slag, and the slag is in a condition to absorb the sulphur. Dr. Thallner mentions that the life of the Héroult furnace is very good, as shown by experience with a 1½-ton furnace in the Lindenberg works at Reinscheid. This furnace has had 2,337 charges, varying between four and ten per day. Sometimes the charges have been cold, and at other times molten. No repairs of any importance have been found necessary, and any small repairs which were required have been easily carried out at small expense. The furnace is not hard to work, but it requires careful attendance.

ELECTRICAL SCIENCE

British and American

Lecture at the Royal Institution.—Prof. E. Rutherford delivered last Friday evening's discourse at the Royal Institution, the subject being that to which he has so largely contributed, radioactivity. It is four years since his last appearance here, so most of his lecture was devoted to a review of the progress made in that time in radioactive knowledge. Some of his remarks on the most recent discoveries may be mentioned. We learn that of the family of radium the youngest known member is radium-G, formerly known as polonium, and extracted several years ago from pitchblende by Mme. Curie. The transformation product, formerly called radium-E, has of late been shown to be complex, and to consist of substances now called respectively radium-E and radium-F. The lecturer complained that there was little advance in the direction of cheapness of radium, but stated that meso-thorium and radio-thorium, which were extremely active substances, were likely soon to be put on the market and to become useful substitutes, in certain experiments, for radium. Prof. Rutherford then traced the story of the pursuit and capture of the father of radium. This has been named ionium by Boltwood, its discoverer; but as these matters have been already dealt with at a number of dates in this column, we need not recapitulate the lecturer's account of the discovery.

Inductance in Parallel Wires.—The effective inductance for high-frequency currents of a circuit consisting of or comprising two parallel wires is often required with considerable accuracy. For instance, in the measurement of small inductance experimentally, the inductance of the leads used should be known with fair accuracy. In *Nature* of January 30th, J. W. Nicholson gives a formula for the case when the two wires, one the return of the other, are equal in radius. His formula is

$$\frac{L}{l} = 4 \log \frac{c}{a} + \frac{4\mu}{x} \cdot \frac{\mathrm{ber}\, x\, \mathrm{ber}'\, x - \mathrm{bei}\, x\, \mathrm{bei}'\, x}{(\mathrm{ber}'\, x)^2 + (\mathrm{bei}'\, x))^2}.$$

where L is the self-induction of a length l, c the distance between the wires, a the radius of the wires, and μ the permeability of their material. The quantity x is equal to

$$2\pi a \sqrt{\frac{2\mu N}{\delta}}.$$

where N is the frequency of alternation per second; and the functions ber x and bei x are those introduced by Lord Kelvin, and subsequently tabulated. The formula becomes less accurate, as c, the distance between the wires, decreases, and also as the frequency increases or the radius of the wires increases. So far as the first cause is concerned the error is not more than 1 per cent. when the distance between the wires is ten times the radius, or 4 per cent. for five times the radius, or 10 per cent. when the distance is only three times the radius. All the other causes of error in the formula taken together yield very slight error, even with frequencies as high as a hundred million per second, so that the range of application of the formula is extremely wide. When the frequencies become low, the formula given above relapses into the common formula for two parallel wires not too near together, namely,

$$\frac{L}{l} = 4 \log_e \frac{c}{a} + \mu.$$

where the symbols have the same meaning as before. The author mentions that the formula he has deduced for two parallel wires, whose radii are not equal, is much more cumbrous than his formula given above.

Continental

Positive Electrons.—A. Dufour has made an observation which, he says, receives its most obvious interpretation on assuming the existence of positive electrons. The observation in question is described in the *Comptes Rendus* for January 20th. When the Zeeman effect is observed in a direction parallel to the magnetic field, each line is resolved into a doublet of light circularly polarised in opposite directions. The shortened wave-length is emitted by the electrons revolving in the sense of the positive magnetising current. In analogous phenomena observed in the absorption spectra of certain crystals and liquids, the same rule is observed, except in a few anomalous cases observed by Jean Becquerel. But no exceptional behaviour has hitherto been observed in bright-line spectra shown by a glowing gas. Now Dufour describes such an anomalous effect in the arc spectrum of pure calcium fluoride, which, according to Fabry, exhibits flutings with sharp edges at 6036·96 A units (D), 6050·81 (D′), and 6064·49 (D″). In a magnetic field, only D″ shows the normal displacement and polarisation. In D the effect produced indicates positive electrons, though the polarisation is not complete. The other lines indicate a similar effect, though more feebly, and it can also be observed in the corresponding absorption spectra. The author's startling conclusion would be more convincing if the effect were shown on pure elementary spectrum lines.

Slightly Damped Oscillations.—Max Wien produced trains of slightly damped oscillations by loosely coupling a strongly damped primary with a feebly-damped secondary. The decrement of the latter, originally d, is increased to

$$d_2 + \frac{\pi^2 k^2}{d_1 - d_2}.$$

by the coupling, where d_1 is the decrement of the primary, and k is the coefficient of coupling. The second term may be reduced by making the coupling loose (reducing k, and also by making d_1 very large. The effect of doing so resulted in small damping, but since loose coupling means a feeble transmission of energy, large capacities had to be employed in the primary in order to get a perceptible transmission. However, the author found that there is no real necessity of making the coupling loose. When k is large, and the spark crosses in air, the spark increases very rapidly in resistance after the first oscillation. For subsequent oscillations the primary circuit is practically open, and the secondary alone oscillates, and continues to oscillate freely. This means that large amounts of energy can be transmitted without much damping. On working out this new method, the author found himself in a position to bring down the decrement to 0·006.

Magnetic Action of Cathode Rays.—Both Hertz and von Geitler looked for the action of a beam of cathode rays upon a magnet as a counterpart to the action of a magnet upon cathode rays. Neither of them succeeded in tracing such an action, and Hertz considered that this negative result proved the cathode rays to be ether waves and not charged particles. Quite recently E. Klupathy has discovered the effect sought for. It is described in No. 1 of the *Annalen der Physik*. A piece of steel wire was magnetised and suspended vertically above a long cathode-ray tube, so that its north-seeking pole was close to the outer glass surface. It was suspended from one end of a rod hung parallel to the tube, and counterbalanced at the other end of the rod by a copper wire. The rod itself was suspended by a long quartz fibre, so that the N-pole was free to move in a direction at right angles to the tube, and oscillated with a period of 85 seconds. The magnet and suspension were enclosed in a glass case. The deflection observed was in the direction expected, and indicated a current of a few millionths of an ampere. On replacing the tube by a wire traversed by an equal current, the same deflection was obtained. A Wehnelt oxidised cathode did not give this effect, probably owing to the high ionisation of the gas in the tube.

Energy in Three-phase Circuits.—G. Lignana deals, in *L'Elettricista*, of December 15th, with the problem of measuring the total energy in a three-phase system having four wires, three attached to the points of the star and one to its centre. This, as a rule, requires three wattmeters of equal range, connecting the central wire with each of the three-phase wires respectively. The author, on the other hand, puts one wattmeter between wires 1 and 2, another between 1 and 3, and a third, provided with a commutator, between 0 and 1. The last of these may be considerably smaller than the two others. Its reading may be positive, negative, or zero. To avoid ambiguities, the load on one of the wires may be varied so as to make the deflection of the third wattmeter zero. In that case the total energy is measured by the sum of the readings of the other two wattmeters. This implies a dissymmetrical charge and a current in the fourth wire, which, however, may be avoided by means of the commutator on the movable coil of the third wattmeter.

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"ELECTRICAL ENGINEERING" PATENT RECORD

(This Patent Record is compiled by our own Editorial Staff and is Strictly Copyright.)

Specifications Published Jan. 30th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

1906 Patents

24,582, BRUCE PEEBLES & CO. & LA COUR. This is a compensated phase transformer for the conversion of single-phase current into polyphase, or *vice versa*, and consists of an ordinary polyphase induction machine with two rotor windings. In the three-phase arrangement, two of the phases of the stator winding are supplied direct from the single-phase circuit, and the third phase is energised by the action of the short-circuited rotor winding. The second winding is an ordinary closed circuit winding with a commutator into which current is supplied from tappings on the stator. This exciting current, the object of which is to prevent the phase transformer from taking a wattless current from the single-phase circuit, can be made to vary with the size and nature of the load, by passing it through a series transformer, the primary of which is in series with the load. Five claims, six figures.

1907 Patents

2,595, ATELIERS THOMSON-HOUSTON. This relates to dynamo-electric machines having good commutation at all loads whilst permitting the direction of rotation to be reversed without displacing the brushes. In compensated machines in which the polarising ampere turns differ from the number of compensating ampere turns, a single winding is so arranged that in every zone of the stator the ampere turns of the winding are equivalent to the geometrical sum of the superposed polarising and compensating ampere turns, and adapted for rotation in either direction without moving the brushes, the ampere turns of each section being equivalent to the geometrical sum of the ampere turns necessary for polarisation, and those for compensation in every zone of the motor. Two claims, four figures.

11,621, BROOKS & AKERS. An arrangement for regulating alternating-current machines when coupled in parallel, and connected to the main bus bars through the primary windings of transformers, the secondaries of which are in closed series. The transformers are combined with reactance coils, through which the machines are connected to an auxiliary bus bar, by means of which the transformers effect the balancing of the load, and the coils counteract the tendency to get out of step. One claim, one figure.

12,923, THE BRITISH WESTINGHOUSE ELECTRIC CO., LTD. This relates to means for neutralising and preventing disturbances in electric circuits caused by electro-magnetic induction from other circuits near to them, and is particularly of service to telephone and telegraph circuits which run parallel to alternating distributing circuits. The E.M.F. is neutralised by means of a transformer, the primary winding of which is connected in series with an auxiliary circuit; the secondary is connected in series with the intelligence transmission circuits, so that its voltages oppose and neutralise those induced in them, by the E.M.F. set up by the power transmission system. If all the circuits have earth return conductors, a part of the current of the power transmission will return through the metallic conductor of the intelligence transmission circuit. The auxiliary circuit should be of the same character as the transmission circuit, and an earth return is provided in the auxiliary circuit. The transformers may be placed at varying distances from each other. Two claims, five figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Names in brackets indicate communicators of inventions from abroad.

Summaries of the more important of these patents will appear in our next issue.

1906 Patents

22,379, HATFIELD. Voltameters.
25,411, BERRY. Electrically-heated apparatus for cooking.
28,628, CLARK & VLASTO. Electric switches.

1907 Patents

783, CALVERT. Covering, arranging, and mounting electric conductors.
813, DAVIES. Automatic fog-signalling apparatus for railways and the like.
899, HOLLIDGE. Magnetic separators.
919, PARSONS & BALL. Electric clocks.
1,005, LANCASHIRE DYNAMO & MOTOR CO., WARBURTON, & KELSALL. Auxiliary dynamo-electric machines.
1,099, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric switches.
1,099A, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric switches.
1,191, STOCKALL. Electric circuit closing devices.
1,195, HAMILTON. Electrostatic measuring instruments.
1,277, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric switches.
1,279, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Systems of electric motor control.
1,449, FRASER. Braking of electrically-propelled vehicles.
1,499, MANDERS. Production of continuous electrical oscillations for therapeutic purposes.
3,432, EDGAR & EDGAR. Electric switches.
3,633, BRITISH THOMSON-HOUSTON CO. & HOLDEN. Electric meters.
4,081, ELECTRIC IGNITION CO. & HALL. Electric ignition-apparatus of internal-combustion engines.
4,183, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Protective devices for electrical apparatus.
4,782, BROADBENT. Electric switches.
5,424, DAMSEAUX. Electric incandescent lamps of variable intensity and holders for the same.
5,502, BOLTON & COVENTRY WATCH MOVEMENT MANUFACTURING CO. Electrical switches.
6,266, BRITISH ELECTRIC PLANT CO. & OELSCHLAGER. Commutation of dynamo-electric machines.
7,279, ANGOLD & MAXIM ELECTRICAL CO. Electric arc lamps.
9,240, MÖLLER. Electric time-pieces.
9,337, NORTH & POHL. Electrolytic electricity meters.
9,991, ELLIOTT. Multiple sockets for incandescent lamps.
10,406, W. T. HENLEY'S TELEGRAPH WORKS CO. & NICHOLS. Junction boxes for electrical cables.
10,469, HAHN. Electrical vapour apparatus.
10,786, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electrical signalling systems and apparatus therefor.
11,616, FLUEGELMAN. Electro-magnetic counters.
11,717, SIEMENS & HALSKE AKT.-GES. Metallic filament lamps.
11,823, LAKE (*Stone*). Devices for amplifying telephone currents.
12,356, STEPANOW. Method of signalling by means of electric lights and apparatus therefor.
12,531, TURNER. Electric connectors or couplings.
15,755, ANKER. Ear-guard for telephone receivers.
16,251, HINSKY. Insulating conduits for electric wires.
17,079, GSCHWEND. Medical electric heating appliances.
17,722, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric controllers.
17,968, CLASSEN. Process for electrolytic metallic coating upon metals.
17,969, CLASSEN. Electrolytic process for the production of metallic dark coatings upon metals.
18,921, BRITISH INSULATED AND HELSBY CABLES, LTD., & HARRISON. Electric telegraph apparatus.
19,800, LAKE (*Fabrik Elektrischer Zunder*). Dynamos especially applicable for exploding electric igniters.
20,650, HARTENSTEIN. Electric furnaces.
20,948, SIEMENS BROS. DYNAMO WORKS, LTD. (*Siemens Schuckertwerke Ges.*). Method for reducing disturbances in telephone and telegraph wires.
21,862, RICKMANN. Armature for magneto-electric igniting apparatus.
22,322, JONES. Brakes for tramway and railway vehicles.
24,028, WOLFRAM LAMPEN AKT.-GES. Process for decarbonising tungsten filaments containing carbon or carbide.
26,130, BREWER (*Taylor*). Electric furnaces.
26,846, ALLGEMEINE ELEKTRIZITÄTS GES. Arc lamps.

Complete Specifications open to Public Inspection before Acceptance, under the Patents Act, 1901.

1907 Patents

5,506A, LAMME. Connections for dynamo-electric machines.
16,854, TARDIEU. Telephonic apparatus.

1908 Patents

327, LERTOURNÉ. Electric speed indicators.
328, LERTOURNÉ. Electric motors.
660, ALLGEMEINE ELEKTRIZITÄTS GES. Multiple-rate meters.
661, ALEXANDERSON. Dynamo-electric machine.
700, AGRELL. Electric type printing apparatus.
889, SEIBT & AMALGAMATED RADIO TELEGRAPH CO. Radio-telephony.

Expiring Patent

The following patent expires during the current week, after a life of fourteen years:—

No. 3020, February 12th, 1894. FREDERICK TUDSBURY. Improvements in electrical machines, to increase the output and efficiency of induction machines, and particularly applicable to machines of the "Wimshurst" type.

For LOCAL NOTES, &c., see pp. 213 to 220

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Pooje E. S. Co. Ld.	10	7	5/-*	10¾—11¾	
Do. 4½% Cum. Pref.	10	4½	4½*	10—11	
Do. 6% Cum. Second Pref.	10	6	6	10⅝—10⅞	
Do. 4½% Debenture, Red.	Stock	4½	4½	100—103	+1
Bromley (Kent) E. L. & Power Co., Ld.	5	5½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	95—98	
Brompton & Kensington E. S. Co., Ld.	5	10	4½*	7—8	
Do. 7% Cum. Pref.	5	7	7%*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	97—100	
Ch. Cross. W. E. & City E. S. Co.	5	5	5%*	4¼—4¾	-¼
Do. 4½% Cum. Pref.	5	4½	2½*	4¼—5	
Do. 4% Deb. Red	Stock	4	4%	97—100	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½	4¼—4¾	
Chelsea Electric Supply Co., Ltd.	5	4½	2-*	3⅝—4⅛	
Do. 4½% Deb. Red	Stock	4½	4½	101—104	+1
City of London Elec. Lt. Co., Ltd.	10	6	5%*	10—11	
Do. 6% Cum. Pref.	10	6	6%*	11½—12½	
Do. 5% Deb. Red	Stock	5	5	120—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	98—101	+1
City of Durham E. P. Dis. Co.	5	4	2/1%*	3½—4¼	
Do. 5% Pref.	5	5	5%*	4⅝—4⅞	
County of London Elect. Sup. Co. Ld.	10	5	4%*	7—7¼	+¼
Do. 6% Cum. Pref.	10	6	6%*	11—11½	+⅝
Do. 4½% Deb. Red	Stock	4½	4½	105—108	+2
Do. 4½% 2nd Deb. Red	Stock	4½	4½	96—99	+1
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅜—⅝	
Do. 6% Cum. Pref.	5	3½	—	⅜—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	70—80	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4⅝—5⅛	+⅛
Do. 5% Cum. Pref.	5	5	2/6*	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6¼—6⅞	-⅛
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½	92—95	
Kensington & Knightsbridge E. L. Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%	95—98 xd	-1
Kens. & N'ting Hill E. L. Cos. Db. Rd.	Stock	4	4%	99—103	
London Electric Supply Corporation	3	4	2/1½d*	1¼—1¾	
Do. 6% Pref.	5	6	6%*	4⅝—5⅝	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	91—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	6—6½	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅝—5⅝	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	102—106	
Do. 3½% Mort. Deb. Red	Stock	3½	3½	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D	100 & 500	4½	4½	97—100	+1
Newcastle & Dist. E. L. Co., £9 paid	10	5	3/7½d.*	9½—10½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6¾—6⅞	
Do. £2 Pm.	5	8	1/4½d*	6¾—6⅞	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5½	
Do. 10/- Pm.	5	5	1/4½d	5—5½	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	6%*	11½—12½	+½
Oxford Electric Co., Ltd.	5	7	2/6*	5⅝—6½	+⅛
Do. 4% Deb. Red.	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ld.	5	10	5/-*	7⅜—8¾	
Do. 7% Non-Cum. Pref.	5	7	3/6*	6¾—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—1½	
Do. 4% Deb. Red	Stock	4	4/-*	70—74	-1
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2½—3	
South Metropolitan E. L. & P. Co.	1	2½	6d*	⅝—¾	
Do. 7% Cum. Pref.	1	7	8½d.*	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	101—104	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1½—2¼	
Do. 5% Cum. Pref.	5	5	2/6*	2—2½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	5%*	8—9	-½
Do. 4½% Cum. Pref.	5	4½	4½%	5—5½	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	87—90	
Central London	Stock	4	3%	65—68	
Do. 4% Preferred	Stock	4	4%*	84—86	
Do. Deferred	Stock	4	—	43—46	
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	74—77	+1
City and South London Cons.	Stock	2⅝	2⅝	41—43	-3
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%*	116—119	
Do. 5% Perp. Pref. 1895	Stock	5	5%*	114—117	
Do. 5% Perp. Pref. 1901	Stock	5	5%*	113—116	
Great Northern & City Pref. "A"	10	4	11½d.	1¼—1⅜	
Gt. Northern, Piccadilly & Brompton	10	4	4/-*	4—5	
Do. 4% Perp. Deb.	Stock	4	4%	82—85	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	¾%	37½—38½ xd	+1
Do. 3½% Preference	Stock	3½	3½%	36—89 xd	-1
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79 xd	-1
Do. 3½% Convertible Pref.	Stock	3½	3½%	72—75 xd	-2
Metropolitan District	Stock	nil	—	10—11	
Do. 6% Perp. Deb.	Stock	6	6%	106—111	+1
Do. 4% Pref. Deb.	Stock	4	4%	70—75	
Do. Extension Pref. (5%)	Stock	nil	—	20—25	+2
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½%	46—51 xd	-1
Underground Elec. Railways Co of London 5% Profit Shg. Sec. Notes	Various	5	5%	36—40	
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	1¼—1⅜	
Do. 5% Cum. Pref.	1	5	5%	1⅜—1⅝	
Do. 4½% Deb. Red.	Stock	4½	4½%	90—95	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1—1½	-¼
Do. 6% Cum. Pref.	10	6	6%*	4½—5	-¼
Do. 5% Perp. Deb.	Stock	5	5%	93—96	
Do. 4½% 2nd Deb.	Stock	4½	4½%	70—74	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4¼—4¾	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	96—99	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%			
Dublin United Trams Co.	10	6	6%*	12½—13½	-½
Do. 6% Pref.	10	6	6%*	12⅝—13⅝	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	⅞—1⅝	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs.. Pr. Lien Db.	Stock	5	5%	92—95	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7⅛—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—85	+1
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	95—98	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—1/8	
Do. 5% Cum. Pref.	1	5	6d*	½—⅝	
Do. 4½% Deb. Stk Red.	Stock	4½	4½%	94—97	+1
National Elec. Construction Co. Ltd.	1	10	2/-	⅛—⅜	-1/16
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅝—1⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	½—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9½d*	¼—⅜	-1/16
Do. 5% Cum. Pref.	1	5	5%*	⅜—½	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3½	4%	4⅛—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	1/1½	⅞—1⅛ xd	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	60—70	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1¼	
Do. 6% Cum. Pref.	5	nil	—	3½—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	30/-	57—60	
Do. 6% Pref. Ord.	Stock	6	3%	101½—103½	-½
Do. Def. Ord.	Stock	1¾	—	16—16½	-1
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	85—88	+4
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3½	
Do. 10% Cum. Pref.	5	10	5/-*	8½—9½	+¾
Do. 4½% Debs.	50	4½	4½%	98—101	+1
Direct United States Cable Co. Ltd.	20	4¼	4⅜%	13¾—14¼	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4½% Mt. Deb.	100	4	4%	97—100 xd	-1
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12½—13	+½
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102 xd	-1
Eastern Telegraph Co.	Stock	5⅜	5%	130—135	
Do. 3½% Pref.	Stock	3½	1¾%	84—87	+2
Do. 4% Mort. Deb.	Stock	4	4%	100—103	+1
G. N. Tel. Co. (Copenhagen)	10	20	5%	33—35	+3
Indo-European Telegraph Co. Ltd.	25	13	65/-	53—56	+1
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅝—¾	+1/16
National Telephone Co., Ltd., Pref.	Stock	6	6%*	111—113	+½
Do. Deferred	Stock	5½	6%*	110—112	
Do. 6% Cum. 1st Pref.	10	6	6%*	11—13	
Do. 6% Cum. 2nd Pref.	10	6	6%*	10½—12½	+½
Do. 5% 3rd Pref.	5	5	5%*	5⅜—5⅝	+⅛
Do. 3½% Deb. Red	Stock	3½	3½%	97—99	+⅛
Do. 4% Deb. Red.	Stock	4	4%	99½—101½	+½
West African Telegraph Co. Ltd.	10	4	4/-	10—10½	
Western Telegraph Co., Ltd.	10	7	6%	12⅝—13⅜	-⅛
Do. 4% Deb.	Stock	4	4%	98—101	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	7/16—⅝	
Do. 6% Cum. Pref.	1	6	7½d	¾—1⅛	+⅛
Babcock & Wilcox, Ord.	1	20	1/7½*	3½—3⅝	
Do. 6% Pref.	1	6	7½d	1⅛—1⅜	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6⅝—7⅛	+⅛
Do. 6% Cum. Pref.	5	6	6%	5¾—6 xd	-⅛
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	100—103	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%*	85—89	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅝—1	
Do. 4% Mort. Deb. Red.	Stock	4	4%	40—45	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅜	+⅛
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	82—85	-1
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	9½—10½	
Do. 5% Cum. Pref.	5	5	5%	5¼—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	104—106	
Consolidated Electrical Co., Ltd.	1	3	8½d*	⅞—1	
Crompton & Co., Ltd.	3	5	5%	1⅜—2	+1/16
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	-2
Dick, Kerr & Co., Ltd.	1	10	2/-*	1—1¼	-⅛
Do. 6% Cum. Pref.	1	6	7½d	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	99—102	
Edison & Swan United "A." £3 paid	5	4½	2/6	⅞—1⅛	
Do. do. (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	1/16—⅛	
Do. 7% Cum. Pref.	2	7	—	1/16—⅛	+1/16
Do. 4% 1st Mort. Deb.	Stock	4	4%	65—69	+1
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	10½—11½	
Do. 4½% Cum. Pref.	5	4½	2/3*	4⅞—5⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	104½—106½	
I. R. & G. P. Co., Ltd.	10	10	10%	14¾—15¾	+½
Do. 4% Deb. Red.	100	4	4%*	98—100	
Tel. Const. & Maintenance Co.	12	15	5%*	29—31	+½
Do. 4% Deb. Bds. Red	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3½—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

ABERDEEN: *The Tramway Service.*—Complaints have been made by the residents along certain tramway routes as to the service being behind schedule time. The tramway manager has submitted a statement which shows that for sixteen weekdays the cars on these routes were only one-sixteenth of a minute behind schedule time, and the committee have accordingly agreed that there has been no foundation for the complaint. Mr. J. D. Laird, the traffic superintendent, having secured a position with the Halifax Corporation, the General Manager has arranged that the work of superintending the traffic shall be carried on without an increase of staff.

Electricity Supply.—The Electrical Engineer has received an application from the Admiralty for a supply of electric power to the proposed wireless telegraph station which is to be established at Aberdeen. A schedule of prices is to be drawn up. During December, 1907, 696,771 Board of Trade units were generated compared with 760,865 during the corresponding month of 1906.

Purchase of Deeside Co.'s Undertaking.—The Corporation electrical engineer, Mr. J. A. Bell, has prepared a report showing the capital expenditure of the Deeside Electricity Supply Co., without any allowance for depreciation, sinking, or reserve funds. The nominal capital of the company was £10,000, and the price paid by the company in December, 1905, to Messrs. Lowdon Brothers for the undertaking was £7,500. Subsequently, the company installed plant to the value of £1,712, and a workmen's cottage had been erected at a cost of £330, making a total of £9,842. The valuation Mr. Bell made for the Corporation of the undertaking as a going concern was £6,137, which, however, did not include anything for the cost of the company's provisional order, or the flotation of the company, amounting to £667, or for good-will, &c. The company's profit for the year ended December, 1906, was £283 3s. 9d., from which was deducted, interest £54, and proportion of preliminary expenses, £36 7s. 8d., leaving £192 16s. 1d. as the net profit for the year. The units sold for the year ended December, 1907, show a 10·4 per cent. increase over the preceding year. The undertaking, as taken over by the Corporation, had 141 consumers. It will be remembered that the Corporation sought and obtained powers to purchase the company's undertaking in a Bill last session.

ACCRINGTON: *Tramway Supervision.*—The General Works Committee have agreed to take over the supervision, maintenance, and repair of the tramways, the cost thereof to be chargeable to the tramways' department.

BATH: *Purchase of Electric Light Works.*—The arrangements between Mr. Schenk, which were made some time ago on behalf of the Somerset and District Electric Light Co. and the Corporation to purchase the electricity works, expires at the end of March. Up to the present the necessary capital to carry out the purchase has not been obtained, and if the agreement has not been put into force by the time mentioned, the deposit of £2,500 will be forfeited. In the meantime a suggestion has been made that the works should be leased or the option to purchase shall be further extended.

BLACKBURN: *Tramway Statistics.*—The Borough Treasurer's statement relating to the working of the Corporation electric cars for the nine months ended December 31st shows total expenditure amounting to £28,492, averaging 8·06d. per car mile, and receipts £47,424, averaging 13·42d. per car mile. The sum of £18,931 is carried to net revenue account, and after payment of sinking fund and interest, the net profit on the nine months' working is returned at £3,362 16s. 2d.

BRIGHTON: *Tramway Undertaking.*—A resolution is down to be moved at the next meeting of the Corporation recommending the Tramways Committee to obtain expert advice as to the present system of running the cars with a view to improving the service generally.

BURY: *Proposed New Electricity Works.* In response to a request from the Bury Chamber of Commerce, the Corporation has decided to supply details of the scheme for building a new generating station. No application has yet been made for the necessary borrowing powers.

CANADA: *Electric Railway Developments.*—It is stated that progress is being made in connection with the company which proposes to spend £2,000,000 upon electric railway and other enterprises in Canada. Engineers are said to be engaged in making the necessary surveys in connection with electric railways in the rural districts of Ontario and Montreal. It is also proposed to take the Toronto Street Railway in hand and greatly improve it.

CARDIFF: *Telephone Call Boxes.*—The National Telephone Co. have opened six public call boxes in the Docks district, the charge being 1d. for communication with subscribers connected to any exchange in the Cardiff area, and 2d. per call to certain places beyond.

Tramway Receipts.—Mr. Arthur Ellis, the Tramways Manager, reports that, based upon nine months' actual expenditure from figures supplied by the City Treasurer, he estimates that at the end of the year there will be a profit of £15,000 from the tramway system, as against £4,000 last year.

COLNE: *Road Repair by Tramway Co.*—A dispute between the Town Council and the Colne and Trawden Light Railway Co., on a question of principle regarding the repair of the roadway just outside the light railway track, is to be submitted to arbitration.

DERBY: *Tramway Extensions.*—Preliminary runs have been made over the recently converted Nottingham Road route, and it is anticipated that the line will be opened for traffic this week.

DORCHESTER: *Provisional Order Revocation.*—The Board of Trade has revoked the Dorchester Electric Lighting Order, 1901.

DUNFERMLINE: *Electricity Supply.*—After considering the report made by Sir Alexander Kennedy, in which he advises the transfer of their electric lighting provisional order to the Fife Electric Power Co., the Town Council has requested Sir Alexander to ascertain upon what terms the company would acquire the order.

EASTBOURNE: *Assessment of Electricity Works.*—As the result of a conference between the Electric and Lighting Committee, and the Assessment Committee it has been agreed that the assessment of the electricity undertaking shall be increased from £1,420 to £3,020.

FINCHLEY: *Extensions of Electric Lighting Area.*—As we have already reported, a ratepayers' meeting has rejected the clause in the Corporation's Bill for enlarging the electric lighting area. The matter came up at a special meeting of the Council last week, when this decision of the ratepayers was confirmed.

HALIFAX: *Workmen's Tramway Fares.*—In reply to a communication from the Board of Trade, the Tramways Committee state that the delay in working out a scheme of workmen's fares to meet the wishes of the ratepayers, who memorialised the Board of Trade, has been due to the recent changes in the managership.

HANWELL: *Tramway Nuisance.*—At the last meeting of the District Council a letter was received from the Board of Trade in answer to the Clerk's letter, regarding the noise of the trams, stating that so far as the section of the Tramway Act relating to the obligations of the London United Tramways Co. were concerned, the Board was not prepared to order any inspection, since it did not appear to them that an inspection could determine the question whether the track was being maintained with such materials and in such manner as the road authority should direct, and to their satisfaction. The Board asked whether the Council alleged that the company had failed to comply with the provisions of the former section, viz., that they should "maintain the track so as not to be a danger or an annoyance to the ordinary traffic." The Clerk was directed to reply that the state of the track was both a danger and annoyance to the ordinary traffic.

HULL: *Telephonic Intercommunication.*—Arrangements have now been completed for intercommunication between the Corporation telephone service and that of the National Telephone Co. The company will in future abandon the present transfer system and pass all calls direct.

Electricity Finances.—At the meeting of the Electricity Committee on Thursday last week it was decided to transfer the sum of £20,362, the amount of the present reserve fund, towards extinguishing the capital expended beyond the amount sanctioned by the Local Government Board. It was stated that the amount sanctioned was £334,365, whilst the sum actually spent at March 31st, 1907, was £355,321. This action on the part of the committee has been brought about by a suggestion made by the Local Government Board Inspector at the recent inquiry for further loans when dealing with the excess expenditure.

ILFORD: *Tramways Intercommunication.*—The Board of Trade have communicated with the Council, asking whether any decision has been come to regarding the proposed interrunning of tramcars between the Ilford and Barking tramways systems. The Tramway Committee now state that it is impossible to arrange such a system of intercommunication between the two systems, but recommend that an offer be made to run Ilford cars over certain of the Barking lines, the conditions being that the whole of the receipts, whilst the cars are running on the Barking section, be handed to the Barking Council, less the Ilford Council's actual working expenses.

INDIA: *Progress Under the Electricity Act.*—The Calcutta *Statesman* gives the following list of applications for electricity supply and tramway powers under the Indian Electricity Act for authority to establish electrical undertakings in India, with the progress made in each case.—*Calcutta*—Electricity supply and tramways scheme in operation. *Darjeeling*—General electricity supply, in operation. *Barrackpore*—General electricity supply, in operation. *Howrah*—General electricity supply, suction gas plant, in operation. Tramways scheme, Diesel engines, in progress. *Coal Fields District*—Power-licence granted. *Hooghly River District*—Power-licence granted. *Dacca*—General electricity supply, in operation. *Cawnpore*—General electricity supply and tramways, in oper-

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ation. *Lucknow*—General electricity supply and tramways, in progress. *Benares*—General electricity supply and tramways, licence granted. *Amritsar*—General electricity supply, licence granted. *Delhi*—General electricity supply and tramways, in operation. *Bombay*—General electricity supply and tramways, in operation. Hydro-electric long-distance power transmission, licence granted. *Nagpur*—General electricity supply and tramways, in progress. *Jubbulpur*—General electricity supply and tramways, licence granted. *Secunderabad*—General electricity supply and tramways, licence granted. *Madras*—electricity supply and tramways schemes, in operation. *Rangoon*—General electricity supply and tramways, in operation. *Mandalay*—Tramways, in operation.

KNARESBOROUGH.—*Electricity Supply.*—The Council's attention having been called to the decision of the Harrogate Cortention having been called to the decision of the Harrogate Corporation to apply for a Provisional Order extending the area of their present electricity undertaking to include Knaresborough, it has been decided to take no action in the matter.

LANCASTER: *The Tramway Question.*—A discussion took place in the Town Council last week with regard to the continued decrease in the local tramway receipts. The question of converting the lines to electric traction in conjunction with the Morecambe tramways has received attention from time to time, and the suggestion was again raised. No action was taken with regard to the matter, however.

LEYTON: *North East London Railway Act.*—The Urban District Council has resolved to call the attention of the Board of Trade to the serious delay in putting into operation the powers granted by the North East London Railway Act, 1905, and the serious effect entailed on the district by this delay.

Supply of Electricity Bill.—The Legal and Parliamentary Committee have recommended that the seal of the Council should be affixed to a memorial to the Prime Minister and the Board of Trade in favour of the reintroduction of the Supply of Electricity Bill.

LITTLE LEVER (LANCS.): *Tramway Extension.*—A deputation from the Little Lever District Council has been appointed to wait upon the Bury Corporation to ask that authority to provide tramways in that district.

LONDON: *Camberwell: Local Firms' Tenders.*—At the last meeting of the Borough Council, a resolution was moved to the effect that in the case of tenders received from local firms, a reduction of 10 per cent. should be made for the purpose of comparison between these tenders and those coming from firms whose works are outside the Borough. In the event of this reduction of 10 per cent. making the local tender the lowest, the mover of the resolution suggested that it should be accepted. The object was, he said, to induce firms to set up works in Camberwell, and so increase the rateable value of the district. The motion was almost unanimously rejected.

City of London: Audit of Electric Supply Companies' Accounts.—The Court of Common Council has decided to support the Bermondsey and other Borough Councils in protesting against the Board of Trade proposal to dispense with the official audit of the accounts of electric lighting companies. Further information concerning this matter was published in our issue for January 23rd, page 112.

MORLEY: *Proposed Purchase of Tramways.*—At a meeting of the Town Council on Monday, a resolution was carried committing the Council to the purchase of the light railways authorised to be constructed in the town. The lines will subsequently be leased for a term of 28 years at a rental of £3,000 per annum.

NEWPORT (MON.): *Parcel Carrying on Tramcars.*—The Electricity and Tramways Committee looks favourably upon the suggestion of introducing a system of carrying parcels upon the tramcars, and inquiries are being made into results obtained in this connection in other towns.

OXFORD: *The Dolter Surface Contact System.*—A reply has been sent to the Town Clerk by the engineer to the National Electric Construction Co. to the report upon the Dolter surface contact system made by the consulting engineer to the Corporation, Mr. Stephen Sellon (ELECTRICAL ENGINEERING, January 2nd, p. 28). Mr. E. A. Mitchell says that Mr. Sellon is not very definite as to what he means by "experimental stage." Did he suggest that no progress should be made, and that no endeavour should be made to eliminate any small defects? He had, from the local paper, taken the number of passengers carried on the front line from January 26th, 1907, to November 16th, 1907—40 weeks—and the total is 2,255,135. If an efficient service of cars had not been maintained it would have been impossible to have carried this number of passengers over so short a route. Mr. Sellon had evidently overlooked the fact that at Hastings the Board of Trade have given the Dolter system a clean certificate, that ever since they opened there they have had to report every live stud, and that, owing to danger from salt-water flooding the track, the Board of Trade inspector made a special test of the effect of salt-water, and then defined that a "live stud" should mean any stud reading over 18 volts to earth. Could Mr. Sellon point to any system where such stringent requirements have been laid down? Mr. Mitchell also asks where Mr. Sellon obtained his information from regarding the patrol of four men on the look-out for live studs. Certainly not from observation. As a matter of fact, at the present moment, only two men were on the track at any one time. He did not know how Mr. Sellon arrived at his figure of "25 per cent. more current than the average electrical undertaking." He had figures of current consumption obtained from the Hastings Tramway Co., on November 22nd, 1907, which showed an average of 1·196 units per car mile. It must be admitted by any unbiassed electrical engineer that a track impregnated with salt-water, as at times at Hastings, would give more surface leakage than a similar track which has only to deal with rain-water, and he had, therefore, no hesitation in saying that the current consumption per car mile along the front at Hastings was excellent, and, in his opinion, would not be improved upon by the overhead system. In conclusion, Mr. Mitchell points out the Dolter system at Hastings has been installed under very onerous conditions, the principal being that the line was to be put down at the company's expense for a period of twelve months, the Hastings company to take it over and pay for it upon the expiry of that period, if it was satisfactory. Certain guarantees were also given as to the efficient working, and so on, and these guarantees he claimed to have fulfilled. Having regard, therefore, to the amount at stake, it was only natural that with a new system, which had not been working in this country before, the directors should err on the side of safety, and the result of experience proved that the staff could have been reduced considerably. It is now stated that the installation has been taken over by the Hastings company as satisfactory.

PENGE: *The London Power Bills.*—Reporting upon the London and District Electric Supply Bill and the London Electric Supply Bill (Joint Committee), the Town Clerk states that neither appears to adversely affect the interests of Penge, and the Council accordingly does not deem it necessary to take any action with regard to opposing these measures.

POTTERIES DISTRICT: *Tramway Fares.*—The North Staffordshire Trades and Labour Council and the Tunstall Education Committee are reviving the agitation against the increase of workmen's fares and the price of weekly tickets. The Fenton and Stoke Urban District Council and the North Staffordshire Chamber of Commerce are also taking the matter up, and making representations to the British Electric Traction Company.

RICHMOND: *West London, Barnes, and Richmond Tramways.*—Mr. H. B. Renwick and Mr. Stephen Sollon, representing the promoters of the West London, Barnes and Richmond Tramways, met the Tramways Committee of the Borough Council on the 29th ult., with the object of agreeing to terms.

SOUTH SHIELDS: *The Tramway Staff.*—The Tramways Committee has submitted a report to the Corporation to the effect that, in view of serious difficulties which have arisen from time to time between the tramway manager and the car-shed superintendent, and the apparent impossibility of their being able to work together to the advantage and satisfaction of the committee and the undertaking, and to the fact that the machinery and the cars have not been maintained in such a condition of order and repair as might have been, the committee deem it advisable to request the car-shed superintendent to hand in his resignation. The resolution has been adopted.

SUNDERLAND: *Tramway Statistics.*—The Tramways Committee have presented a statement showing the estimated expenditure and revenue up to March 31st, 1908, for the purpose of fixing the amount which will be available for the borough rates. The actual figures for the year, however, will not be available until April. Owing to the extremely bad state of trade and the distress in Sunderland during the past year and at the present time, the receipts have suffered a considerable drop, and are still going down. According to the statement above referred to, the income for the year ending March 31st, 1908, is estimated at £71,286 14s.; the traffic expenses amount to £18,959; general expenses, £5,172 3s.; general repairs and maintenance, £4,110; power expenses, £12,840; deducting interest on loans, £8,563 16s.; sinking fund, £9,370; reserve and renewals fund, £6,200, and various other items, leaves a balance available for the Borough funds of £4,288.

TORQUAY: *Tramway Extensions.*—Representations are being made to the Town Council objecting to the proposal of the Tramways Company to delay construction of the tram lines along the sea front until after Easter. It is pointed out that the construction of tramways in this part of the town during the season will be a serious inconvenience and annoyance to the visitors.

WALTHAMSTOW: *Auditor's Criticisms of Electricity Accounts.*—In his report upon the electricity accounts for the year ending March 31st, 1906, the District Auditor, Mr. D. H. Boggis-Rolfe, makes some strong remarks upon the manner in which the accounts have been kept, and goes into detail as to items which should have been charged to revenue, but which are charged to capital. The gross profit shown was £10.550 8s 4d., with a net available profit of £171 19s., this, together with £1,302 10s., the balance brought forward from last year-making £1,474 9s. 4d., has been carried to the relief of rates. The auditor regards this action as absolutely unjustifiable. Likewise the account of stock in hand is criticised and the certifi-

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cate given by the Electrical and Tramways Engineer, who was not appointed until May, 1906, is considered valueless. Complaint is also made that the Council continues to use tramways money for electric lighting purposes, and that no certificates have been furnished as to the state of repair of the works. The auditor arrives at the conclusion that the year's working has resulted in a loss. Among the reasons for this are that the sum of £200 charged in respect of officers' salaries is inadequate, whilst the amount debited for public lighting is excessive. The auditor also reports upon the accounts for the year ended March 31st, 1907, but his remarks are not of such a condemnatory character. The gross profit is £6,191, compared with £10,550 8s. 4d. in the previous year. After debiting interest and sinking fund, there is a loss of £4,247 5s., after being charged against the accounts sums amounting to £1,489 17s., which the auditor states has been unjustifiably charged to capital in former years. The light railways accounts are also adversely criticised.

WEDNESBURY: *The New Electricity Works.*—At the request of the Board of Trade, a meeting was held a short time ago between representatives of the Midland Electric Corporation for Power Distribution and the Wednesbury Corporation with regard to the supply of electricity. At present the Corporation take a supply in bulk from the company, but has gone into details with the object of erecting a separate generating station. At the meeting at the Board of Trade offices, the terms upon which the Midland Company would continue to give the present supply were discussed, but the representatives of the Corporation were of the opinion that these new terms would not enable them to carry on their undertaking except at a loss. Since then the Corporation has received a notice from the company intimating their intention to terminate the present agreement for a supply in bulk on March 31st. As the Corporation's generating station has not yet been commenced, a letter disapproving of the company's action has been served upon the company. The peculiarity of the position is that the Midland Electric Corporation for Power Distribution has a Provisional Order for giving a general supply in Wednesbury, and has declared its intention of laying mains in order to give a direct supply, and not through the Corporation as at present. The Wednesbury Corporation has been seeking to obtain a revocation of the company's order at the hands of the Board of Trade on the ground that the price at which energy is now supplied entails a charge upon the rates at the end of each year's working.

WIGAN: *Infirmary Lighting.*—The Board of Guardians have before them estimates for an electrical installation and a supply of gas from the Gas Co. The former is being strongly opposed on the ground that the wages for looking after the plant would be about £500 per year, and after a long discussion, the matter has been referred to the Estate Committee.

WIMBLEDON: *Refuse Destructor Management.*—A subcommittee has been appointed to consider whether, in view of the fact that most of the machinery at the Sewage Disposal Works is now electrically driven, it is desirable to make any re-arrangement of the staff there, and whether the refuse destructors should be placed under the control of the Borough Surveyor or the Electrical Engineer, or under the joint control of both.

YORK: *Commercial Developments.*—A complete scheme for developing the electric supply department of the Corporation is now being put into force, and will include advertising, canvassing for consumers, maintenance of electric light installations, &c. Electrical installations will also be carried out on the hire purchase system, and where electricity is used for power purposes, an amount equal to 10 per cent. of the total consumption will be allowed at power rates for lighting purposes.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ACCRINGTON.—The Electricity Committee have decided to obtain tenders for the supply of a cooling tower for the new 2,000 kw. plant.

ASTON.—The Electric Supply Committee recommend the installation of a 2,000-kw. three-phase 6,600-volt turbo-generator, in order to meet the increasing demands upon the station. The approximate cost of the necessary works is put at £33,000, of which sanction has already been received to £7,787, leaving a balance of £25,213 still to be sanctioned. The scheme also includes the installation of two 400-kw. and one 300-kw. motor-generators.

AUSTRALIA.—The representative of the Commonwealth in London (Captain R. Muirhead Collins, C.M.G., notifies that he has received tender forms, specifications, &c., in connection with the supply and delivery of thirty-three switchboards for private branch exchanges for common battery working, for which tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 2.30 p.m. on March 4th. Specifications, tender forms, &c., may be obtained at the Commonwealth Offices in London, 72 Victoria Street, S.W., where also preliminary deposits on tenders may be paid. Copies of the specification and conditions may be inspected at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, London, E.C.

Captain R. Muirhead Collins, C.M.G., has also received tender forms, specifications, &c., relating to the following :—Required by the Postmaster-General's Department at Melbourne :—(*a*) Apparatus for exchange : one common battery switchboard, of 30 sections in all, together with all associated frames, racks, power plant, and parts ; (*b*) apparatus for subscribers' premises : 3,000 telephone wall sets, 1,000 telephone table sets, 150 extension switches (complete), 70 switchboards for 2 and 6 lines, 50 switchboards for 3 and 10 lines, 10 switchboards for 6 and 20 lines, 10 switchboards for 8 and 50 lines, 200 telephone wall sets, and 100 telephone table sets for party lines. Tenders will be received at the Office of the Deputy Postmaster-General, Melbourne, until 3 p.m., on May 26th.

BARKING.—The Council invite tenders for the supply and delivery of electrical sundries, carbons, meters, &c. Full particulars from the Electrical Engineer's office, East Street, and tenders to the Town Clerk by February 25th.

BELFAST.—Tenders are invited by the Corporation for the supply of low-tension cable during the twelve months ending March 31st, 1909.

BLACKBURN.—The Electricity and Tramways Committee invite tenders for the supply of the following stores during the year ending March 25th, 1909 :—General stores (including paints, varnishes, &c.), iron brass castings, bolts, bars, &c. ; timber ; glass ; insulating material ; tools, brushes, &c. ; oils, &c. ; wrought-iron pipes ; house service fuse boxes, switches, &c. ; motors ; motor starting switches ; screwed tubes for inside wiring. Specification and forms of tender from the Borough Electrical Engineer, and tenders to the Chairman of the Electricity Committee by February 15th.

BRISTOL.—The Docks Committee invite tenders for the supply, delivery and erection, and maintenance for 12 months after they have been in use, of electric cables for the supply to Avonmouth Docks. The tenders are also to include the construction, delivery, erecting in place, fitting, completion, and testing and the maintenance for 12 months after they shall have been taken into use of the electric lighting installations, complete in all details, for the various buildings, railway yard, wharves, &c., at the Royal Edward Dock, now in course of construction at Avonmouth. Specifications, &c., from the Secretary of the Docks Committee (fee £5, returnable), and tenders to 19 Queen Square, Bristol, by February 17th.

BURNLEY.—Tenders are invited for the supply of a booster to the electric lighting station at Burnley Union Workhouse. Tenders should be sent in by February 12th.

The Tramways Committee recommend the purchase of five additional tramcars similar in design to those recently put into use on the Manchester-road service. The cost is estimated at £800 each. The bodies of the cars, together with motors and fittings, will be purchased separately, and the cars built at the local depôt.

The Town Council has adopted a recommendation to purchase a 750-kw. steam generator at a cost of £6,835, and a motor-driven centrifugal pump at the cost of £265.

BURY.—The Corporation has had laid before it the estimates of expenditure upon the proposed new electricity works. Land, buildings, sidings, and plant for an initial capacity of 2,000 kw. is estimated to cost £39,881 ; for a capacity of 3,000 kw., £48,155, and for a capacity of 4,000 kw., £55,720. The cost of connecting up the new works with the existing generating station is estimated at £6,300, whilst £10,000 is included for transformers and high-tension mains. Mr. S. J. Watson, the Borough Electrical Engineer, estimates the cost per kilowatt installed at £19·9, £16·05, and £13·9 respectively for the three capacities mentioned above. The committee, having considered the three schemes, has decided to recommend the Corporation to apply for borrowing powers to the extent of £72,000.

CASTLEREA.—The Rural District Council invite tenders for a suction gas plant, dynamos, battery switchgear, overhead distribution lines, arc lamps, and service connections for the electric lighting of the town of Ballaghaderreen. Plans may be inspected at the office of the Consulting Engineer, Mr. L. J. Lawless, 27 Castlewood-avenue, Rathmines, from whom specification, &c., may be obtained (fee £2, returnable). Tenders to the Clerk of the Council by February 22nd.

CLACTON.—The Electricity Committee recommend an expenditure of £4,000 upon additional generating plant.

COLNE.—A special report has been presented by the Electrical Engineer relating to the necessity for purchasing an additional feeder for supplying electricity to the centre of the town. It was resolved to apply to the Local Government Board for sanction to borrow £1,670 for high-tension cable, £1,000 for extension to mains, and £1,500 for the hiring out of motors.

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CORNWALL.—The County Asylum Committee are considering the question of installing electricity or gas at the County Asylum.

EDINBURGH,—Tenders are invited for an extension switchboard panel. Specifications, &c. (fee, two guineas, returnable), from Sir Alex. B. W. Kennedy, the consulting engineer to the Corporation, 17 Victoria Street, London, S.W., and tenders to the Town Clerk by February 10th.

FINCHLEY.—The application of the District Council for sanction to borrow £22,000, for purposes of electric lighting—to which no opposition was offered—was the subject of a Local Government Board inquiry, conducted on January 30th by Mr. H. Ross Hooper, M.I.C.E. The estimate upon which the present application was based is as follows:—Buildings, £12,000; mains and meters. £10,000.

GRAVESEND.—Stores are required by the Electricity Department as follows:—Small coal, engine stores, oil stores, lamp stores, carbons, and meters. Specifications, &c., from the Borough Electrical Engineer, and tenders to the Town Clerk by February 17th.

GLASGOW.—The Tramways Department invite tenders for the supply and erection of two movable bridges over the Forth and Clyde Canal at Dalmuir and Kilbowie. Full particulars from the General Manager, 46 Bath Street, Glasgow, and tenders to the Town Clerk by April 13th.

HALIFAX.—The Tramways and Electricity Department invite tenders for lighting fittings, electrical accessories, oils and grease, paints and varnishes, tubes and fittings. Full particulars may be obtained from the General Manager, and tenders to the Town Clerk by February 12th.

HEYWOOD.—The Electricity and Tramways Committee recommend the expenditure of £8,000 upon extensions of the Electricity Works.

HORNSEY.—The Council invite tenders for the installation of electric light wiring and fittings in the following depôts:—Sanitary Depôt, Highgate; Central Fire Station, Hornsey; Branch Fire Station, Harringay; Branch Fire Station, Muswell Hill; Fire Box, Stroud Green; Fireman's Mess Room, Highgate; Firemen's Dwellings, Hornsey; Clock Tower, Crouch End. Particulars, &c., from the Borough Electrical Engineer (fee, 10s. 6d., returnable), and tenders to the Town Clerk by February 17th.

HULL.—The Education Committee of the Corporation invite tenders for an electric light installation and fans at the Selby Street West School, now in course of erection. Full particulars may be obtained from the City Architect, and tenders should be sent to the Town Clerk by February 10th.

ILFORD.—Tenders are invited for the supply and delivery of a 1,000-kw. steam generator, watertube boiler, &c. Particulars from the Council's Electrical Engineer, and tenders by February 28th. (See an advertisement this week.)

LEEDS.—Tenders are invited by the Electric Lighting Committee for steam, exhaust, overflow, and other pipes, valves, &c., in connection with a steam turbo-generator of 3,000 kw. capacity. Particulars from H. Dickinson, manager, the Whitehall Road, Leeds (fee, two guineas, returnable), and tenders to the Town Clerk by February 10th.

The Tramways Committee invite tenders for the supply of stores during the year ending March 31st, 1909, including electrical sundries.

Tenders are also invited for the supply of steam coal for the generating set for six, nine, or twelve months' supply. The consumption is approximately 500 tons per week; also for the supply of household coal and delivered at the various offices and depôts as required. Particulars may be obtained from the General Manager, at the Tramway Offices, City Square, Leeds, and tenders should be sent to the Town Clerk not later than February 21st.

LONDON: *Bermondsey.*—Tenders for the supply of the following stores during the year ending April 1st, 1909, are invited:—Arc lamp carbons and brushes, cable and jointing material, conduits, electricity meters, demand indicators, and main fuses, engine oils, meter boards, street frames and covers and joint boxes. Full particulars from the Electrical Engineer, and tenders to the Town Clerk by February 17th.

Battersea.—The Council invite tenders for the supply of stores as follows, for the year ending March 31st, 1909:—Oils, engine room stores, coal, carbons for arc lamps, electricity meters, service joint boxes, ironmongery, tools, &c. Particulars from the Electrical Engineer, Electric Light Station, Lombard Road, Battersea, and tenders to the Town Clerk by February 18th.

Hammersmith.—The following stores are required for the Electricity Department during the twelve months ending March 31st, 1909:—Arc lamp gloves, &c., brooms and brushes; electrical goods; files; fire bricks; clay and lime; gauge glasses; insulated wires; metals; meters; oilman's goods; packing and jointing materials; screws and tools. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by February 19th.

Islington.—The Borough Council invite tenders for the supply of the following stores during the year ending April 1st, 1909: Engine-room stores, &c., arc lamp carbons and globes, oil, transformers and accessories, &c.; electricity supply meters, prepayment meters, cables; electrical sundries: lamps, brushes, arc lamp parts, &c.; terminal service and network boxes. Particulars from the Town Clerk, to whom tenders by February 18th.

Tenders are also invited by February 25th for (*a*) one 1,500-kw. steam-turbine alternator, &c., (*b*) water-tube boiler, conveyor, &c.

LONG EATON.—A Local Government Board inquiry was held last week into an application by the Council to borrow £10,000 in connection with the electricity undertaking. There was slight opposition.

OLDHAM.—A Local Government Board inquiry was held last week into the application of the Corporation for sanction to morrow £1,500 for meters. There was no opposition.

PORTSMOUTH.—Tenders are invited for supplies from April 1st as follows:—Electrical goods, paints and sundries, printing, brooms, brush, &c., castings and ironmongery, street works (laying cables, &c.), also for carting coal from steamers to bunkers at the electric lighting station, Portsmouth. Particulars from the Electric Supply Works, and tenders to the Town Clerk by February 12th.

RATHMINES AND RATHGAR.—Tenders are invited for the supply of the following stores during the twelve months to March 31st, 1909:—Coal, arc lamp carbons, incandescent lamps. Tenders to the Town Clerk by February 15th.

SALFORD.—The Tramways Committee invite tenders for an additional electric light installation at the Central Depot in Frederick Road, Pendleton. Full particulars from the General Manager, 36 Blackfriars Road (fee £1 1s., returnable), and tenders to the Town Clerk by February 17th.

SHEFFIELD.—Tenders are invited for a supply of stores as follows for the twelve months ending March 25th, 1909:—Electrical supplies and fittings, cable, car fittings, car lamps, wood slipper blocks, steam tubes and fittings, overhead line material. Full particulars from the General Manager, Tramway Department, Division Street, Sheffield, to whom tenders by February 10th.

The Cleansing Department of the Corporation requires engineering and electrical fittings among other stores during the year ending March 25th, 1909. Tenders to the Superintendent, from whom full particulars may be obtained, by February 11th.

SOUTH SHIELDS.—A Local Government Board inquiry was held last week into the application by the Corporation for sanction to borrow £7,052 for the provision of additional plant at the electricity works. There was no opposition.

STOKE-ON-TRENT.—The Electrical Engineer having prepared estimates with regard to the probable future demand upon the electricity undertaking, the electricity committee recommend that application be made to the Local Government Board for sanction to borrow £5,965.

SWANSEA.—Tenders are invited for the supply and delivery of motors and starting switches during the ensuing year. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by February 21st.

WALTHAMSTOW.—An automatic signalling apparatus on the Hoe Street and Chingford Road tramway route is to be provided, subject to the Board of Trade giving their sanction to the cost being met out of capital.

WEST HAM.—Tenders are invited for the supply of engine-room stores, rubber-covered cable electric wiring materials and accessories, and chemicals. Particulars from the Borough Electrical Engineer's office, 84 Romford Road, Stratford, E. Tenders by February 6th.

WIMBLEDON.—The Corporation invite tenders for the supply and erection of the undermentioned plant at their electricity works, and are prepared to accept tenders subject to the sanction of the Local Government Board being obtained for the necessary loan:—(*a*) A 1,000 kw. turbo-alternator, with condensing plant; (*b*) two water-tube boilers, economisers, pipe-work, and feed pump; (*c*) high-tension main switchboard and switchboard gallery. Forms of specification and tender, with the general conditions, may be obtained from Mr. H. Tomlinson-Lee, the Borough Electrical Engineer, Electricity Works, Durnsford Road, Wimbledon (fee £1 each specification, returnable), and tenders to the Town Clerk by February 18th.

Having regard to the present favourable price of copper, tenders for the supply of cables and conduits for the financial year beginning March 31st, 1908, are to be invited at once.

NEW PUBLICATIONS

"The Deinhardt-Schlomann Series of Technical Dictionaries in Six Languages," Vol. II.: Electrical Engineering, including Telegraphy and Telephony. Edited by C. Kinzbrunner. (London: Archibald Constable & Co.) 25s. net.

"The Hughes and Baudot Telegraphs," by Arthur Crotch. (London: S. Rentell & Co., Ltd.) Price 1s. 6d.

Electrical Engineers' Volunteers.—Captain and Honorary Major E. Towers resigns his commission, with permission to retain his rank, and to wear the prescribed uniform.

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TENDERS RECEIVED AND ACCEPTED

AUSTRALIA.—The tender of Messrs. Swanson Bros., of Melbourne, for the erection of the Windsor Telephone Exchange at £7,374 has been accepted by the Postmaster-General's Department. The following tenders have been accepted by the Queensland Postmaster-General's Department:—Brisbane Electrical Company: 1,760 No. 2 carporous cells, at 2s. 3d. each; 20 coin attachments, at £1 4s. 6d. each; 9 battery pole-changers, at £3 13s. each; 50 B.S. telephones, at £3 10s. 6d. each. G. R. Hodson, Brisbane: 536 No. 2 Leclanche cells, at 1s. 1d. each; 48 Edison Lalande cells, type Q, at 7s. 4d. each; 288 copper oxide plates, at 1s. 1½d. each; 576 zinc plates for Lalande cells, at 6d. each. I. R. G P. and Telegraph Works Co., Sydney: 8 resistance coils, at £2 11s. each. James Paton & Co., Sydney: 60 visual vibrating indicators, at 8s. 3d. each; 4 operators' sets, at £2 2s. 9d. each. Lawrence & Hansen, Sydney: 880 B.S. wall telephones, at £2 17s. 6d. each.

BURY.—Subject to the sanction of the Local Government Board, the tender for the construction of the chimney at the proposed new electricity works has been given to Mr. C. Dennis, of Bury.

GLOUCESTER.—The following tenders for stores have been accepted by the Light Railways Committee:—L. Andrews & Co., micanite plate, red fibre sheet, asbestos sheet, Baker's fluid; Anglo-Russian Oil Co., light car oil paraffin; Anti-Attrition Metal Co., anti-friction metal; British Insulated & Helsby Cables, Ltd., cables; Brown Bayley Steel Works, Ltd., car wheel tyres; J. M. Butt & Co., brake blocks.

HULL.—Upon the recommendation of the Telephone Sub-committee, the tender of the British Insulated & Helsby Cables, Ltd., for the supply of cables at £254 3s. was accepted, and also the tender of Messrs. Macmillan & Co., for instruments at £368 15s.

LONDON: *Bermondsey.*—An order has been placed with Messrs. Grover & Sons for a pair of 7-ft. wheels for a cable drum at the electricity works, at £16 10s.

Shoreditch.—The following tenders have been received for the supply of lead-covered, paper-insulated cable service cables:—W. T. Henley's Telegraph Works Co., Ltd. (accepted), £298 1s. 5d.; Western Electric Co., £302 11s.; W. T. Glover & Co., Ltd., £302 15s.; British Insulated, &c., Cables, Ltd., £304; Callenders' Cable and Construction Co., Ltd., £305 15s. 6d.; Siemens Bros. & Co., Ltd., £306 13s.; Lahmeyer Electrical Co., Ltd., £321 13s. 9d.; Geiple & Lange. £338 10s 8d.

LEYTON.—The Council has confirmed the recommendation of the Electricity Committee that the tender of Messrs. Carter and Wright for the supply of a lathe, and of that of Messrs. Tangyes, Ltd., for the supply of a screwing machine, and Messrs. Carter and Wright, emery grinder, at £14.

METROPOLITAN ASYLUMS BOARD.—The tender at £30 of Messrs. Buchanan & Curwen for the supply of new main cables has been accepted.

"ORIFLAMME" LAMP CONTRACTS.—The following orders have been received by Oliver Arc Lamp, Ltd., for the "Oriflamme" lamp:—From the Admiralty for H.M. Dockyard, Devonport (Keyham Extension); Haulbowline Dockyard; London & North-Western Railway, for Crewe (37 lamps); and from the Portsmouth Corporation, extension order for 25 lamps for street lighting.

ROCHDALE.—Subject to the Corporation accepting the recommendation of the Electricity Committee, the contract for a steam dynamo has been placed with the General Electric Co. (Browett, Lindley & Co.'s engine), and the contract for coal with Messrs. Simeon Wood, of Rochdale.

VLADIVOSTOK.—It is announced that the contract for the erection of an electric lighting installation and also for the construction of tramways in Vladivostok has been given to a German firm at £158,000. The work is to be completed by July, 1909.

WIMBLEDON.—Two transformers, one of 25 kw. capacity and the other of 35 kw., belonging to the Corporation, being reported useless, the Electrical Engineer has been authorised to obtain a new 75 kw. transformer in exchange, plus payment of £58.

COMPANIES' MEETINGS AND REPORTS

BLACKPOOL & FLEETWOOD TRAMROAD.—The report for the half-year ending December 31st, 1907, states that, including the sum brought forward from last half-year, the balance of profit, after providing for debenture interest, is £12,537 16s. 11d., and the directors recommend a dividend at the rate of 9 per cent. per annum, which will absorb £6,750, writing off a sum of £2,500 to depreciation reserve, and £878 18s. to general reserve account, leaving a balance of £2,408 18s. 11d. to be carried forward to the current half-year. The number of passengers carried during the half-year was 1,799,442. The receipts from all sources amounted to £23,869 17s. 5d.

CITY & SOUTH LONDON RAILWAY.—The report of the directors for the half-year ending December 31st, 1907, shows that the receipts from all sources have amounted to £89,149 14s. 8d. and the cost of working has been £41,387 3s. 7d., leaving a profit of £47,762 11s. 1d. Inclusive of the balance brought forward from June 30th last, the net revenue account shows an aggregate total of £49,619 16s. 1d. After making provision for the debenture stock interest, rent charge, and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £34,069 12s. 3d. Out of this sum the directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891, 1896, 1901, and 1903, and that a dividend at the rate of 1¾ per cent. per annum be paid upon the consolidated ordinary stock for the half-year, leaving a balance of £1,119 12s. 3d. to be carried forward to the next account. The number of passengers, exclusive of season ticket holders, during the half-year under review was 10,732,145, compared with 9,104,295 during the corresponding period of 1906. The dividend paid for the June half-year of 1907 was 2½ per cent., and 2 per cent. for the December half-year of 1906. The reduction of dividend in the present accounts is attributed to the abnormally high cost of coal and general stores, and also to the competition with the electric tramways in the north of London. Concerted arrangements have been entered into with all the Tube Railways and the Metropolitan and District Companies for exhibiting a combined large map, and for the gratuitous distribution of small folder maps, as well as for advertising generally. By this means it is hoped to educate travellers to make more use of the intercommunication between the various underground systems. Through bookings, of a kind likely to be of great convenience to the public, have been arranged between this company's line and the suburban stations on the Great Northern and Midland Railways, also with the Metropolitan Railway and the Central London, Hampstead (and Highgate) and Piccadilly Tubes. These are in addition to the previously arranged through bookings with the Brighton Railway and the Baker Street and Waterloo and Great Northern and City Tubes. Two additional new steel five-coach trains have just been delivered by the Brush Electrical Engineering Company. One of these has been put into the traffic, and the other will follow in a few days. The additional engine required at the generating station for the Euston extension has been erected, and is at work. The train mileage run during the December half-year of 1907 was 683,950, compared with 652,048 in the corresponding period of 1906. The rolling stock now consists of 52 locomotives and 155 carriages. The meeting will be held on Tuesday, February 11th.

GIANT'S CAUSEWAY & PORTRUSH ELECTRIC TRAMWAY.—The directors report a decrease in the receipts during the year 1907 of £385, and a decrease in the passengers carried of 15,000. This unfavourable result is mainly attributed to the unfavourable weather, the International Exhibition in Dublin, and the prolonged strike in Belfast, which prevented many excursions being made.

GREAT NORTHERN AND CITY RAILWAY.—The report for the half-year ending December 31st, 1907, shows total revenue receipts of £47,582 6s. 6d., and working expenses of £24,778 4s. 8d., the percentage of expenses to receipts being 52·07 per cent. Inclusive of the balance brought forward from June 30th last, and after providing for interest on debenture stock and other charges, and setting aside £500 to renewal fund, there remains a balance of £379 10s. 8d., which the directors recommend to be carried forward to next account. The number of passengers carried during the six months under review, including season ticket-holders, was 7,543,174, as against 7,901,923 for the corresponding period last year. The number of local season tickets issued during the half-year was 3,703, as against 3,013 for the half-year ending December 31st, 1906. The directors, after careful consideration, and in conjunction with the Great Northern Railway, decided upon a revision of fares which involved certain increases. This new arrangement came into operation on November 1st, 1907. The effect has been, to a large extent, to check the decline in revenue arising from the severe competition which the company has had to contend during the past half-year. The train mileage run during the half-year was 367,339, and the car mileage 1,109,179. The meeting is to be held to-day.

LANARKSHIRE TRAMWAYS.—An exraordinary general meeting was held last week at 83 Cannon Street to confirm the promotion of a Provisional Order under the Private Legislation.

LIVERPOOL OVERHEAD RAILWAY.—The report of the directors for the half-year ended December 31st, 1907, shows

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that the gross revenue receipts amounted to £41,136 2s. 6d., and the working expenses to £32,154 7s. 2d. The number of passengers carried were 5,864,629, compared with 5,425,595 in the June half-year, and 5,555,555 in the December half-year of 1907. The revenue account shows that the receipts from passenger traffic amount to £40.135 19s. 6d.; miscellaneous receipts and interest, £1,000 3s.; a total of £41,136 2s. 6d. Deducting working expenses, transfer to renewal fund, and interest on mortgage debentures, and on calls paid in advance, leaves £4,652 7s. 2d., to which is added the balance brought forward, June 30th, 1907, viz., £4,452 8s. 1d., leaving available for dividend, £9,104 15s. 3d. The increase in the working expenses is mainly owing to additional cost of coal and stores. The directors recommend the declaration of dividends at the following rates (less income tax):—5 per cent. dividends at the following rates (less income tax):—5 per cent. per annum on preference shares, £3,675 17s.; ½ per cent. per annum on ordinary shares, £1,250; leaving a balance of £4,178 18s. 3d. to be carried forward to next half-year. The meeting will be held on Tuesday.

METROPOLITAN RAILWAY.—At the half-yearly general meeting on Wednesday last week the report and accounts given in our last issue were adopted. Sir C. McLaren, Bart., M.P., who presided, said that there had been a decrease in the ordinary passengers carried over the previous year of 1,131,040. This was attributed to the multiplication of tube railways in London having only one class of car, and which discouraged the habit of paying a higher fare on such lines as the Metropolitan, where more than one class of accommodation was given. Another factor in the decrease was that it had been necessary to increase slightly the number of their fares, which experience had shown to be too low. The increase in the third-class fares, however, had helped the receipts materially, but the company still felt very seriously the effect of the new competition from the Piccadilly and Brompton Railway, the City and South London Railway, and also the London County Council Tramways. Whilst, however, these new means of communication had diverted a considerable amount of traffic, yet, on the other hand, they were beginning to bring traffic in their capacity as feeders to the Metropolitan Railway, and the directors had confidence that in time this new source of revenue would balance the loss in the other direction. With regard to the expenditure, the maintenance of permanent way, works, and stations showed a decrease of £1,982, but mainly owing to the greater train mileage run and to the high price of coal, the locomotive and generating expenses had increased by £4,754. Fortunately, they had arranged their contracts for most of their power-house coal before the rise took place. Rates and taxes showed a decrease of £4,513, due to money returned upon the adjustment of their assessments. The balance of account for working trains for other companies showed an increased credit of £4,427, a portion of which was due to the arrangement with the District Company to provide the whole of the Inner Circle train service. In this way the percentage of expenses to receipts had been reduced from 62·19 per cent. to 59·76. The result was that the amount taken to net revenue account had increased by £9,690, and the balance available for dividend was £124,357. With regard to the London Traffic Conference, he thought there was every reason to be satisfied with the progress made up to date. In conclusion the chairman stated that the view of the Board was that the prospects of the company at the present time were much brighter than they had been for several years.

NOTTING HILL ELECTRIC LIGHTING.—An extraordinary general meeting was held on Monday to pass a resolution confirming the Bill introduced into Parliament by the Notting Hill Electric Lighting Co. in conjunction with the Kensington & Knightsbridge Electric Supply Co., St. James and Pall Mall Electric Supply Co., The Westminster Electric Supply Corporation, and Central Electric Supply Co., having for its object the removal of certain restrictions imposed upon the companies by their present Provisional Orders. Sir William Crookes, who presided, stated that the Bill gave the companies power to associate for the purpose of bulk supply, to lay down the necessary mains for the purpose of this bulk supply, and to provide that the mains so laid should not be liable to purchase by the local authority. The Bill also revises the charges imposed by Provisional Orders. Referring to the Bill promoted by some other of the London companies for the purpose of giving a bulk supply in London, the Chairman said that the companies concerned in the Bill before the meeting thought it advisable to oppose the abovementioned Bill, and also that promoted by the London & District Electric Supply Co., in order to get certain clauses amended. The resolution before the meeting was approved.

Obituary.—The death took place at Belfast of Mr. John Woodside, a well-known Irish electrical engineer, on the evening of the 2nd inst. He carried out many important installations, including those of the Belfast and Sheffield Hippodromes, Purdysburn Asylum, and numerous mills and factories in the north of Ireland, and at the time of his death he had the lighting of Portrush and the Abbey Sanatorium, Whiteabbey, in hand. He was in his thirty-seventh year.

NEW COMPANIES

BRITISH PHOTO-LEXIGRAPH CO.—This company was registered on January 28th with a capital of £12,500 in £1 shares to work, exploit, hire, or acquire an electrical advertising apparatus known as the "Photo-Lexigraph," and patents Nos. 5,996 of 1905, and 13,284 of 1906 in respect thereof to adopt an agreement with C. J. Marrian and H. E. Wells, and to carry on the business of general advertising agents and contractors, electricians, electrical and mechanical engineers, manufacturers of and dealers in electrical, magnetic, and other appliances, &c. The subscribers are:—T. W. O. Wheeler, J. Hewett, H. E. Wells, C. J. Marrian, F. W. Marrian, R. D. Walrond, and F. A. Walton. No initial public issue. The number of directors is not to be less than two, nor more than five; the subscribers are to appoint the first. Qualification, £100. Remuneration, £150 each per annum. Registered office, 3 Mincing Lane, E.C.

CONTRACT AND FINANCE SYNDICATE.—This company was registered on January 29th with a capital of £1,000 in £1 shares to acquire mines, to explore and prospect land supposed to contain minerals or precious stones in Spain or elsewhere, to construct and maintain railways, tramways, or aerial cable ways operated by electric or other power, to carry on business as financiers, contractors, and carriers, &c. The subscribers are:—C. N. Jelly, Elizabeth M. Rogers, F. A. Wilmot, J. R. Thorn, H. S. Pilch, O. H. Snazelle, and H. G. Gorringe. No initial public issue. The number of directors is not to be less than two, nor more than five. The subscribers are to appoint the first. Qualification (except first directors), 150 shares. Remuneration (except managing director), £50 each per annum (chairman, £75), and 5 per cent. of the surplus profits remaining after 10 per cent. has been paid on the shares, dividend (maximum in any year, £2,500). F. A. Wilmot is secretary.

HESWALL DISTRICT POWER CO.—This company was registered on January 28th with a capital of £30,000 in £1 shares to adopt an agreement with H. W. Robinson and R. Carter, and to carry on at Heswall, Cheshire, or elsewhere the business of an electric supply company. The subscribers are:—R. Carter, C. A. Robinson, T. L. Miller, H. W. Robinson, E. B. Driffield, F. T. P. Deyes, W. H. Pollitt. Minimum cash subscription, 25 per cent. of the shares offered to the public. The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first. Qualification, £100. Remuneration as fixed by the company.

MERCEDES ELECTRIC MANUFACTURING CO.—This company was registered on January 25th with a capital of £50,000 in £1 shares to carry on the business of manufacturers of motors, motor-cars, cycles, and other vehicles of all kinds, whether driven by electrical or other power, &c., and to adopt an agreement with Mercedes Mixte, Ltd. The subscribers are:—F. H. March, G. W. Eastham, J. Irwin, V. Jackson, W. S. King, T. R. Wells, J. E. Murray. No initial public issue. The number of directors is not to be less than two, nor more than eight; the subscribers are to appoint the first. Qualification, £100. Remuneration as fixed by the company. Registered office, 11A Regent Street, S.W.

PEEBLES & CO.—This company was registered in Edinburgh on January 27th with a capital of £15,000 in £1 shares to purchase and carry on the business of gas-meter, gas governor, and gas apparatus manufacturers, carried on by Bruce Peebles & Co., at Tay Works, Bonnington, Edinburgh. Power is also taken to carry on the business of engineers, electricians, brass and iron-founders, tube makers, metal workers, wire drawers, &c. The subscribers are:—W. H. Tilley, F. C. Tilley, W. C. Peebles, J. Peebles, A. Blyth, B. Sutherland, and G. K. Grieve. The number of directors is not to be less than two, nor more than five; the first are W. C. Peebles, W. H. Tilley, and F. C. Tilley. Remuneration, £50 each per annum. Registered office, Tay Works, Bonnington, Edinburgh.

SCRIVEN HERMANOS Y COMPANIA.—This company was registered on January 29th with a capital of £5,000 in £1 shares to equip, work, and maintain a railway or railways in Spain, to acquire any rights, benefits, and privileges which may be conferred by the Spanish Government or other authority, to construct, equip, or acquire, work and maintain tramways or aerial cable-ways, operated by electric or other power, telegraph and telephone lines, &c. No initial public issue. The subscribers and other particulars are the same as in Contract & Finance Syndicate, Ltd.

S.P. (SUCHOSTAWER PATENTS) SYNDICATE.—This company was registered on January 27th with a capital of £6,500 in £1 shares to adopt an agreement with D. Suchostawer and S. A. Lehmann, and to carry on the business of iron and brass-founders, mechanical engineers, tool makers, metal workers, electrical, railway, tramway, and water-supply engineers, manufacturers of rolling stock and electric, steam, water, gas, air, and other engines, pumps, and machinery, &c. Minimum cash subscription, £300. The number of directors is not to be less than two, nor more than five; the subscribers are to appoint the first. Qualification, £10 shares or stock. Remuneration, £50 each per annum (£75 for the chairman). Registered office, 88 Fenchurch Street, E.C.

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"Z" ELECTRIC LAMP MANUFACTURING CO.—This company was registered on January 25th with a capital of £150,000 in £1 shares to acquire the business of the "Z" Electric Lamp Syndicate, Ltd., and that of the Albion Electric Lamp Works, which the said syndicate has contracted to purchase, to adopt an agreement with the said syndicate, W. L. Pakenham (as trustee for the holders of the "A" shares therein) and H. F. Brown (as trustee for the holders of the "B" shares therein), and to carry on the business of manufacturers of incandescent lamps and the component parts thereof, makers of and dealers in electrical apparatus, fittings, and plant, &c. The subscribers are:—W. B. M. Bird, H. E. Andrews, H. M. Stevenson, H. F. Brown, A. P. Simpson, and E. P. S. Freed. No initial public issue. The number of directors is not to be less than three, nor more than seven; the first are J. G. B. Stone, chairman (9 Drapers Gardens, E.C.), F. R. Reeves (Salisbury House, E.C.), A. R. Norbert (12 Rue Pelouze, Paris), H. Stevenson, and W. B. M. Bird. Qualification, £500 shares or stock. Remuneration, £100 each per annum (£150 for the chairman). Directors' borrowing powers restricted to £75,000. Registered office, Orient House, New Broad Street, E.C.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night, was £63 to £63 10s. per ton (last week £64 to £64 10s. per ton).

CANNON STREET ARC LIGHTING.—We are informed that all the arc lamps in Cannon Street for the experimental City lighting are now of the "Oriflamme" type.

E.C.C. STAFF DINNER.—The annual dinner of the staff of the Electric Construction Co. took place at the Star and Garter Hotel, Wolverhampton, on Saturday last week. The chair was taken by Mr. W. Bullock, the manager, who was supported by Mr. W. Buchanan.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—In the liquidation of Messrs. Johnstone, Benjamin & Co., electric cable makers, a committee of inspection has been appointed to act with the Official Receiver and liquidator.

Creditors of the "Z" Electric Lamp Syndicate, Ltd., are requested to send in particulars of their claims to Mr. H. J. Owens, Orient House, New Broad Street, the liquidator, by March 2nd.

A general meeting of Wolfram, Ltd., will be held at the office of the company, 8 Laurence Pountney Hill, Cannon Street, London, E.C., on March 2nd, at 4.15 p.m., for the purpose of hearing the liquidator's account of the winding-up.

At an extraordinary general meeting of the "Z" Electric Lamp Syndicate, Ltd., on January 7th, resolutions were passed confirming the agreements made, whereby a new company has been registered, as notified above.

MESSRS. BROWN, BOVERI & CO.—We are informed that this firm's Italian house, "The Tecnomasio Italiano Brown Boveri," has lately amalgamated with Messrs. Gadda & Co., who were formerly their most important Italian competitors. In the future Messrs. Gadda will not themselves manufacture electrical machinery, but will confine themselves to contracting for electrical plants and managing the same. Moreover, Messrs. Gadda have bound themselves to buy from the Tecnomasio Italiano Brown Boveri all the electrical material they—or their sub-contractors—may require. The Tecnomasio Italiano Brown Boveri will take over Messrs. Gadda's works at the Via Castiglia, Milan, which employ about 1,000 workmen, and are equipped with the most modern tools and machinery. The old works of the Tecnomasio Italiano Brown Boveri in the Via Pace will be shut down and handed to Messrs. Gadda for sale. The erection of the new works of the Tecnomasio at the Porta Romana, which were started some time ago, will now be held back till required. After completion of these new works, which will allow of a considerably increased output, the Tecnomasio intend to abandon the Via Castiglia works and to remove entirely to the Porta Romana. The capital of the Tecnomasio Italiano Brown Boveri will be increased shortly to six million lire (£240,000). The Baden house intends to subscribe such a proportion of this increase as will enable the A. G. Brown, Boveri & Co. to hold half the whole capital. Both the technical and commercial management of the Technomasio Italiano Brown Boveri will remain in their hands.

Franco-British Exhibition.—The Town Clerk of Fulham has sent a circular-letter to the various Metropolitan Borough Councils, inquiring whether they favour the suggestion that the London local authorities owning electricity undertakings should co-operate with the London electric supply companies in arranging for a collective exhibition or demonstration of electricity at the Franco-British Exhibition.

MISCELLANEOUS CITY NOTES

AMERICAN WESTINGHOUSE CO.—The committee of creditors of the Westinghouse Electric & Manufacturing Co. has completed their plans for the readjustment of the company's financial position. From a statement prepared, it appears that there is a total unsecured debt to be provided for of about £7,000,000, and it is proposed to create an issue of first mortgage and collateral trust 5 per cent. 25-year gold bonds to this amount secured upon the principal manufacturing plant of the company.

BRUSH ELECTRICAL ENGINEERING CO.—It is proposed to consolidate the two present issues of 4½ per cent. debenture stock of £125,000 each, and at the same time to increase the amount by £100,000.

CARIBBEAN ANGLO-COLOMBIAN CABLE CO.—The *Financial News* states that the prospectus is in circulation of this company, which will have a capital of £200,000, divided into ordinary shares of £1 each; £110,000 six per cent. first mortgage debenture stock, and £50,000 six per cent. second mortgage debenture stock. The prospectus states that the company has acquired the exclusive privilege granted by the Government of the Republic of Colombia for a period of fifty years for laying and working submarine cables, or any other means of telegraphic communication between the Atlantic coast of Colombia, and any points situated outside the jurisdiction already supplied with telegraphic service. Under this concession the India Rubber, Gutta Percha & Telegraph Works Co., Ltd., will at once lay a cable between Puerto Colombia (Savanilla), and Kingston (Jamaica). At this latter point a connection will be made with the lines of the Direct West India Cable Co., with whom working arrangements have been made. The Colombian Government has guaranteed a half-yearly income of £14,384, and the India Rubber, Gutta Percha & Telegraph Works Co., Ltd., will provide the amount necessary to make the first two payments in respect of interest on the first and second debentures and the sinking fund for a reduction thereof.

CITY OF BUENOS AIRES TRAMWAYS CO. (1904).—A balance of 1s. 3d. per share for the year ended December 31st, 1907, is recommended, transferring £3,600 to the General Amortisation Fund, and carrying forward £144.

METROPOLITAN DISTRICT RAILWAY CO.—A dividend at the rate of 1¾ per cent. per annum is announced on the 4 per cent. guaranteed stock for the half-year ended December 31st, 1907. This compares with 1½ per cent. last year.

MONTREAL STREET RAILWAY CO.—Applications have been invited during the week for subscriptions at 96 for £460,000 4½ per cent. sterling debentures redeemable on May 1st, 1922.

NATIONAL TELEPHONE CO.—Subject to final audit, the directors recommend the following dividends for the half-year ended December 31st, 1907, after payment of dividends on the preference shares:—6 per cent. per annum on the preferred stock, and 6 per cent. per annum on the deferred stock, less income tax. The sum of £145,000 is carried to reserve, and about £10,000 is carried forward.

WESTMINSTER ELECTRIC SUPPLY CORPORATION.—A dividend of 10 per cent. per annum, less tax, for the half-year ended December 31st, 1907, is recommended. Last year the dividend was 13 per cent.

Telegraph Traffic.—Traffic may now again be accepted for India and the Far East, *viâ* Eastern, their Egyptian land lines having been restored on January 29th. At the same time their Perim-Djibouti cable broke, and was repaired on the following day. A notice of interruption was issued on the 1st instant of the Thorshavn-Seydisfjord cable, but was cancelled on the same day, it having been issued in error. Communication failed between Rome and Constantinople on the 3rd instant, and was put into working order again on the same day. Since the 4th instant the cable between Alexandria and Larnaca has ceased carrying traffic. The Russian Government now again accept telegrams in code and cypher without restriction, but when demanded the sender must produce and exhibit his code. The cable between Teneriffe and Senegal having been repaired, traffic can be sent *viâ* Teneriffe-Noronha. The Agricultural Conference at Barbados, one of the British West India Islands, has passed a resolution favouring the extension of the existing cable system at Bermuda to Barbados, Trinidad, and Demerara. As mentioned in a note elsewhere, the island of Trinidad has passed a similar motion in their Assembly. Reductions of rates would follow the laying of these cables. The Marconi Co. have announced their willingness to accept ordinary wireless telegraph messages at the rate of 7½d. per word; but they can only be accepted for Montreal, and must be handed in at the offices of the company, Watergate House, Adelphi.

Proposed Reorganisation of Tramways Round Paris.—A Reuter telegram states that at a discussion of the Conseil-Général of the Seine on the subject of the reorganisation of the tramways of the department, several speakers remarked that in England systems of traction by surface contact seemed to have given good results. It was eventually resolved that no change of system could be made except after special deliberation by the Council.

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PARLIAMENTARY INTELLIGENCE

GREAT EASTERN RAILWAY (GENERAL POWERS) BILL.—The Leyton Urban District Council has agreed to request the Members of Parliament for that division to oppose this Bill upon the general principle involved in Clause 19, given in our issue for January 9, page 58, which empowers the company to supply electrical energy. The Council is also petitioning against the Bill in the ordinary course.

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.—The Greenwich Borough Council has several matters in dispute with the London County Council in connection with their Tramways Bill, but the question of petitioning against it has been postponed, pending a conference to discuss the points of difference.

LONDON ELECTRIC POWER BILLS.—The Greenwich Borough Council has decided to petition against the London Electric Supply Bill and the London and District Electric Power Bill. The Leyton Urban District Council has also been advised by its legal Parliamentary Committee to oppose these two Bills mainly with a view to securing clauses to protect the streets, sewers, tramways, and electric mains.

The Thames Conservancy has resolved that a clause saving the rights of the Conservators should be introduced in the London Electric Supply Bill, which empowers the joint committee to be established to lay mains within certain riverside districts. In regard to the London and District Electricity Supply Bill, the Board has agreed that clauses and amendments for the protection of the Conservators' interests should be inserted in the Bill, including provisions that none of the works at Barking (the Bill authorises the acquirement of easements across or under a part of Barking Creek, for the purpose of laying electric mains or other works) shall be at a higher level than 30 ft. below Trinity high-water mark, and that dredging shall not be carried out except with the license of the Conservators. The Board also expressed the opinion that the clause allowing the company to abstract up to 200 million gallons of water per day from the river for condensing or other purposes should be amended so as to provide that the quantity of water to be taken in any one day shall not exceed 50 million gallons. Petitions will be presented should the promoters not undertake to insert the amendments required.

The Southwark and Shoreditch Borough Councils will also lodge petitions against the Bills.

Coupling Rods on Electric Cars.—Some tests have been made in America to determine what advantage is gained by coupling the wheels of motor bogies on electric cars. According to information given in the *Engineering Review*, an equipment with four motors showed a saving in energy consumption of about 30 per cent. when the wheels of the bogies were coupled together. One motor was then removed from each bogie, and the car tested against another car with a similar two-motor equipment, but without coupling rods; a saving of 15·5 per cent. was shown in the former case.

Iron and Steel Institute.—The annual general meeting will be held at the Institution of Civil Engineers, Great George Street, on Thursday and Friday, May 14th and 15th. The annual dinner will be held, under the presidency of Sir Hugh Bell, in the grand hall of the Hotel Cecil, on Thursday, May 14th. The Council will shortly proceed to award Carnegie research scholarships, and candidates must apply before February 29th. The awards will be announced at the general meeting. In order to be included in the voting list at the general meeting, applications from candidates for membership of the institute must be received at the office of the institute not later than Tuesday, March 24th.

Creosoted Wood for Tramway Tracks.—Mr. Justice Phillimore and Mr. Justice Walton, sitting as a Divisional Court in the King's Bench Division of the High Court on Monday and Tuesday, had before them the case of West *v.* The Bristol Tramways Co., on the appeal of the defendants from the decision of Judge Castle at Tolzey Court. Plaintiff, who is a market gardener at Bristol, complained that by reason of the defendant company having paved the roadway opposite his garden with wood blocks, treated with creosite, his plants had been injured, and consequently he brought an action, alleging that there was a nuisance. The case came before the Recorder of Bristol and a special jury. At the first hearing the jury disagreed, and on the second occasion judgment was entered on their findings for the plaintiff. An appeal was now brought by the defendant company, who pleaded that they were protected in what they had done by their statute, and submitted that on this ground, and also on the findings of the jury, that judgment should have been given in their favour. On Tuesday Mr. Justice Phillimore gave judgment. He said that in his opinion the appeal must be dismissed. No doubt the tramway company was ordered to keep in repair a portion of the highway, and to do it by using wood-paving, but the Act did not state that they were to use wood blocks treated with creosite. The plaintiff was therefore entitled to recover in respect of any damage he had suffered in consequence. Mr. Justice Walton agreed, and the appeal was dismissed with costs. Their lordships gave further leave to appeal.

APPOINTMENTS AND PERSONAL NOTES

The salary of the manager of the Leyton tramways (Mr. F. Schofield) is to be increased from £300 per annum by £25, from the 1st proximo, with annual increments of £25 to a maximum of £400. The salary of Mr. J. Cornell, head clerk of the tramways depôt, is to be increased from £130 by £10 from the 1st proximo, with annual increments of £10, to a maximum of £180.

The manager of the Hull Corporation Telephone Department, Mr. T. Holme, has made an application for an increase in salary, but the matter has been deferred for further consideration.

In consequence of the promotion of Mr. W. E. Ireland to rolling stock superintendent of the London County Council Tramways, the Highways Committee of the Council recommend the appointment as assistant rolling stock superintendent, at a salary of £250 per annum, of Mr. H. S. May, at present engineer and rolling stock superintendent in the tramways department of the Blackpool Corporation.

Mr. John Carnegie, assistant superintendent to the Edinburgh Telegraph Department, has just retired at the age limit. Mr. Carnegie joined the service of the Electric Telegraph Co. in 1865, and was subsequently transferred to the Post Office. He has been presented with a marble timepiece by the staff.

The Marconi Companies in America.—The *Electrical World* (New York) gives the following extracts from a memorandum of objections to the Berlin Convention submitted by the Marconi Wireless Telegraph Co. to the Senate Committee on Foreign Relations:—"The convention makes it obligatory upon private enterprises like the Marconi Co. to exchange wireless telegrams with all other ships and stations without distinction of wireless telegraph systems adopted by such ships or stations, and without regard to whether any business or commercial arrangement of interchange of traffic has been made or not. The arrangement thus proposed represents an enforced partnership to which the Marconi companies contribute everything and the German manufacturers of wireless apparatus nothing, neither invention nor capital, nor skilful enterprise. In short, the German company proposes to obtain artificially, through international legislation, the advantage of the position obtained by the Marconi companies in open competition and by private effort at private expense." The company also complain that the establishment of standard wave-lengths of 300 and 600 metres would render certain of their stations useless. It is also announced that plans are under consideration by the company for the opening of a new transatlantic station in the near future. As yet no definite steps have been taken in the matter, but it is stated that the intention is to build the new station at some point along the coast or in the vicinity of New York City.

TENDERS INVITED.

ILFORD URBAN DISTRICT COUNCIL,

ELECTRICITY DEPARTMENT.

THE ILFORD URBAN DISTRICT COUNCIL invite tenders for the Supply and Erection of the following plant, and are prepared to accept tenders subject to the Local Government Board's sanction being obtained for the necessary Loan:—

CONTRACT A 4.—One 1,000 Kilowatt Steam Dynamo comprising Vertical Engine coupled direct to Multipolar Dynamo.

CONTRACT A 5.—One Water-tube Boiler and Accessories.

Copies of the Specifications, including General Conditions, Forms of Tender, &c., may be obtained on and after Monday, 10th February, 1908, on depositing a cheque for One Guinea for each Contract with the undersigned, which sum will be refunded to *bona fide* Tenderers after the Tenders have been adjudicated on.

Extra copies of the Specification may be obtained by *bona fide* Tenderers at a charge of Ten Shillings per copy, which sum will not be refunded.

Any further information may be obtained at the offices of Mr. Arthur H. Shaw, M.I.E.E., A.M.I.Mech.E., Electrical Engineer to the Council, at the Electricity Works, Ley Street, Ilford.

Tenders sealed and marked "Tenders for Contract No. A——, Electricity Works," to be addressed to the "Chairman of the Urban District Council, Town Hall, Ilford," and to be delivered on or before 12 o'clock noon, on Tuesday, the 25th February, 1908.

The Council do not bind themselves to accept the lowest or any Tender.

JOHN W. BENTON,
Clerk to the Council

Town Hall, Ilford,
4th February, 1908.

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ELECTRICAL ENGINEERING

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SUMMARY

The annual Parliamentary return relating to tramways and light railways under municipal and under company control, contains detailed figures showing the growth of the tramway industry through the successive periods of horse, steam, and electric traction. (Page 225.)

The Postmaster-General received a deputation on Tuesday with regard to the new telephone charges, and in reply to the objections raised, pointed out the inequitable nature of the flat-rate systems, which he hopes will soon be totally abolished. (Page 226.)

A Parliamentary return of the amount of energy delivered during the past year in the Metropolitan Police district, and the average prices per unit obtained for power and heating, private lighting, and public lighting, has been issued. The total amount of energy delivered in the whole district was some 213 million units, and the average price obtained 2·839 pence per unit. Of the local authorities, West Ham, with the largest annual output of 8 million units, charges the lowest for energy for all purposes, the average price being 1·48 pence per unit. The lowest charge for private lighting was that of Fulham, where 1·1 million units were sold at an average price of 2·1 pence per unit. Of the supply companies, the lowest average charge for all purposes was that of the North Metropolitan Electrical Power Supply Co., in which case the average price was 1·39 pence per unit. (Page 226.)

The report of the District Railway Co. states that the gross receipts for the half-year to December 31st amounted to £224,463, an increase of £8,617 on the receipts for the corresponding half-year of 1906. The working expenses amount to £156,069, an increase of £350. There is a deficit of £34,391, after providing loan charges and interest on debenture stock, added to which is the sum of £10,937 dividends on 4 per cent. guaranteed stock. The accounts of the Baker Street & Waterloo Railway for the December half-year shows a credit balance of £17,670. The gross receipts of the Charing Cross, Euston & Hampstead Railway Co. amounted to £74,328, and the expenditure to £61,354. After providing for interest and loans, the accounts of the Great Northern, Piccadilly & Brompton Railway Co. show a credit balance of £7,114. (Page 227.)

A good deal of interest was shown in Mr. J. S. Peck's Paper on protective devices for high-tension circuits, discussed last Thursday at the London meeting of the Institution of Electrical Engineers. The Paper itself, which dealt generally with the nature of voltage surgings in transmission systems, and described several

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forms of lightning arrester, was given in a slightly abbreviated form in our last issue. Prof. G. KAPP described a method of making the action of the horn arrester more reliable, and dealt with a proposed system of cable charging with the object of preventing voltage surgings, and several speakers related experiences pointing to the unsatisfactory nature of some forms of protective apparatus hitherto available for overhead lines. Some remarks were made by Mr. PATCHELL and Mr. BRAZIL on the ultimate success of the methods adopted for the protection of the cables of the Charing Cross Co.'s system after a good deal of experiment. Mr. PECK briefly replied, but was prevented from business reasons from giving the information asked for regarding the newest form of arrester which he had described. Some written communications were also received, among which one from Mr. E. A. WATSON containing an explanation of the large number of gaps required in arresters of the multi-gap type. One or two engineers connected with actual high-tension distribution systems took part in the Manchester discussion, and a good deal of practical information was elicited. (Page 228.)

Two articles, dealing with the fluctuation in candle-power with pressure variation for carbon and metallic filament lamps, have been published recently—one in Germany and one in America. The former points out that a simple relation exists between the percentage fluctuation in candle-power and the percentage pressure variation, and compares various types of lamps on this basis, and the latter contains tables showing the percentage variation of resistance, current, candle-power, and energy consumption with percentage pressure variation. (Page 233.)

A PATENT specification by Mr. A. F. BERRY, published last Thursday, describes an interesting system of electric heating and cooking by alternating currents, in which a metal "hot plate" is heated principally by eddy currents induced by an embedded winding. (Page 235.)

THE water-power generating station at Trezzo, Italy, contains an equipment of nine 1,000-kw. alternators driven by low fall vertical shaft turbines. Owing to the sharp bend in the River Adda, very simple hydraulic arrangements are possible. A steam reserve plant is also provided. In the switchgear a somewhat more elaborate arrangement of bus-bars is used than usual, and a feature of the transmission system is the employment of iron wire for short branch lines. (Page 237.)

A NEW surface contact system is being developed under the patents of Mr. D. SUCHOSTAWER. (Page 239.)

SOME new designs of motor control switchgear are described in an illustrated article. (Page 240.)

THE Paper by Messrs. T. F. WALL and S. P. SMITH, which has been discussed recently before the Newcastle and Birmingham Local Sections of the Institution of Electrical Engineers describes some experiments made to determine the magnitude of the eddy-current losses in the pole shoes of generators and motors. The results emphasise the importance of the ratio of the width of slot to the radial depth of air-gap. The losses increase very rapidly, if the pole shoes are not laminated, after this ratio reaches a value of about 2·0. These losses are some 50 per cent. higher at full load than at no load. In the discussion at Newcastle, Dr. THORNTON suggested that experiments should be made to determine the influence of the shape of the pole shoe. Mr. TURNBULL said that for economy the ratio of slot-width to air-gap should be considerably over 1·5. Mr. HUNT referred to the experiments made by Dr. THORNTON to determine the depth to which the flux surgings penetrate. Mr. CARTER stated in a communication that laminated poles were really cheaper than solid pole shoes. (Page 241.)

A NEW system for ensuring electrical continuity in non-screwed conduit is described. (Page 244.)

THE British Aluminium Co. have now three works in operation for the manufacture of metallic aluminium—two in Scotland, and one in Norway. The price of aluminium is now considerably lower than it was last year, and although copper is reduced in price, aluminium is claimed to be cheaper for current carrying purposes than copper. In America the production of aluminium for the year 1907 was considerably more than for 1906, but the amount of copper produced was rather less, although the value owing to the enhanced price was greater. The patents describing the preparation of boron carbide, and a method for electrolytic etching, are also given under ELECTROCHEMISTRY AND ELECTROMETALLURGY. (Page 244.)

UNDER "Electrical Science," in the British and American section, is an abstract of an important discussion of the method of demagnetising by reversals. In the Papers abstracted in the Continental section, HEYDWEILLER discusses the damping and "resistance" of sparks, SCHOTT deals with the influence of sudden accelerations on the "mass" of electrons, RITZ gives some additional hints regarding the magnetic theory of spectrum lines, and WEISS AND PLANER discuss the disappearance of rotational hysteresis in very strong fields. (Page 245.)

AMONGST the patent specifications published last Thursday was one by THE BRITISH ELECTRIC PLANT CO. & OELSCHLÄGER for a special arrangement of the magnetic circuit of the commutating poles in dynamo-electric machines, and another by ANGOLD & THE MAXIM ELECTRICAL CO. for improvements in the flame arc lamp, full particulars of which have already been given in ELECTRICAL ENGINEERING. Others dealing with electrolytic meters, flywheel buffer machines, conduit wiring, the earthing of transmission systems, and finally one dealing with the decarbonisation of tungsten filaments, are abstracted. (Page 246.)

THE poll of ratepayers in connection with the proposed purchase of the Whitewell and Cavehill tramways by the Belfast Corporation has resulted in a majority of 112,150 in favour. The Bristol Corporation has decided to oppose the Bristol Tramways Co.'s Bill for an extension of time to construct tramways authorised in 1904 on the ground that the company has not shown sufficient activity in dealing with the powers they already possess. In connection with the complaints as to vibration from the electricity works by adjoining owners of property, the Colchester Corporation denies liability. It has been found that the meters registering the current supplied to the Croydon Corporation tramways have been registering about one unit per car mile instead of 1·29 units per car mile. The interesting point is that the tramways undertaking was purchased from the British Electric Traction Company on the former basis. Penalties amounting to £1,465 have been deducted from payments due to Messrs. R. W. Blackwell, owing to the contract time for the construction of certain of the Derby Corporation's tramways having been exceeded. The Electrical Engineer to the Eastbourne Corporation has presented a report in which he states that the increasing use of Osram lamps will tend to reduce the revenue, at any rate for the present. A combined refuse destructor and electricity works were opened on Friday at Greenock. The chairman of the Hull Electricity Committee resigned on Thursday in consequence of the rejection by the Council of the recommendation by the Electricity Committee to accept tenders of a German firm of dynamo makers. (Pages 247-249.)

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The Aston Corporation invites tenders for a 2,000 kw. turbo-alternator; the sum of £102,418 is required for telephonic and telegraphic developments in Australia; an additional electric lift is to be provided on the West Cliff at Bournemouth; Darwen Corporation will shortly be inviting tenders for a 750 kw. steam-generator and motor-driven centrifugal pump; the Handsworth Corporation require a 315 kw. generator set; Leipsig Town Council will erect an electric lighting and power works at a cost of £1,000,000; Salford Corporation propose to spend £20,000 on the tramway undertaking. A loan of £25,000 will be applied for by the Stalybridge, &c., Joint Board. (Page 249.)

The report of the National Telephone Co., for the half-year ended December 31st, 1907, shows a gross revenue of £145,346. The net result, after deducting £132,621, Post Office royalties, is a profit of £474,236. The directors of the Smithfield Markets Electric Supply are still unable to recommend a dividend out of the balance of £3,337, in consequence of the uncertainty of the future of the company, whose licence expires in a few years' time. The expenditure upon electrical working by the North Eastern Railway Co., for the half-year ended December 31st, 1907, was £17,467. Meetings of the debenture holders of the Brush Electrical Engineering Co. were held on Thursday to consider a resolution for consolidating the company's debentures, but owing to the absence of a quorum the meetings were adjourned. An advisory Committee has been appointed to confer with the Board of the Underground Electric Railways Co., of London, in devising a scheme for dealing with the profit-sharing secure notes, and the financial requirements of the company generally. At the ordinary general meeting of the Central London Railway Co., on Wednesday last week, it was stated that the directors have decided to charge against revenue the sum of £25,300, which has been incurred in the various proposals before Parliament to extend the line, an idea which has now been abandoned for the present. The falling off of the number of passengers carried by the Great Northern & City Railway Co. during the past half-year—namely, 358,749—was attributed by the Earl of Lauderdale at the meeting on Thursday largely to the competition of the London County Council tramways in the north of London since their conversion to electric traction. At the meeting of the City & South London Railway Co. on Tuesday a substantial increase in the receipts was recorded in consequence of the opening of the Euston extension, but owing to the extra charges to be met on capital account, the additional revenue was more than counterbalanced. (Page 251.)

In the House of Commons last week the Postmaster-General stated that there was an understanding that the Radio-Telegraphic Convention would not be ratified without simultaneous ratification by certain other Powers, but that these did not include the United States. A statement with regard to the opposition concerning the proposed purchase of the Whitewell & Cavehill Tramways Co. was made in the House of Commons on Monday by Mr. Birrell. The report of the committee appointed by the Treasury to inquire into the work performed by the National Physical Laboratory has been presented to Parliament. (Page 252.)

Owing to the state of affairs in Portugal, the International Telegraph Conference, which was to have been held in Lisbon in April, is postponed. (Page 253.)

A good deal of light on the progress of the tramway industry is shown by the publication of the annual return of statistics connected with the tramways and light railways of this country up to as late a date as complete information is available. We abstract the figures in an article on another page, where attention is drawn to the directions in which developments have taken place. During the last 15 years there have been two great changes in the conditions of tramway working, electrification, and municipalisation. The former is the more vital, general, and important; the change in ownership has been neither so extensive nor so rapid as that in motive power. Both have contributed to the developments revealed by the comparative tables in the report, but it would be practically impossible to disentangle in them the effects of the two great changes. The rough coincidence in time of the introduction of electric traction and municipal ownership has arisen from the operation of the purchase clause (Section 43) of the Act of 1870. The 21 years, at the end of which the local authorities could purchase at the "then value" of the structure, were nearing their end in the early 90's in the case of many of the pioneer companies. Although it was then clear that electric traction must come, it was equally clear that the companies could not raise the capital needed, when all hope of resultant prospective profits was denied them. Therefore electrification was deferred until the local authorities either purchased the lines, or decided not to purchase immediately, and entered into agreements deferring the purchase time for a sufficient period to justify the companies in electrifying. The particulars contained in the returns demonstrate clearly how the effect of electrification on British tramways as a whole has been an enormous increase of their public utility, coupled with a large diminution of cost per unit of service. When it is remembered that the tramways are nearly all urban, and that but a short length is worked at its maximum utility, it must be apparent that we are not nearly at the end of the benefits of electric traction on roads. The immediate problem is to extend these benefits to the rural population without excessive capital expenditure, a problem the solution of which is far more dependent upon legislators and local authorities than upon engineers, and seems to many thoughtful people a necessary condition of that improvement and repeopling of rural areas, and coincident relief of urban congestion which all parties agree is urgently required by the body politic.

One of the most important points wherein the metallic lamp filament differs from that made of carbon, apart from its great superiority as regards efficiency, is the fact that its brilliancy is much less affected by variations of supply voltage. Not only is the falling off in the light for the same percentage drop of voltage much smaller, but, as is of scarcely less importance, the effects of overrunning are not so serious. On another page will be found results of quantitative investigations of this effect conducted independently in Germany and in America, but, on the whole, in excellent agreement. From these the general law governing these changes may be traced. The advantages from the consumer's point of view of a diminution in the variations of light, which are only too familiar with the carbon filament lamp, are obvious, but the wider question may be raised as to whether the extended use of metallic filament lamps may not enable the Board of Trade to extend somewhat the range of voltage variation permissible on supply mains. In the case

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especially of outlying districts, this would lead to economies in expenditure on mains of a magnitude greater than would appear at first sight. The improvements constantly being made in the construction and suspension of the new filaments, tending to diminish their susceptibility to shock and vibration, should also open up a field for their use for electric tramway and railway work where fluctuations of voltage are unavoidable. For train lighting from accumulators or self-regulating dynamos, the metallic filament has already made considerable headway, as well as on a smaller scale for omnibus and carriage lighting, and here again the advantage is felt of a lessened diminution of candle-power as the battery voltage falls than was obtainable with our dear old friend the carbon filament.

THE discussion on Mr. J. S. PECK's Paper on Thursday last showed that a good deal more interest is taken in the protection of high-tension transmission circuits than is generally supposed. We have reason to know that the increasing use of overhead lines is resulting in serious inquiries from the engineers responsible for them as to the precautions necessary. Although it is correctly said that severe thunderstorms are of rare occurrence in this country, as compared with the tropics, and some other regions, it has been found necessary from the earliest days of electric telegraphy to defend the wires and instruments against lightning damage. The most effective device for that purpose is the "earth wire," which is a distinctive feature of British telegraph construction. This saves poles and insulators from destruction, but a good deal of damage is annually done to instruments and underground cables by the portions of the discharges carried off by the line wires. One of the earliest lightning arresters used to protect telegraph instruments had a quantity of powdered graphite between electrodes connected to line and earth respectively. This arrester is somewhat on the "coherer" principle desiderated by Mr. ALEXANDER RUSSELL. Occasionally it failed to "decohere," and shunted the instrument to a serious degree, but a few taps restored the high resistance. It is evidently not very easy to adapt such an arrester to high-tension apparatus with a great power behind it, but Mr. PECK's description of the carborundum block arrester indicates an attempt to utilise the idea for moderate pressures. Damage by lightning is fairly frequent on certain tramways, where arresters in feeder pillars are occasionally blown to pieces. The arresters on cars are less often damaged, probably because there is more surface leakage from the trolley standard and the car wiring than from the side feed cables. There are considerable electrical disturbances in the atmosphere, besides those associated with thunderstorms, which have not been very systematically investigated, although meteorologists recognise that the vertical potential gradient in the air is connected with weather changes, and record it constantly at certain stations. Nearly seventy years ago ANDREW CRASSE set up masts and lengths of insulated wire near Taunton, and recorded the sign and potential of the charge collected for considerable periods. Reference to his work will show that very high pressures were not infrequent, and that his wires sometimes collected considerable currents from the atmosphere. His measurements by spark length and electroscopes indicate potentials up to 70,000 volts, as occurring during fogs, snow and hail storms; and from lengths of collecting wire, varying between 1,600 and 8,000 feet, currents of sufficient strength to decompose water and fuse fine iron wire were frequently obtained. An overhead arc light circuit on the east coast has been known to give off $\frac{3}{8}$ in. sparks for hours on end, though not particularly well insulated, and with the very high insulation required for extra high-tension lines and apparatus, it seems likely that such atmospheric effects may give occasional trouble. Mountainous districts, where the lines connect different altitudes, may be expected to suffer most frequently, and this is borne out by the experiences in India, referred to by Col. CROMPTON. The water-jet discharger would appear to have some advantages in dealing with such cases, as the potential changes are comparatively gradual, and a high resistance leak circuit will generally carry off the small current collected by the wires.

ARRANGEMENTS FOR THE WEEK

(TO-DAY), THURSDAY, FEBRUARY 13TH.

Royal Society.

4.30 p.m. Meeting at Burlington House. Among the Papers to be read are the following—(1) "The Constitution of the Electric Spark," by T. Royds; (2) "The Effect of Hydrogen on the Discharge of Negative Electricity from Hot Platinum," by Prof. H. A. Wilson, F.R.S.

Rugby Engineering Society.

8 p.m. Ordinary Meeting. Paper to be read:—"Mechanically-propelled Commercial Vehicles, with Special Reference to the Petrol Electric System," by Bernard Hopps.

FRIDAY, FEBRUARY 14TH.

Northampton Institute Engineering Society.

5.45 p.m. Meeting at the Institute, Clerkenwell, E.C. Paper to be read:—"Some Problems of Electric Railway Operation," by E. V. Panell.

Physical Society.

8 p.m. Annual General Meeting at the Royal College of Science, Imperial Institute Road, South Kensington.

SATURDAY, FEBRUARY 15TH.

Institution of Electrical Engineers: Students' Section.

10.30 a.m. Visit to the National Physical Laboratory.

MONDAY, FEBRUARY 17TH.

Institution of Electrical Engineers: Leeds Local Section.

7.30 p.m. Meeting at the University, when Mr. J. F. C. Snell's Paper, read in London, on "The Cost of Electrical Power for Industrial Purposes," will be discussed.

TUESDAY, FEBRUARY 18TH.

Institution of Electrical Engineers: Manchester Local Section.

7.30 p.m. Meeting at the University. Paper to be read:—"Direct Current Turbo-Generators," by W. Hoult.

Post Office Engineering Department.

7.30 p.m. Annual Dinner at the Grand Hotel, Trafalgar Square, W.C.

THURSDAY, FEBRUARY 20TH.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at 25 Great George Street, Westminster, S.W. Papers to be read:—(1) "Electrical Power in Railway Goods Warehouses," by H. Henderson. (2) "Electric Power in Docks," by C. E. Taylor.

FRIDAY, FEBRUARY 21ST.

Electro-Harmonic Society.

8 p.m. Concert (ladies' night) at the Bechstein Hall, Wigmore Street, W.

Institution of Mechanical Engineers.

8 p.m. Annual General Meeting at Storey's Gate, St. James's Park, London. The following Paper will also be read and discussed:—"Tests of a Live Steam Feed Water Heater," by Prof. John Goodman.

Royal Institution.

9 p.m. Evening Discourse by Sir Oliver Lodge on "The Ether of Space."

SATURDAY, FEBRUARY 22ND.

Birmingham and District Electric Club.

7 p.m. Meeting at the Municipal Technical School, Suffolk Street, Birmingham. Paper to be read:—"The Electro-deposition of Silver," by T. J. Baker.

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TRAMWAY RETURNS FOR 1906-1907

THE annual return of tramways and light railways for the year ended December 31st, 1906, for companies, and March 31st, 1907, for municipalities, which has just been issued, shows a further increase in traffics and other figures. The passengers carried number 2,454,807,487, the gross receipts £11,849,175, and the capital expended £64,092,091. Out of 2,394 route miles open for service, 2,195 are worked electrically, whilst the number of horses has fallen from 9,786 in 1905-6, to 7,378 in 1906-7. It may therefore be said that tramway electrification is practically complete in the United Kingdom, and as the work has been in progress since the early 90's, but only on a large scale since 1898, it is a good time to look back on the figures of past years, and see what they tell as to the effect of electrification as compared with the older methods of traction. The "Comparative Table" in the front of the return groups the more important figures for the years 1878, 1886, 1894, 1898, 1902, 1905-6, and 1906-7, and affords a convenient assemblage of data for comparison.

In the "Prefatory Memorandum," which introduces the return, an attempt is made to distinguish an intermediate "Steam Period" between the "Horse" and "Electric Periods." But, in fact, there never has been a "Steam Period" in British tramways generally. The year chosen to represent "Steam" is 1898, in which the number of steam locomotives reached the maximum of 589. But the same year shows the maximum number of horses in service, and that they had increased at a greater rate than the engines. In certain districts there was a "Steam Period" generally without a preceding "Horse" period. To show what steam traction did, it would be necessary to separate out the steam lines. These were a great boon to the public of the districts served, districts mostly hilly and of the manufacturing class. They generally paid their shareholders well, but were too objectionable to eye and ear to be tolerated generally.

The most striking figures in the comparative return are, of course, those which show the wide extension of public utility of the tramway system due to electrification. The most significant figures in this respect are those of the number of passengers carried annually. The figures given are as follows to the nearest million:—

Year—	1878.	1886.	1894.	1898.	1902.	1905/6.	1906/7.
Millions of passengers	146	384	617	858	1,394	2,236	2,455

Although a few short tramways were electrified between 1883 and 1885 (a total length of about 15 route miles), the process was not at all general until the late 90's, and 1894 may be roughly classed as in the pre-electric period. By 1898 the mileage electrified had risen to about 163, route, or about 16 per cent. of the whole length in service, of which 89 miles were new lines, so that the large increase in passengers between 1894 and 1898 coincides with the commencement of effective electrification. The difference made to the rate of progress will be better appreciated when it is noted that the increase in the twelve years between 1886 and 1894 was 233 millions, or, say, 19½ millions per annum, and in the four years between 1894 and 1898, 251 millions, or, say, 63 millions per annum.

Since 1898 the increase of passengers has been at the rate of 200 millions or more per annum, and the enormous total for the last year represents an average of 60 journeys per head of the population of the United Kingdom. Measured by journeys, then, tramways now render four times the public service that they did in 1894. But this is not nearly the full measure. The average length of a tramway journey has undoubtedly increased, whilst the average cost has diminished. Statistics as to the length of journey are not available, but the average fare paid has fallen from 1·41d. in 1894, to 1·10d. in 1906-7. There is an intimate connection between reductions of fares and increase of traffic, but without electric traction the reductions in fares would not have been possible, and probably without electric traction there would have been much less municipalisation. The extension of the useful range of tramways in virtue of the higher speed is another consequence of electrification. So that while municipalisation has had an important share in the progress, to electrification must be attributed the major part, and even the possibility of successful municipalisation.

The increased public service rendered is attributable in a great degree to the greater potential carrying power of electric tramways due to factors which it is unnecessary to recapitulate here. That this carrying power is utilised in widely varying degrees is well known, and the following figures of mileage passengers and passengers per route mile only indicate what has been and is now done, but by no means what can be done.

Year—	1878.	1886.	1894.	1898.	1902.	1905/6.	1906/7.
Route miles ...	269	865	975	1,064	1,484	2,240	2,394
Millions of passengers	146	384	617	858	1,394	2,236	2,455
Thousands of passengers per mile	543	444	633	806	939	998	1,025

Great as the increase in passengers carried per route mile has been, it has been lessened by the extension of lines into comparatively "thin" areas. The L.C.C. electric routes carry at the rate of about 4¼ million passengers per mile per annum, so there is still plenty of spare capacity available.

The greater utility of electric lines is also well shown by the greater number of passengers carried annually per car in service. Taking 1894, the latest year given in which the number of electric cars is known to have been insignificant, and the year 1906-7, in which the returns give the figures as 10,369 "Electric," and 1,377 "Non-electric," the relative figures are:—

Year—	1894.	1906/7.
Millions of passengers	617	2,455
Cars in service...	4,179	11,746
Passengers per car	147,600	209,000

This, again, does injustice to electric traction, because a much larger reserve of cars is kept available for rush hours and holiday traffic than was commercially practicable in the horse days, when it was useless to keep cars unless horses were also available, and horses standing idle or underworked mean a good deal in working expenses.

Looking at the other side of the account, it is interesting to see what this increase of public usefulness, due mainly to electrification, has cost on capital account. The total capital expended on tramways has increased nearly sixteenfold since 1878,, and the relation between this expenditure, the mileage open, and the traffic carried is tabulated below:—

Year—	1878.	1886.	1894.	1898.	1902.	1905/6.	1906/7.
Capital expended in £1,000's ...	4,207	12,573	14,389	16,493	31,562	58,178	64,092
Route miles open	269	865	975	1,064	1,484	2,240	2,394
Capital per route mile	£15,640	£14,720	£14,710	£15,450	£21,270	£25,970	£26,770
Capital per passenger carried.	6·91d.	7·86d.	5·60d.	4·61d.	5·43d.	6·24d.	6·26d.

Whilst the expenditure per route mile has largely increased, and is now nearly double what it was at the minimum of 1894, the service rendered has also increased, though not so fast. As the fare received per passenger has fallen from 1·41d. in 1894, to 1·10d. in 1906-7, the growing relative importance of capital charges is made apparent in a somewhat novel way by the above table, which shows that while in 1898 each

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passenger carried had the equivalent of the use of 4·61d. for a year, in 1906-7 each had the equivalent of the use of 6·26d. for a year.

The working expenditure, on the other hand, has decreased, as shown below:—

Working expenditure—						
1878.	1886.	1894.	1898.	1902.	1905/6.	1906/7.
£868,315	£2,021,556	£2,859,056	£3,507,895	£4,817,783	£6,835,713	£7,363,762
Working expenditure per passenger—						
1878.	1886.	1894.	1898.	1902.	1905/6.	1906/7.
1·43d.	1·26d.	1·11d.	0·98d.	0·83d.	0·73d.	0·72d.

so that each passenger in 1906-7 cost 0·72d., *plus* the interest and other charges on a capital of 6·26d., whilst in 1898 each cost 0·98d., *plus* the interest and other charges on a capital of 4·61d. As the saving in working expenditure—0·26d.—is nearly 16 per cent. on the extra capital employed, it is hardly disputable that the total cost has been reduced. To follow the figures into net receipts and proper capital charges would involve the discussion of somewhat controversial subjects, which are beyond the present purpose.

THE NEW TELEPHONE CHARGES

A DEPUTATION, organised by the Newcastle Chamber of Commerce, was received by Mr. Sydney Buxton, Postmaster-General, in the Grand Committee Room of Westminster Hall, on Tuesday. The object of the deputation, which was introduced by Lord Joicey and was representative of all the different commercial interests in the Kingdom, was to urge that a Select Committee should be appointed to inquire into the system of telephone rates and the future telephone policy.

Mr. HERBERT SHAW (Newcastle Chamber of Commerce) complained that the new rates had been put into force too suddenly. As a result of the new tariff, subscribers making 13 calls a day would have to pay £15, an increase of nearly 100 per cent., and he understood that a charge of £5 for 15 calls was profitable. The delegates were emphatic in their opinion that the flat-rate system must be maintained, and that a measured rate should be optional.

Mr. D. M. STEVENSON (Glasgow Corporation) said that they objected to the Treasury making money out of telephones, because they considered that an interference with trade. Wherever the Post Office had the service concurrently with the National, they had raised the rate. The delegates were agreed that 10,000 calls a year was not an unreasonable number. With regard to future policy, they hoped that all localities who chose to carry on the local exchanges would get an opportunity of buying them or leasing them.

Mr. BUXTON, in reply, assured the deputation that the Post Office desired to give a very efficient telephone service at the cheapest possible rate. He would say that, with regard to the small users, the new system was cheaper than the old flat-rate. The only places in which the Post Office had adopted the higher rates of the National Telephone Company were where the Post Office had no exchange, and therefore had no option in regard to the matter. As the demand of the telephone user was so varied, it was clear that a fixed rate, which was calculated to cover the average cost, if each subscriber paid the same amount, must be unduly favourable to some subscribers and excessively burdensome to others. In a very large number of cases of large users the charge amounted to only a fifth of a penny per call, whereas the measured service worked out at a penny per call, and now a halfpenny call was proposed. The cost of the actual message might be put at something not below a halfpenny per call; consequently the large users on the flat-rate were being charged less than cost price. The subscribers who were using 3,000 calls during the year five years ago had now increased their calls to 11,000. In no case had they taken a second line, and they were paying no more now for their 11,000 calls than they were for their 3,000 calls five years ago. The result was that about 20 per cent. of the ineffective calls due to engaged lines was due to the overloading of the lines by such subscribers. Other countries had abolished the flat-rate system, and Germany was doing so as well. It was proposed to leave the present flat-rate subscribers under the present conditions. If they had the two systems side by side, all the large users would go into the flat-rate, and unless the flat-rate was raised heavily, where would be the revenue for the Post Office? The Post Office authorities were not putting the measured rate up, but the large users on the flat-rate system would have to pay a larger amount than at present. If they could abolish the existing flat-rate system, the measured rate could be materially lowered. They would not be in a position to say how much the measured rate could be lowered until 1912. With regard to the telegraph system, the rates were reduced, and that system was being carried on at a very serious annual loss.

PRICE OF ELECTRICAL ENERGY IN LONDON

A PARLIAMENTARY return of the amount of electrical energy delivered and the average price charged per unit by local authorities and companies in the Metropolitan Police District during their last completed year of account, has been issued. Information is given of the number of units delivered for power and heating, private lighting, and public lighting respectively, and the average price obtained in each case. The local authorities included are those of Battersea, Bermondsey, Fulham, Hackney, Hammersmith, Hampstead, Islington, Poplar, St. Marylebone, St. Pancras, Shoreditch, Southwark, Stepney, Stoke Newington, Woolwich, Acton, Barking, Barnes, Beckenham Bexley, Croydon, Ealing, East Ham, Epsom, Erith, Finchley, Heston and Isleworth, Hornsey, Ilford, Kingston-upon-Thames, Leyton, Surbiton, Walthamstow, West Ham, Willesden and Wimbledon. Dealing with the figures given for these local authorities only, the average prices obtained in the above districts were as follows—for power and heating, 1·301 pence per unit; for private lighting, 5·677 pence per unit; and for public lighting, 1·850 pence per unit. For the total number of units delivered, an average price of 2·563 pence per unit was obtained. The lowest charge for power and heating was that of West Ham, where 1·4 million units were sold at an average price of 0·95 pence per unit. This borough had, however, an output for traction of nearly 4 million units, and an output for lighting of over 2 million units during the year, the average price obtained being 1·0 and 2·7 pence per unit respectively.

The lowest charge for private lighting was that of Fulham, where 1·1 million units were sold at an average price of 2·1 pence per unit. St. Marylebone, with the largest output of 7·5 million units for lighting, obtained an average price of 4·91 pence per unit (including, however, meter rental charges). The highest charge was that of Bexley, where 730,000 units were sold at an average price of 5·65 pence per unit. The lowest and highest charges for public lighting were as follows:—The lowest charge was that of Stepney, where one million units were sold at an average price of 1·29 pence per unit; the highest charge was that of Epsom, where 95,000 units were sold at an average price of 4·3 pence per unit. The lowest average charge for all purposes was that of West Ham, where over 8 million units (the largest total output) were sold at an average price of 1·48 pence per unit; St. Marylebone, with a total output of 8 million units, obtained an average price of 4·7 pence per unit, but, as above stated, 7·5 million units, *i.e.*, nearly 94 per cent. of the total output, was for private lighting. This was the highest average price obtained.

Passing next to the supply by power companies, the following electric light and power companies are included, as supplying energy in the Metropolitan Police District:—Brompton and Kensington, Charing Cross, West End and City; Chelsea, City of London, County of London, Kensington and Knightsbridge, London Electric Supply, Metropolitan, Notting Hill, St. James's and Pall Mall, South London, South Metropolitan, Westminster, Bromley (Kent), Chislehurst, Chiswick, Harrow, North Metropolitan Electrical Power Distribution, North Metropolitan Electrical Power Supply, Northwood, Richmond, South Metropolitan Electric Tramways and Lighting, Twickenham and Teddington, and the Uxbridge and District. The average prices obtained by the above companies were as follows:—For power and heating, 1·45 pence per unit; for private lighting, 3·853 pence per unit; and for public lighting, 1·62 pence per unit. For the total number of units delivered, an average price of 3·034 pence per unit was obtained. The lowest charge for power and heating was that of the Westminster Electric Supply, and the St. James's and Pall Mall Electric Light Co., 1·0 pence per unit being the price in both these cases. The outputs were 2,500,000 and 670,000 units respectively. The lowest charge for private lighting was that of the City of London Electric Lighting Co., by which 14·5 million units were sold at an average price of 3·11 pence per unit. The highest charge was that of the Chislehurst Electric Supply Co., by which 98,000 units were sold at an average price of 6·9 pence per unit. For public lighting the lowest charge was made by the St. James's and Pall Mall Electric Light Co., by which 191,000 units were sold at an average price of 0·721 pence per unit. The highest charge was that of the Charing Cross, West End, and City Electricity Supply Co., by which 454,000 units were sold at an average price of 2·93 pence per unit. Out of the twenty-four companies included, only eleven supplied for public lighting. The lowest average charge for all purposes was that of the North Metropolitan Electrical Power Supply, the total output (5·5 million units) of which was entirely for power purposes; and the average price obtained was 1·39 pence per unit. The City of London Electric Lighting Co., with the largest total output (22 million units), of any company or local authority, obtained an average price of 2·65 pence per unit.

Taking the figures for both local authorities and supply companies in the Metropolitan Police District, the following average prices were obtained. For power and heating, 1·388 pence per unit; for private lighting, 3·777 pence per unit; for public lighting, 1·802 pence per unit. The total amount of energy delivered, during the year, in the whole district, was 213 million units, and the average price obtained was 2·85 pence per unit.

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UNDERGROUND ELECTRIC RAILWAYS OF LONDON

BAKER STREET & WATERLOO RAILWAY.—The directors' report for the half-year ending December 31st, 1907, shows capital expenditure during the half year of £161,044 18s. 11d. The gross receipts amounted to £69,249 8s. 11d., an increase of £24,689, or 55·5 per cent. on the gross receipts in the corresponding half of 1905. The working expenditure (including rates and taxes) has been £45,925 11s. 7d. No detailed comparison with the expenses in 1906 is given in the accounts, as in 1905 the company were not bearing, as they now do, the whole of the revenue expenditure. After providing for interest and rents, and crediting to net revenue account the sum of £2,440 16s. 10d. receivable from the Underground Electric Railways Co. of London, Ltd., under their guarantee agreement, there remains a balance of £17,670 9s., available for dividends, and the directors recommend that a dividend at the rate of 4 per cent. per annum be declared on the preference shares, and that a dividend at the rate of 3 per cent. per annum be declared on the ordinary shares other than those held by the Underground Co. or their nominees, who have consented thereto. The directors propose that these dividends shall be payable on February 24th 1908. The following gives the number of passengers carried since the opening of the railway, including estimated journeys by season ticket holders :—Half-year ending June 30th, 1905 (16 weeks), 3,006,276; half-year ending December 31st, 1906, 6,799,895; half-year ending June 30th, 1907, 9,956,995; half-year ending December 31st, 1907, 10,662,876. Further progress has been made with the extension of through booking facilities, and arrangements have been made with the following companies :—Great Northern, Piccadilly & Brompton Railway, Charing Cross, Euston & Hampstead Railway, District Railway, Central London Railway, Metropolitan Railway, City & South London Railway, London & South-Western Railway (some stations). Negotiations are also in progress with other railway companies for a joint scheme of advertising, so as to encourage and develop the use of all the urban railways as one comprehensive system. The meeting will be held on Monday.

CHARING CROSS, EUSTON & HAMPSTEAD RAILWAY.—The report for the half-year ending December 31st, 1907, shows capital expenditure during that period of £82,731 3s. 2d. The gross receipts amounted to £74,328 8s. 9d., and the working expenditure (including rates and taxes) has been £61,353 17s. 9d. The following gives the number of passengers carried since the opening of the railway, including estimated journeys by season ticket-holders :—Half-year ending June 30th, 1907 (8 days), 421,466; half-year ending December 31st, 1907, 9,881,357.

METROPOLITAN DISTRICT RAILWAY.—The expenditure on capital account during the half-year has been £99,645, but, after deducting £186,305 received from sale of lands, &c., there is a net credit to capital account of £86,659. The gross receipts amount to £224,463, being an increase of £8,617 on the receipts for the corresponding half of 1906. The working expenses amount to £156,069, being an increase of £350. After providing for rent charges, interest on debenture stock and other charges, the net revenue account shows a deficit of £34,591. To this deficit must be added the sum of £10,937, being the company's proportion of net revenue arising from the City Lines Joint Undertaking, which, although included in the net revenue account, is not available for payment of Debenture interest, being specially appropriated to the payment of dividend on the Four per Cent. Guaranteed stock. With the above-mentioned addition, the deficiency for the half-year chargeable to capital under the company's statutory powers is £45,328. The dividend payable on the Four per Cent. Guaranteed stock is at the rate of £1 15s. per cent. per annum. The arrangements with the Great Northern, Piccadilly and Brompton Railway Company for the user of this company's widened lines between West Kensington and Hammersmith, and for the grant of rights of user of South Kensington, Gloucester Road and Earl's Court stations, which have been referred to in several half-yearly reports since 1903, have now been finally adjusted and embodied in formal agreements. These agreements comprise the sale to the Brompton Company of lands for their car-sheds at Lillie Bridge, and for stations and sidings. The compensation payable by the Brompton Company for the lands and rights acquired by them, other than the right of user of the widened lines to Hammersmith, and for works carried out by the District Company in connection with the provision of accommodation for the Brompton Company has been settled at £165,999, including interest up to June 30th, 1907, and this amount has been paid and credited to capital. The negotiations with the London, Tilbury and Southend Railway Co. in regard to the payment by that company for the working of the District Company's rolling-stock on the Tilbury line, which were referred to in the directors' report for the half-year to December 31st, 1906, have now been satisfactorily completed, and the terms settled for a period of five years. The two high-tension cables, extending from Earl's Court to Whitechapel, which carry electric current for the use of the Tilbury Company, and the ducts in which these cables are placed, have been sold to that company at the price of £18,110, and this sum is credited to capital. During the past half-year the directors have given much consideration to the financial position of the company. They are unable, under existing powers, to raise further moneys to meet the recurring deficits on revenue account and to provide for all the financial requirements of the company, and the situation occurs just at the time when there is every reason to believe that the company are about to realise the benefit of their large outlay in recent years upon the electrification and improvement of the railway. Under these circumstances the directors came to the conclusion that the best course in the interest of all classes of stockholders was to submit a statement of the position to the debenture stockholders, and to deposit a Bill in Parliament to enable the requisite funds to be raised by the issue of prior lien debenture stock, ranking next after the rent charge stocks. The directors believe that if authority is obtained to issue the proposed prior lien stock the finances of the company will be placed on a safe footing, and they hope that the scheme which they recommend will receive the approval of the proprietors of the various stocks. Details of the Bill in question were given in our issue of December 26th.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY.—The report for the half-year ending December 31st, 1907, shows that the capital expenditure amounted to £20,727 3s. 4d., the gross receipts to £119,271 6s. 9d., and the working expenditure (including rates and taxes) has been £70,752 19s. 5d. After providing for interest and rents there remains a balance of £7,114 7s. available for dividend, and the directors recommend that a dividend at the rate of 4 per cent. per annum be declared on the ordinary shares other than those held by the Underground Co. or their nominees, who have consented thereto. The following gives the number of passengers carried since the opening of the railway ,including estimated journeys by season ticket-holders :—Half-year ending December 31st, 1906 (16½ days), 806,120; half-year ending June 30th, 1907, 11,953,759; half-year ending December 31st, 1907, 13,914,779. The report continues that the company's traffic is increasing most satisfactorily. The receipts during the four weeks of January in this year show an increase of 55½ per cent. on the receipts for the corresponding weeks in 1907. The construction of the railway having now been completed, to the entire satisfaction of this company, the directors have been engaged in settling up with the Underground Electric Railways Co., of London, Ltd., questions of account relating to the construction contracts. The mutual claims arising out of these questions approximately balance each other, and the directors have come to the conclusion that the best way of dealing with them is to make a general compromise and settlement involving no payment on either side, except a payment of £10,000, which, although not provided for in the construction contracts, the Underground Co. have agreed to make in order to supply the company with working capital on the cancelment of the existing agreement for leasing the undertaking to the Underground Co. An agreement to this effect will be submitted to the shareholders for their approval at the general meeting on Tuesday. The directors have been in communication with the directors of the Underground Co. in regard to the agreement between the two companies, dated January 15th, 1905, under which this company agreed to grant, and the Underground Co. agreed to take, a lease of the undertaking in perpetuity at a rent equal to 4 per cent. per annum on the debenture and share capital of the undertaking. The Underground Co. desire that the above-mentioned agreement should be cancelled. Inasmuch as the Underground Co. or their nominees are entitled to the whole of the share capital of the company except 55,704 shares of £10 each, the directors see no objection to the cancelment of the agreement of January 15th, 1905, on condition that 33,540 of such shares, which are held by shareholders unconnected with the Underground Co., are converted into preference shares bearing a fixed preferential dividend at the rate of 4 per cent. per annum, payable out of the profits of the company in each half-year, and that the Underground Co. guarantee such dividend in perpetuity, and also guarantee payment of the interest on the debenture stock of the company. A Bill has accordingly been deposited in Parliament and will be submitted to the proprietors for approval at the special meeting, to be held after the general meeting on February 18th, by which power is sought to cancel the agreement of January 15th, 1905, and to convert into preference shares on the terms set forth in the last paragraph the 33,540 shares of which the denoting numbers are scheduled in the Bill, and which are held by shareholders other than the Underground Co. or their nominees. The Bill also seeks to enable the company, with the previous consent of the Underground Co., by resolution from time to time, to convert not exceeding 86,460 further shares into preference shares ranking *pari passu* with the above-mentioned 33,540 shares, but (unless the Underground Co. otherwise expressly declare) without the benefit of the guarantee of the Underground Co. to which such 33,540 shares will be entitled.

For Reports of other Tube Railways, see pp. 251 *and* 252.

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PROTECTIVE DEVICES FOR HIGH TENSION CIRCUITS

LONDON DISCUSSION.

MR. J. S. PECK'S Paper on protective devices for high tension circuits, read first at Manchester, was discussed at the London meeting of the Institution of Electrical Engineers last Thursday. In the Paper, which was given at some length in our last issue (ELECTRICAL ENGINEERING, February 6th, page 201), the author considered the nature of the "static" strains produced by lightning, switching, grounding, or by any occurrence which causes an abrupt change in static potential, which may appear as high pressure to earth or between wires, or as a concentration of potential upon a portion of the circuit. To relieve the high pressure between line and ground or between wires, lightning arresters are used. To protect apparatus from concentration of potential, choke coils may be placed in series with the apparatus to be protected. Lightning arresters usually consist of an air-gap in series with a current limiting and an arc suppressing device. Four types of lightning arresters are in general use—the horn, the multi-gap, the water-jet, and the electrolytic. The electrolytic is the last type to enter the commercial field, and while the time it has been in active service is short, the author considered that there were indications that it would afford greater protection than any other arrester yet produced.

After reading an abstract of the Paper, Mr. Peck showed a series of lantern slides illustrating some of the forms taken by the protective appliances manufactured by the Westinghouse Company.

Professor G. KAPP (Birmingham University), in opening the discussion, congratulated the Institution upon having had a Paper which was the outcome of a very large amount of experience and experiment, and referred to the happy nature of certain mechanical analogies which the author had employed to make his remarks clear. Mr. Peck had said that the electrolytic lightning protector was charged with a certain electrolyte. He thought all of them would like to know what the electrolyte was, whether it was an alkali, an acid, or what? Also he would like to know what voltage per tray could be allowed as the limit; and, finally, whether the arrangement as represented in Fig. 10 (see page 204, ELECTRICAL ENGINEERING, February 6th), was the usual arrangement. It seemed to him that in this arrangement the electrolytic protector really took the place of a dead resistance, while the protector was the horn. Would the author kindly say in his reply whether the electrolytic protector could be used without the horn? Mr. Peck said that there were waves which returned along the line, especially if there were discontinuity as regards the capacity per unit length, such as at the transition from an overhead to an underground line. As a matter of fact, where there are waves there are nodes and anti-nodes. If you happen to put the lightning protector at a place where there is a node, there is no protection because there is no rise of pressure; so that it is quite possible, if you put only one protector on a line, that it will not protect your machinery if it happens to go on to a node. Therefore the only remedy is to put enough protectors on the line to hit an anti-node somewhere. There was another point he would mention, in the hope of getting some more information. The theoretical rise of pressure on switching off a current was the current multiplied by the square root of the ratio of Henrys upon farads. If that formula were applied to any current, even at the quite innocent pressure of 110 volts, it would be seen that there was an enormous rise of pressure because the capacity was so small. With a continuous current there would be an enormous rise of pressure, but the frequency was also enormously great because the frequency alters inversely as the square root of the capacity. The very great frequency would produce in the iron of the circuit an enormous iron heat loss, and this iron heat was equivalent to an enormous magnetic resistance. So that the case was not so bad, because you had, instead of using the simple formula, to divide by a function of the resistance. There was thus no danger of a continuation of this very high pressure, but, the very first moment the high pressure was there, there was no doubt about it. Yet we switched on 500-volt apparatus in our tramcars every day, and nothing broke down. The only explanation which he could offer was that a high electric pressure, if it only lasts a thousandth of a second, would do no harm. In an alternating line they always had the chance that, in switching, the arc which was drawn by the switch would last long enough for the current to pass through zero. If they switched under oil, the oil seemed to have the property of extinguishing the arc exactly at the time when it went through zero, and thus alternating currents could be switched on much more easily than continuous currents. The speaker had with him part of a horn type of arrester which was designed by Mr. Zapf, of the Land und See Kabelwerke, a sketch of which is shown in Fig. 1. In order to

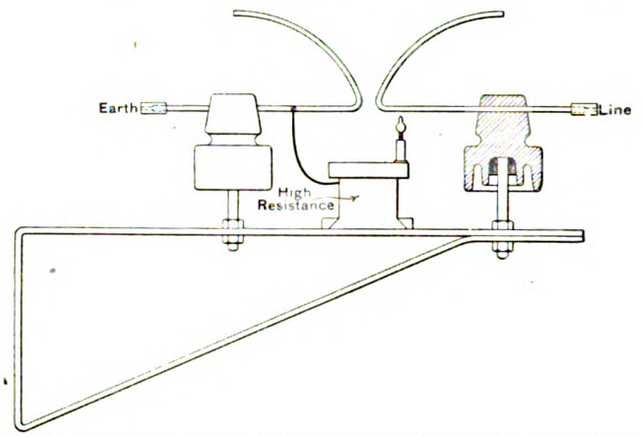


FIG. 1.—DRAWING OF ZAPF LIGHTNING ARRESTER SHOWN BY PROF. KAPP.

make an ordinary arrester go off at a voltage which was not too much above the normal, one had to set the horns so close that anything accidentally coming between, such as a fly or a spider, would sometimes send the thing off. When it went off and the horns were set close, an arc was formed; a little metal was melted, forming a globule, which protruded so that the arrester had to be set again. To avoid this difficulty, Mr. Zapf designed an arrester in which the horns could be set at a suitable distance, such as an inch apart, for 20,000 volts. That by itself, of course, would not go off; but he adopted a kind of trigger arrangement. The earth was connected with a high resistance box, provided with a platinum point with a screw adjustment; this point formed a spark gap which could be set very close. It might be said that the argument of the fly applied here also; it would get in and set that off. It would, but that would not matter, because there was only a very slight discharge owing to the high resistance in series. If the discharge persisted, however, it would ionise the air in the neighbourhood, and the large gap would go off. Prof. Kapp also showed a diagram, reproduced in Fig. 2, to show a method by which the danger of

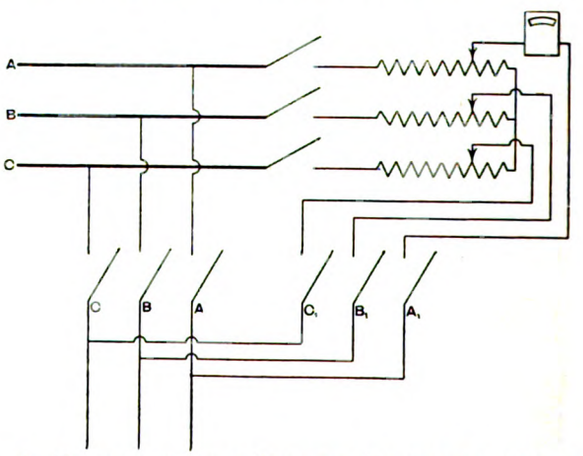


FIG. 2.—DIAGRAM OF CABLE CHARGING ARRANGEMENT SHOWN BY PROF. KAPP.

piling up the volts on the first few portions of an apparatus could be avoided by throwing the volts on gradually. This was done by a sort of auto-transformer, the secondary of which was picked off from points which could be shifted. Thus very few volts could be put on to begin with, so that the charge with the first rush of current would be very small. The contact points were then run along to the end, when they had the same potential as the busbars, and the main switch could be closed. In switching off, the same thing could be done. He had tried this combination apparatus for paralleling dynamos, and found

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that this was possible without synchronising, even if the speeds were different by as much as 1½ per cent. All that is done is to shift the auto-transformer about a quarter from the end, so that a quarter of the pressure is obtained. The current was so strong that it jerked the machine immediately into synchronism. It was gripped immediately from the busbars and jerked into the proper phase. The whole process could be done in a few seconds instead of many minutes, as in the case where it was necessary to synchronise accurately.

Mr. W. B. ESSON endorsed what the author said about the coils giving way. In his early transmission days this always happened. They had then, however, no step-up transformers, because the pressure was not high enough, and he remembered it was always the coils nearest the line which gave way. This was put down to the fact that the coils simply acted as choking coils, and made the current jump between the terminals instead of going through the wire to find the earth point of the machine. They soon discovered a cure, and it was to do the choking outside the alternator instead of inside. Mr. Peck had dealt with the subject of switching the current on to the apparatus, and Prof. Kapp had also described a very ingenious method of doing this gradually. Such devices had been used for a great many years, but it was not the everyday kind of work that troubled the power engineer; it was the trouble which came on when it was least expected and in a way which was quite unforeseen. As a matter of fact they did not get surges in the lines, when they switched on, to anything like the same extent as when a short circuit took place in the line and the curent was suddenly broken. A short circuit was the greatest stress to which a line could be put, because its effect was to make a very much larger current flow, and consequently a much greater result was produced when the current was broken. Mr. Vaughan, who controlled some of the greatest power transmission plants in the world, comprising 700 miles of line working at 40,000 to 50,000 volts in America, had given this matter great attention, and in a Paper read before the St. Louis Congress he went fully into the question of these surges. He found that under average circumstances the surge pressure in volts due to breaking the circuit amounted numerically to two hundred times the number of amperes which were broken. The curious thing was that as an approximation the rise in pressure was practically independent of the working pressure and length of the line; it depended simply on the current which was broken. From this Mr. Vaughan drew very important conclusions, and showed why it was much easier to work at pressures, say from 50,000 to 60,000 volts, than to work at from 25,000 to 30,000 volts. As the current was only half in the one case, the surge pressure was very much less. With regard to lightning arresters, he had used all three types mentioned in the Paper, but only for very low pressures, but it was in connection with high pressures that difficulties arose. Mr. Vaughan pinned his whole faith on the horn arrester, and he did not think it was too much to say that he had tried multigap and other forms of arresters by the hundred, but found that he could not get them into line for burning up. In fact, Mr. Vaughan had come to the conclusion that any other form of arrester than the horn arrester—he did not believe that Mr. Vaughan had tried electrolytic arresters, however—was only of use when there was no use for it, namely, when there was no lightning. Mr. Vaughan had made some experiments on his line by placing the horn arresters at the power house with 4½ in. gaps, and by short circuiting the lines 100 miles away, he was able to get surges which jumped these 4½ in. gaps. This suggested the question whether in dealing with 50,000 and 60,000 volt pressures lightning arresters were any use at all. In the case of a line insulated for 50,000 volts with a large safety factor, the general impression formed by many engineers was that lightning arresters might almost be dispensed with. In the case he had mentioned of Mr. Vaughan's lines on the Californian Electric and Gas Co. system, the lightning arresters only went at the rate of one a year. In fact, he thought they were only put up there for conscience sake.

Mr. ALEXANDER RUSSELL, dealing with the remarks in the Paper upon resonance, said that the period of the fundamental vibration of a single-phase transmission line was the time taken by light to travel four times the length of the line. Mr. Peck did well to lay stress on the importance of the static charge on a line. One of the main functions of lightning arresters was to get rid of this static charge, which, as the author stated, was due to atmospheric potential. A knowledge of the laws of atmospheric electricity would be essential in order to discuss the relative merits of various lightning arresters. Potential gradient was well known to meteorologists. On an ordinary day in London, taking the earth at zero potential, one metre up would be almost 200 volts, and on a foggy day it would be as much as 1,000 volts. For instance, the tracer of the electrograph at Kew went off the scale whenever the voltage got beyond 750, and on a foggy day it was nearly always off the scale. They could therefore understand, when dealing with an overhead line above the ground, where the potential difference between the stratum of air and the ground might easily be 10,000 to 20,000 volts, that there could be an appreciable static charge induced in that line; and static charge sparked across the arrester and might be followed by an arc. This potential gradient went on diminishing, but the potential went on increasing. At 4,000 metres up, for instance, as meteorologists had found out by numerous balloon experiments, the potential was about 200,000 volts on a quiet day, and on a stormy day, of course, it would be very much more than that. The water-jet arrester, as used in the South of France, seemed to be a very suitable type of arrester for getting rid of the static charge, but he did not think it would be of much use for limiting the pressure between the lines. Its resistance was too high. The electrolytic arrester apparently had the drawback that an air gap in series with it must be used, and he thought that any type of arrester that used an air gap was highly objectionable. They had only to think of the ionisation of the gap that must occur in practice to realise how uncertain the action of such a piece of apparatus must be. It was sometimes stated that lightning arresters were very efficient because continual discharges were taking place. Personally, he thought these discharges must be taking place at the normal voltage. It was simply that the ionisation of the air gap was continually going on on certain days in certain atmospheric conditions, so that the lightning arresters were really a point of weakness in the system. An electrolytic arrester would be very efficient if it had no air gap; it must not be left permanently in the circuit, otherwise heating evaporated the electrolyte and deteriorated the aluminium dishes used. He would like to know what electrolyte was used in the one described in the Paper, because 400 volts seemed to him exceedingly satisfactory. 200 volts was the most that he knew of in connection with any electrolyte with which he was acquainted. Taking 400 volts on a 60,000 volt line, this would mean 250 volts effective; or 240 aluminium cells between the two lines if it were being used as a pressure limiter. This would be rather expensive. An ideal type of arrester would be one of the coherer type. If some powder were invented that offered practically no resistance to the current when the voltage was greater than the normal, and had a higher resistance at the normal voltage or under, this type of arrester would be an ideal type. There had been many references lately in the French technical journals to the Thury type of coherer arrester; he had not read a full description of it.

Mr. W. H. PATCHELL said that the author was very modest in starting with an apology for want of novelty in his Paper, but his name was well known on the other side of the water for many years in connection with the reports got out by the High Tension Committee of the American Institute of Electrical Engineers, and one had only to look at the two important volumes published on this subject to see the part that Mr. Peck had played in the development of this important class of apparatus. The blemish in these reports was that they only commenced in 1903, and the classical Paper by Mr. Thomas referred to by Mr. Peck was unfortunately not included. Then the author put aside his modesty and stated, early in the Paper, that protective devices for high-tension circuits had been carried to a high state of perfection. This was where the commercial man came in; they were told not to wait, but to buy what was available. Then, in the last line of the Paper, the author stated that the electrolytic arrester, which was the last one to enter the field, gave indications that it would afford greater protection than any other arrester yet produced. They thus got to a point which showed that finality had not yet been reached, and this was the fact; it was still in the transition stage. There was no best; some preferred the multi-gap, some the horn type, and some preferred other types. What would suit one condition would not suit another, and because the science had not been reduced to a well-known A B C, many of them had blundered along and made their own experience. Concentration of potential on the end turns of the arrester was a point which the officials of the Charing Cross Co. had had to find out for themselves at Bow. He had mentioned this important matter in the Paper which he read before the Institution in 1905, when he went into the question of surges as far as he could. On this point he would like to ask such a mathematician as Mr. Russell, if the matter was really as simple as he suggested it was. They might get the waves reflected at the velocity of light at the end of lines on the blackboard, but in the line itself they get inductance and capacity and various other idiosyncrasies which they did not get on the blackboard, and perhaps Mr. Russell would reconsider that. Mr. Peck had mentioned switching through a resistance. He believed the first example of this was due to Mr. Ferranti, who had a liquid switch and a tripping switch in series with it. When the switch was closed the coil was tripped, and a flexible conductor was unwound which let a plate down at the bottom of the pot and so short-circuited gradually. The same apparatus was used by Mr. Ferranti for charging cables. Dealing with the various kinds of arrester, Mr. Patchell said the ordinary horn type was worse than useless in many cases. One great trouble was the big flare when breaking. Dr. Kapp had put before them the Land und See Kabelwerke variation of the horn type. He had tried this on alternating and direct current, and the way the little trigger worked was marvellous. In his Paper of 1905, he had mentioned that facing one side of the horn with carbon got over the building up of the metallic bubbles and so upsetting calibration, so that it was possible to work more closely with a carbon-copper horn instead of with the copper horn only. He had tried this up to 40,000 volts, and it was simply marvellous how

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this gave the same point time after time on the voltmeter. Of course, they must keep changes of temperature, moisture, and that sort of thing away. The non-arcing multi-gap arrester was particularly American. Many people who used them said they had no trouble, but when he had inspected the cylinders he found they had never arced. The author mentioned the necessity for limiting the current. This was the crux of the question. The horn arrester or the multi-gap without resistance was just like the best haulage motor without a controller; the trouble was not so much when the arrester kept going, but when it stopped going. The flow of current, then, was what did the damage, and he had tried dry and liquid arresters, and carborundum and coke, and also dust resistances. Since he left the Charing Cross Co., Mr. Brazil had been carrying on this work. Mr. Mershon said the best resistance for 60,000 volts was a concrete pillar; it did not make much difference whether the concrete was made of flint or rock; this did not have so much effect upon the resistance of the pillar as the size of the material with which the concrete was gauged. The water-jet arrester was largely used in the South of France and Northern Italy, but the author had not mentioned that the common method there was to turn the water nearly off when they did not expect any lightning, and to turn it on when they did. Another objection was that in many places where they got lightning they did not get water. He first saw arresters used in parallel outside the Ontario Co.'s power house at Niagara, and these were due to Mr. Mershon, who had described them in his Paper on the Niagara, Lockport, and Ontario Power Co.'s distribution system. With regard to testing arresters, he thought it was best to do this with a big machine behind them. The author did not mention the very important matter of expense in protecting the protecting devices. It was almost more important to consider the methods of protecting the device adopted than to consider the type of device to be employed. Unless they did this, they got very far astray. For instance, horn type arresters for low tension were impossible out of doors, so that they had to consider whether the arresters were to be placed on the top of the poles or in connection with the switchboard under cover.

Mr. H. BRAZIL said that his remarks applied exclusively to underground cables. The author did not appear to speak very highly of the horn type of lightning arrester, but he had had very considerable experience with them, and would like to say a few words in favour of them. The horn arresters illustrated in the Paper were merely those consisting of two pieces of wire going away at a sharp angle. Mr. Patchell had mentioned arresters in his Paper of 1905 which had two horns, one carbon and the other copper. These were the arresters with which he had had experience, and it was astonishing what degrees of accuracy these could be set to, and also for what a length of time this accuracy could be maintained. The Charing Cross Co. had about 14 or 15 of these arresters in use, and over periods of six months at a time it had been found that, year after year, these arresters retained the same sparking voltage, in spite of a large number of discharges having taken place. Mr. Peck had stated that they took a long time to work. He did not know what Mr. Peck meant by this, for he had found they took from two to four seconds, which he did not regard as a long time. The author also stated that they formed a short circuit on the system. On the Charing Cross Co.'s system it would be bad policy to put them on the circuit without a high resistance of considerable size. The resistance usually consisted of a small rod, like an arc lamp carbon, and it was apt to take any surgings, and was of no value in reducing the strain on the system. He therefore thought that an indicator of some sort was what was required, and Mr. Patchell, in his 1905 Paper, described an indicator which he had had the pleasure of getting out for him. This had now been in use for three or four years on the Charing Cross system, and some hundreds of discharges had been recorded quite satisfactorily. One examination of these records went to show that during the summer—the time of light load—there were a very much larger number of discharges indicated. This, he took it, was due to the fact that the cables were less loaded—*i.e.*, the conditions were more nearly those of open circuit, which were the conditions likely to produce high potentials. The other conditions shown by the indicators were bad paralleling, faulty transformers, &c. Electrical engineers would be surprised at the number of times the pressure rose over 50 per cent. above the normal. With regard to non-arcing arresters, he had examined some of these, and non-arcing was hardly the word for them, as there were very distinct signs of arcing.

Mr. W. M. MORDEY was glad to see from the Paper that the method of protecting transmission lines from lightning by stringing an earthed wire above the line was coming into use again. He asked whether Mr. Peck thought that there was any advantage in the use of barbed wire on the principle that prevention was better than cure. Also, in the case of long transmission lines, was there any advantage in going back to what was done in the early days, and what was always done now in connection with the protection of buildings, *i.e.*, making the buildings as far as possible lightning dischargers, by making the protectors of well-earthed pointed structures to give a discharge of the atmospheric electricity in the same way as an ordinary lightning conductor was supposed to. Was there any experience with any of the long transmission lines with which Mr. Peck had been connected of this kind of protection? Referring to Fig. 9, he asked for some further particulars as to the depth of the dishes.

Mr. L. ANDREWS (Key Engineering Co.) remarked that several of the speakers had referred to the electrolytic type of arrester as if it were something quite new. But this arrester was described in a Paper by Mr. Johnson before the American Institute of Electrical Engineers nearly two years ago, and it had then been in use for two years, and, to judge from the discussion on the Paper, it had given very satisfactory results. Mr. Russell had said that an arrester was wanted something in the nature of a coherer. It seemed to him that that was what this electrolytic arrester really was. It was an insulator for normal pressure, and it did not allow any current to pass until the pressure exceeded the normal by 10 or 20 per cent., and it then broke down. Other speakers had referred to the objection of having a spark gap in series with it, but, as he understood it, this spark gap was not a necessity. It was put in as an extra precaution, and it was not subject to the objection of a resistance in series, because directly the electrolytic arrester broke down there was no resistance. He objected to Mr. Peck's explanation of the cause of the breakdown of the horn arrester, viz., that it was due to heated air. This used to be the accepted theory, but some seven or eight years ago he carried out a large number of experiments with this type of interrupter, and found that it worked almost equally well upside down, *i.e.*, the arc was blown down, and this, he thought, clearly showed that it was not due to heated air rising. The arc in his experiments was extinguished principally by magnetic repulsion, and not by heated air.

Mr. V. A. FYNN said that with regard to the concentration of potential, three or four years ago he had had the opportunity of making some tests in connection with a 40,000-volt, three-phase, 400-kw. transformer, and he had a very great difficulty in arriving at any consistent figures. Therefore, he was somewhat surprised to see the neat curve in Fig. 1, which Mr. Peck had given, and perhaps he would tell them how this data was obtained. It seemed that this rise did not occur every time that the transformer was connected to the line, and probably it was due to the fact that they did not connect the poles on the same part of the alternating current. With reference to non-arcing arresters, he did not believe in the theory that there was some special non-arcing quality in the metal employed. He had tried nearly all the commoner metals except gold and silver, and found that they worked practically equally well. Brass had the advantage that it kept clean, and therefore the sensitiveness of the apparatus remained fairly constant. He thought that the operation of these was due to the fact that when an arc was started, and if there was a sufficient amount of metal in the neighbourhood and of a sufficiently high heat conductivity, then the spot from which the arc started did not get a chance to heat sufficiently, and therefore the arc broke down. This was tantamount to saying that these arresters were limited in their discharge capacity, and the fact that they only operated satisfactorily on low voltage also went to show that this was so. For instance, a circuit of 3,000 volts might be considered to be sufficiently safeguarded if the arresters were set at 6,000 or 9,000 volts, but with a 20,000 or 30,000 circuit, if the arresters were set in the same proportion, then it would be found that the circuit was not sufficiently safeguarded, and the result was that the voltage per unit gap was increased as the voltage of the line was increased, and also, of course, the power behind the line was generally greater. He noticed that the author had not mentioned anything with regard to earth in the Paper, and he would like to know if he could state whether any development had taken place in this respect, because it was an important part of protecting devices. With regard to the electrolytic arrester, it had struck him that there might be a possibility of the insulating rod or shaft which held the cells breaking down and short circuiting some of the cells.

The PRESIDENT said he would have liked to say a good deal, had there been more time, of the enormous troubles that had been encountered in India, where there were extraordinary atmospheric conditions of great moisture, and great differences of temperature along a transmission line extending from a point high up in the mountains to the power-house very much lower down. The lightning strokes followed each other with such rapidity as to destroy any form of lightning arrester described in the Paper almost immediately. He wished Mr. Moncrieff could have been present, for he had had much experience in India in this matter. He would have told them of some startling effects upon the Darjeeling line. On one occasion he (the speaker) had seen lightning discharges taking place on this line at the rate of 30 every two seconds. It was a continuous kind of artillery discharge, and, under the circumstances, any form of arrester used on the line was destroyed in a few hours. They had tried Wurts' horn, and other forms, but they were all useless. Eventually, they improvised means on the spot with very large masses of sheet metal with serrated edges, which survived for some considerable time, but at last they had to do without any at all, and he thought they got

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on just as well without them as with them. He had been, at the time, in constant communication with Elihu Thomson on the subject, but even the benefit of his valuable advice made no difference, and they practically had to work without any arresters at all. The arrester they used was the air-gap at the foot of the line, and when the line was struck, and the arc started, it was blown out by the draught of the alternator itself.

Mr. PECK, in replying to the discussion, first dealt with the inquiries as to the nature of the electrolyte. This was not exactly a secret, but it had been kept quiet, because there had been three years spent in developing the arrester, and also a tremendous amount of money, and consequently the company which had developed the arrester was not very anxious to have this information given out. Therefore, he would not say what the electrolyte was, nor what was the method of treating the plates to ensure the continuity of the film. The volts per tray varied from 380 to 400, but it took some little time to treat the plates. At first they would stand only about 100 volts: then, as the process of treating was continued, it was increased to 380 or 400. The electrolytic arrester could be used without a gap, he believed, but it took a charging current. The film was about the thickness of a wave-length of light, so that although they might have a large number in series they still had a thin dielectric, so that the charging current was quite heavy, and it was to prevent this charging current heating the arrester that the gap was used. The particular type of horn arrester mentioned by Dr. Kapp was new to him, and it looked as if it might work very well, but the general trouble was that they had to put the air-gaps too far apart, especially on the multi-gap arrester. They would require a tremendous number of gaps, whereas, he thought, they wanted to reduce the number rather than increase it. Dr. Kapp had also shown a very nice method of charging a cable, but there would be a great many difficulties in working from point to point with 60,000 volts transformers. Mr. Esson had referred to the voltage which they were liable to get on an open transmission circuit when there was a short. Of course, the energy in a transmission circuit varied as the square of the current; therefore, although the voltage might go down, if the current went up there was a higher voltage on breaking. When the voltage rose, the result depended upon breaking the current instantaneously at its maximum point. Different people held different opinions with regard to lightning arresters. They all said they were no good, but they dare not do without them. An air-gap, he supposed, was an objection in any arrester, but in the electrolytic arrester he could not see that it was liable to lead to any great trouble. In the first place, the current obtained at the time of the rise in static potential was practically instantaneous; it was over before there was any chance of heating or burning. A discharge through air was always a very uncertain thing, and an air-gap in any circuit introduced an element of uncertainty, but in the case of high voltage circuits, this was so small as to be almost negligible. Regarding the coherer type of arrester, there was an arrester on the market for direct or alternating current from 500 to 1,000 volt circuits. He himself had had a good deal to do with the development of this, but the original idea was due to Mr. Thomas, who, however, had no idea of the coherer action at the time. His idea was to take a great number of very small filings and mix them up in a block with cement or similar substance to make a solid block with a plate at the top and bottom, to get a discharge jumping from metal to metal. This would give a great number of minute air-gaps in series, so that these would withhold the low voltage, and would not permit an arc to continue. After working at it for three or four years, and finding that the metal was not satisfactory, they took ground coke. This worked very well, but after a number of discharges, its resistance changed, and it broke down, a clean arc burning a hole right through it. It was then found that by using carborundum they could make a block 1¾ in. thick, which would easily withstand 1,000 volts. It had an equivalent air-gap of about 1/10 in., but it showed very great protective power. With regard to electrolytic arresters, he believed Mr. Ferranti was the first to suggest the use of aluminium. Mr. Patchell had referred to testing arresters with large machines. Arresters were usually tested on condensers about as heavy as they could get them, and with the full voltage of the circuit on which they were to be used, so that when they discharged the condenser, they got a very heavy static discharge through the arrester, and there was always plenty of power behind. He did not think there was much value in the use of barbed wire over ordinary wire, as suggested by Mr. Mordey. Mr. Andrews had given some interesting information about the horn type of arrester. He knew that the action was partly magnetic, but he had thought it was principally a heat action. Mr. Fynn asked how the curve in Fig. 1 was obtained; it was obtained by putting the spark gap in shunt to the winding, and then operating a simple swing closing switch probably several hundred times for each gap. The results varied considerably, but by plotting them and drawing a smooth curve they got a very fair average.

A vote of thanks was accorded the author on the motion of the President.

A few written contributions to the discussion, which have been received, are given in abstract below:—

Mr. E. A. WATSON remarked that the immense number of gaps required in connection with the arresters of the multi-cylinder type, and the effect of the neighbourhood of the earth upon the number required might at first appear strange, but a little approximate calculation will show what a great effect the capacity of the cylinders relative to the earth has upon the distribution of potential between them. Considering the multigap arrester as consisting of a number of condensers in series, the one end of the series being connected to earth and the other end to the line. He deduced a formula for the potentials across the various gaps, from which it was seen that this rises at a steadily increasing rate, being, for example, 1·65 for gap 3—4, 2·16 for gap 4—5, 9·88 for gap 9—10, 13·5 for gap 10—11, and so on, mounting up very rapidly. These figures, however, are based on a more favourable case than would ever actually occur in practice. The progressive increase of the potential between successive gaps is the reason why the multi-gap arrester on high voltages requires such an abnormal number of gaps, if the gaps nearest the line are not to break down. Placing shields near the gap and connecting to the line would no doubt be beneficial, provided that the shields do not come too near the earthed end of the arrester, in which case the trouble would only be moved from one end of the arrester to the other. The correct way to treat the case would be to place two cylinders of the arrester midway between two shields, one of which is connected to the line, and the other to the earth. This is then equivalent to placing the arrester in free space, and completely cancels the injurious effects of the "earth capacity" of the cylinders, but he was not aware of its having been tried at all. Leaving the subject of multi-gap arresters, there was a method of protecting H T lines, which was, he believed, employed to some extent on the Continent, but which was not mentioned in the Paper. This consists in the installation of condensers, suitably constructed to withstand the voltage at the entrance to the power-station and sub-stations. These condensers, while only allowing a small current to pass at the ordinary frequency of the supply, act practically as a short circuit to any high frequency discharge, such as that due to lighting, and prevent an excessive rise of pressure on the line.

Mr. P. LOESCHER (General Electric Co.) wrote complaining of the lack of attention given in the Paper to the large amount of work done in this field, on the Continent, especially by Mr. C. E. L. Brown, in connection with the water-jet apparatus, and Messrs. Siemens as regards the horn arrester. Referring to the electrolytic arrester originally due to Mr. Ferranti, he had his doubts as to its behaviour under extremes of climatic conditions, and its ability to withstand very heavy atmospheric discharges representing great quantities of energy.

Mr. J. H. M. WAKEFIELD asked for some details of the cost of lightning protection per mile per wire. The commercial aspect of the question—that is to say, the ratio of the cost of lightning protectors to the cost of plant which it is protecting, was of importance. Air-gap arresters had been used by the Post Office for many years, and had been found to meet all requirements. It would be useful to know the value of the earth resistances which Mr. Peck recommended for lightning protector earths. The standard adopted by the Post Office was a maximum of 10 ohms. The Post Office did not now use an earthed wire above the working wires, as the expense did not appear to be justified, especially over long distances. Each Post Office wood pole and arm was, however, fitted with an earth wire.

MANCHESTER DISCUSSION.

Mr. C. D. TAITE (chief engineer, Lancashire Electric Power Co.), in opening the discussion, said that he had recently had occasion to write round to several engineers in England regarding lightning arresters, and the gist of their replies was to the effect that they had tried most arresters, but they did not believe in any of them, and that they simply used them for the sake of convention. In the first place, we have very little overhead work carried out in this country at all, and, in the second place, our thunder-storms are not so severe as they are in America or on the Continent. Those lines which we have, however, are very difficult indeed to protect, because we generally have to adopt a mixture of overhead and underground. In the case of the company with which he was connected, they had a certain amount of overhead work, and have never had the slightest trouble from lightning discharges. The lines could not be said to be protected in a very scientific manner; on one they had horn-break arresters, which have undoubtedly acted on frequent occasions at about 25,000 volts. They found plenty of evidence that sparks had passed across the horns when set at a distance requiring 25,000 volts to jump. On another line they had a multi-gap arrester, and on another line they had no arresters at all. The line on which they had had the least trouble was that on which they had the most overhead work; that was the one on which they had the horn-break arresters. Perhaps the freedom from trouble was due to the fact that it usually rains when there is lightning about, and that the discharge passed across the insulators. The line which was most affected by faults

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was the one on which there was least overhead work. That line was the one protected by a multi-gap arrester, where the cables went underground, but at the end of the line there was no path provided for lightning or surges to find their way to earth. That had now been remedied by providing another multi-gap arrester there, and since then they had not had any faults at all.

Mr. W. CRAMP referred to the need for adequate protection of underground systems. He though that Mr. Peck's remark, "It is now customary to install a high resistance in series with this arrester in order to limit the current which flows on short circuit, but this resistance retards the static discharge," was not quite correct. Surely the reactance of the discharge circuit, due to a frequency of the order of at least 100,000 a second, would be far in excess of any resistance placed in series, and one would think such resistance would be negligible, just as it was in the case of a lightning conductor. He also asked for information respecting the phenomenon that wind blowing across overhead lines tended to raise the potential as regards earth. Lightning arresters were uncertain in action, and the reason so few were at work in this country was partly due to this uncertainty. The reason seemed to be that lightning arresters were too coarsely adjusted. The air-gap over which the spark had to take place was so large that only very large rises of potential were at all allowed for. They were told in one part of the Paper that, with very high potential differences, the necessity of using a vast number of air-gaps was such as to put the multi-gap type out of the question. Now there was a current continuously passing between all the arrester cylinders to earth due to ionised particles; the result of this was that should there be any slight rise of pressure, a breakdown might occur at a much lower voltage than that for which the gap was set. The only way to get over this would seem to be to place the arrester itself in some kind of filled protection box, so as to minimise the effects of ionisation.

Mr. M. B. FIELD (chairman) said the potential strain generated by the different effects dealt with in the Paper, such as switching, grounding, and so on, might be classified under two broad heads, effects which produce a limited rise of potential, and effects which produce an unlimited rise of potential. Now switching on a generator, and the effects of reflected waves, fall under the first class of limited rise of potential. The potential cannot rise above twice the original potential, and the rises are extremely transitory, so that they need not be taken very much into account, except in so far as they might produce sparking across some air-gap. The other effects, such as breaking circuit, power surges, atmospheric effects, have produced rises of potential which are more or less unlimited. In alternating current work they had an automatic protection against rises of potential which are produced on suddenly breaking a circuit in the oil circuit-breaker, which had the peculiar characteristic of interrupting the circuit at or near zero current. The effects of power surges, atmospheric effects, and lightning are the most important ones on large systems which have to be guarded against. He did not propose to touch upon that now; but the instance described in the American *Journal* of the I.E.E. in 1901 was extremely interesting. With regard to the atmospheric effects referred to by Mr. Cramp, he had noticed in water-power stations, where there was a considerable amount of overhead lines, sometimes in the evenings, when the sky was clear, the arresters would spark over. This he put down to the atmosphere becoming suddenly charged, due to condensation. With regard to the concentration of potential over the first turns of the transformer, it was very clear to him why this effect did not penetrate beyond the first few turns. He had had considerable difficulty from this very thing about twelve years ago, with high-tension motors, and found these motors breaking down in the initial turns over and over again. If they undid the first few wires of the first coil and cut away the insulation, and spread it out, they found them absolutely riddled with small holes, showing where minute sparks had passed between turn and turn. His idea was to put the first turns outside the thing altogether, and he made choking coils specially designed so that they could spark from turn to turn.

Dr. E. ROSENBERG (British Westinghouse Co.) made some remarks respecting the mechanical analogies with which Mr. Peck had illustrated his remarks, and said that as to the oscillograph showing the current through an electrolytic valve, he could only see a slight difference between the positive and negative halves. He would have expected that current in one direction was nearly suppressed, so that the difference in the two halves was much bigger than that shown.

Mr. H. W. WILSON said that in the case of the North Wales power scheme, where they had spark-gap arresters on the lines themselves, and horn-break arresters in the station, the station superintendent had told him that their lightning arresters were in operation fairly frequently. He would be glad of some further information as to the voltages at which the various types of arresters described in the Paper could be used, and the frequency with which they ought to occur on the system.

Mr. W. A. CHAMEN (South Wales Electrical Power Distribution Co.) said that in South Wales they had very little overhead work at present. They had only one line over a mountain top, about two miles in length. Whether it had actually been struck by lightning or not they did not know, but they had had a transformer broken down at one end after a thunderstorm, which looked rather suspicious; they had arresters on one end of the line only. They were of the horn-type, with water resistances. He was quite satisfied that they had saved a great deal of trouble. These horn arresters were in no case fixed on overhead lines or out of doors; they were all under cover in the generating station and substations.

Mr. R. B. SLACKE said, with reference to the water-column arrester in Fig. 7, the overflow pipes did not seem to be required. Surely if the thing was once filled, it would last some considerable time, and if there was an air gap in series with the arrester it would act as a sort of resistance, and serve its purpose without a continuous supply of water. He asked whether there was supposed to be a head of water in that case which kept the water level always above the overflow pipe. He also asked how the number of gaps in a multi-gap arrester was calculated for any given voltage.

Mr. J. S. PECK, in replying, referred to the cost of the electrolytic arrester, which was, he thought, about the same as of the multi-gap arrester. Regarding the curve for the electrolytic arrester in Fig. 11, he thought that the curve, as reproduced, was upside down, because the current there is a charge current, but which has high points where the current breaks through due to the excess of voltage.

Regarding Mr. Cramp's questions as to the resistance in the ground wire, there was, of course, self-induction or inductance in the ground wire. Mr. Jackson, in his Paper read before the American I.E.E., in which he described this electrolytic arrester, referred to a critical resistance in the ground circuit, for which he was very severely criticised. But his idea was this, that if you assume a certain capacity in your transmission circuit, and assume that your wave potential travels along at a velocity of 186,000 miles per second, then if you have a transmission line 186,000 miles long, it would take one second for the whole line to discharge. Now, if you assume they have a potential of 100,000 volts, you know definitely the amount of current stored in that line, and from that you can tell the rate at which the current will arrive at the arrester. Regarding the action of wind on transmission lines, he could not tell them very much beyond that fact that static discharges appear on wires which are disconnected from any apparatus, and more or less continuous sparking over the arrester. Mr. Field had asked why this concentration of potential did not spread to the interior of the winding. He took it that the other turns acted as a choking coil, and delayed the passage of the current to the inner turns. As to the voltages for which different types of arrester were suitable, the electrolytic arrester was made for any voltage from about 2,000 to 60, 80, or 100,000. The multi-gap arrester also was made for any voltage from 2,000 to 100,000. The number of arresters per mile was somewhat a matter of the funds of the treasury. Mr. Wurts in the early days made a number of experiments on trolley circuits, and put arresters in about every 100 yards, and put tell-tale gaps in, and after every storm he went round and found out how many of these arresters had discharged, and then he took out some of the arresters, and gradually arrived at a figure of about four arresters per mile. Regarding the calculation of the number of gaps, the original arrester for 1,000 volts had six cylinders and five gaps, but when they went to 2,000 volts they doubled, and so on. When they got to about 6,000 they found that doubling was not enough. Mr. Thomas carried out a series of experiments extending over two years to determine the number of gaps necessary; his curves stand to-day as the best guide to the determination of the proper number of gaps.

CATALOGUES AND PAMPHLETS RECEIVED

ARC LAMPS, LIGHTNING ARRESTERS, SMALL GENERATING SETS, FITTINGS, AND SWITCHES.—We have received copies of five new lists from the General Electric Company. The first deals with a new gravity feed flame arc lamp, known as the "Flamgold," which represents the result of a long series of experiments with a view to avoiding some of the disadvantages of other types of flame lamp. Another new list is that devoted to tension limiters on lightning arresters, in which a complete series of protective apparatus is included, comprising multi-gap tension limiters, horn-type arresters, magnetic blow-out arresters, automatic movable arm arresters, choking coils, resistances, and other accessories. The third list gives particulars of small paraffin engine generator sets for country house lighting, with 25-volt, 10-c.p. Osram lamps, and prices of complete outfits, with switchboard and accumulators for 25 to 200 lamp installations. A revised list of main switches of the "Peel" type is also issued, and a small booklet gives details of a series of interchangeable parts from which a great variety of electric-light fittings for different purposes can be made up.

BRAZING.—We have received from the Ferrofix Brazing Co., Millwall, a pamphlet in which several examples of fractured castings repaired by their ferrofix process are illustrated. A slip describing a new flux for brazing is also included.

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CARBON AND METALLIC FILAMENT LAMPS

TWO investigators, F. Hirschauer, in Germany, and G. Loring, in America, have recently published articles in which the results of experiments to determine the effect of voltage variation on the brilliancy of glow-lamps of various types are given. In the article by F. Hirschauer in the *Elektrotechnische Zeitschrift*, the effect of fluctuations in pressure on the candle-power is discussed, and some curves are given of the results of tests.

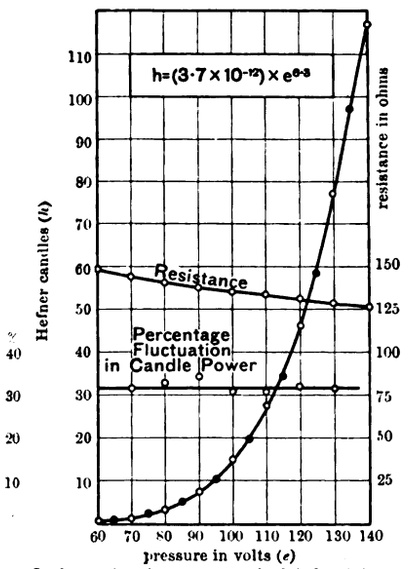


FIG. 1.—CARBON FILAMENT LAMP. 108 VOLTS.

The variation of candle-power with pressure for any glow-lamp can be expressed as follows :—

$$h = Ce^n,$$

where h is the candle-power in Hefner candles (1 Hefner candle = 0·91 British standard candle), e is the pressure in volts, C is a constant for the particular lamp considered, and n is a constant for lamps of the same type. The following values of these constants were obtained for the particular types of lamps tested :—

Carbon filament lamp	$h=(3{\cdot}7\times10^{-12})e^{6\cdot3}$
Nernst lamp	$h=(7{\cdot}1\times10^{-20})e^{10\cdot0}$
Tantalum lamp	$h=(2{\cdot}8\times10^{-8})e^{4\cdot3}$
Osmium lamp	$h=(7{\cdot}5\times10^{-6})e^{4\cdot2}$
Osram lamp	$h=(3{\cdot}4\times10^{-7})e^{4\cdot0}$
Just-Wolfram (tungsten) lamp	$h=(2{\cdot}34\times10^{-7})e^{4\cdot0}$

The curve of candle-power, as obtained experimentally for the carbon-filament lamp, conforms exactly with the curve represented by the formula above for this lamp; this is shown in Fig. 1, in which both observed and calculated points are plotted. In Fig. 2 the corresponding curve for the Osram lamp is plotted. The variation in resistance is also shown in these figures. Little interest is attached to the constant C, but the value of the exponent n is all that is needed in order to predetermine the variation of candle-power with fluctuations in pressure. If the pressure varies $p/2$ per cent. above and below the normal value e, then the total pressure fluctuation is p per cent. Now the candle-power at the higher pressure will be h_2, where

$$h_2 = C\left(e + e\frac{p/2}{100}\right)^n,$$

and the candle-power at the lower pressure will be h_1, where

$$h_1 = C\left(e - e\frac{p/2}{100}\right)^n.$$

The difference in candle-power will be, therefore, $h_2 - h_1$, where

$$h_2 - h_1 = Ce^n\left[\left(1 + \frac{p/2}{100}\right)^n - \left(1 - \frac{p/2}{100}\right)^n\right].$$

This expression can be expanded into a converging series, but the first term only of the series need be considered, as, for

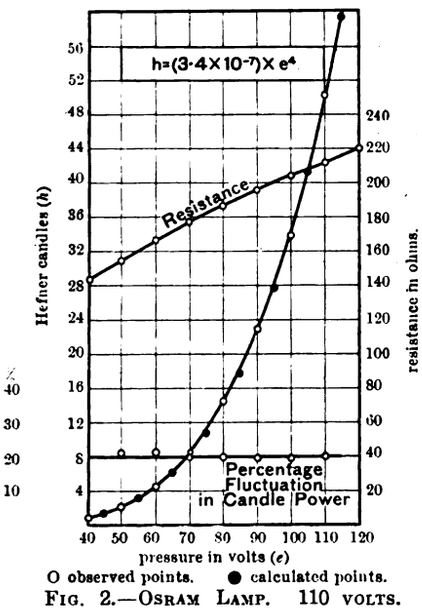


FIG. 2.—OSRAM LAMP. 110 VOLTS.

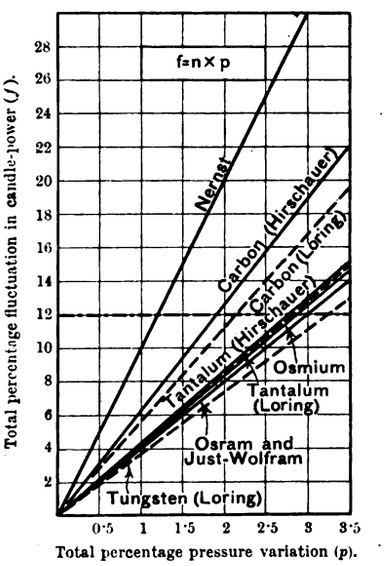


FIG. 3.—FLUCTUATION IN CANDLE-POWER WITH PRESSURE VARIATION FOR DIFFERENT TYPES OF LAMPS.

practical values of n and p, the value of the second term will be less than 0·5 per cent. of the value of the first term, thus :—

$$h_2 - h_1 = \frac{n \cdot p}{100} Ce^n.$$

It is, however, the total *percentage fluctuation* in candle-power to which the eye is sensitive; this is expressed as follows :—

$$\frac{100\,(h_2 - h_1)}{h} = 100\left(\frac{\frac{n \cdot p}{100} Ce^n}{Ce^n}\right) = n \times p.$$

Thus, the percentage fluctuation of candle-power for a given percentage variation in pressure and for a given lamp is constant and independent of the normal value of the pressure. It depends only on the value of the exponent n, and if this exponent is known, the percentage fluctuation in candle-power for a given variation in pressure can be directly determined. Applying this result to the values obtained for the exponent n, for a pressure variation of 2·5 per cent. above and below the normal value (*i.e.*, $p=5$ per cent.), we obtain the following values for the percentage fluctuation in candle-power :—

Type of lamp.	Value of the exponent n.	Total percentage fluctuation in candle-power $f = n \times p$.
Nernst lamp	10·0	50 per cent.
Carbon-filament lamp ...	6·3	31·5 per cent.
Tantalum lamp	4·3	21·5 per cent.
Osmium lamp	4·2	21 per cent.
Osram lamp	4·0	20 per cent.
Just-Wolfram lamp	4·0	20 per cent.

If a total percentage fluctuation in candle-power of only 12 per cent. is permitted, the following total percentage varia-

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tions in pressure, as obtained from the curves of Fig. 3, may be allowed :—

Nernst lamp	1·2 per cent.
Carbon-filament lamp	1·9 per cent.
Tantalum lamp	2·8 per cent.
Osmium lamp	2·85 per cent.
Osram lamp	3·0 per cent.
Just-Wolfram lamp	3·0 per cent.

Thus we see that the lower total percentage fluctuation in candle-power of the metallic filament lamps is a very distinct advantage, as a much greater variation in pressure can be allowed with such lamps than can be allowed with carbon-filament lamps for a given permissible fluctuation in candle-power or brilliancy.

The article in the *Electrical World* (New York), by George Loring, contains the following results of tests similar to those made by Hirschauer, but figures for energy consumption are also given.

From the standpoint of current, candle-power, total watts and watts per candle, tantalum and tungsten lamps are less susceptible than carbon-filament lamps to changes in electrical pressures. The resistance of the metal filament increases, whereas that of the carbon usually decreases with rise in voltage.

Following are tables showing the comparative results upon carbon, tantalum, and tungsten filament lamps when they are operated at from 85 to 110 per cent. of their normal voltage.

Change of Resistance with Change of Voltage.

Percentage of voltage to that of normal.	Percentage of resistance to that of normal voltage. Carbon.	Tantalum.	Tungsten.
85	100·24	95·5	93·5
90	100·16	97	96
95	100·08	98·5	98
100 (normal)	100	100	100
105	99·91	101	102
110	99·81	102·5	104

Change of Current with Change of Voltage.

Percentage of voltage to that of normal.	Percentage of current to that of normal voltage. Carbon.	Tantalum	Tungsten.
85	85	89	91
90	90	93	93·5
95	95	97	97
100 (normal)	100	100	100
105	105	103·5	103
110	110	107	106

Variation of Candle Power Compared to Variation of Voltage.

Percentage of voltage to that of normal.	Percentage of candle power to that of normal voltage. Carbon.	Tantalum.	Tungsten.
85	41	50	55
90	56	64	67
95	75	80·5	82
100 (normal)	100	100	100
105	131	123	119
110	168	148	141

Percentage of Change in Total Watts Compared to Percentage of Change in Voltage.

Percentage of voltage to that of normal.	Percentage of total watts to that of normal voltage. Carbon.	Tantalum.	Tungsten.
85	72·5	75·5	77·5
90	81	83·5	84
95	90	92	92
100 (normal)	100	100	100
105	110·5	109	108
110	121·5	117·5	117

Watts per Candle of Lamps Operated at 85 *to* 115 *per cent. of Normal Voltage when Mean Hemispherical Candle-Power is Carbon* 3·1 *Watts per Candle, Tantalum* 2·1 *Watts per Candle, and Tungsten* 1·25 *Watts per Candle.*

Percentage of voltage to that of normal.	Watts per mean hemispherical candle power. Carbon.	Tantalum.	Tungsten.
85	5·5	3 18	1·76
90	4·5	2·73	1·57
95	3·73	2·39	1·4
100 (normal)	3·1	2·1	1·25
105	2·61	1·86	1·13
110	2·23	1·66	1·03

In glancing over the tables given it will be seen that with the exception of resistance the minimum and maximum points reached in performance when the E.M.F. changes are nearer to that of normal with metal than with carbon-filament lamps. Whereas, at 85 per cent of normal voltage a carbon lamp's resistance is 100·24 per cent. of that secured at normal voltage, that of the tantalum lamp is 95·5 per cent., and of the tungsten lamp 93·5 per cent. At 110 per cent. of normal voltage the per cent. of resistance to that at normal is 99·81 with a carbon lamp, 102·5 with a tantalum lamp, and 104 with a tungsten lamp.

On account of the different characteristics of the resistance of the carbon, tantalum and tungsten lamps the current is naturally affected in such a way that at 85 per cent. of normal voltage it is reduced 15 per cent. with carbon lamps, 11 per cent. with tantalum lamps, and 9 per cent. with tungsten lamps, and at 110 per cent. of normal voltage the current of the carbon lamp is increased to 10 per cent., of the tantalum lamp 9 per cent., and of the tungsten lamp 6 per cent.

The resistance of tungsten and tantalum lamps is less than that of carbon lamps when operated at a voltage lower than normal, and this causes their current, as has been shown, to be higher respectively, so that their candle-power must necessarily be greater. The carbon lamp gives 41 per cent., the tantalum 50 per cent., and the tungsten 55 per cent. of its rated candle-power when operated at 85 per cent. of normal voltage, and 168 per cent., 148 per cent., and 141 per cent. candle-power, respectively, when run at 110 per cent. of correct voltage. This shows that the light delivered by metal-filament lamps is much less affected than that from cellulose-filament lamps by variation of voltage. It is a matter, however, which cannot be brought out too strongly. Referring to the table showing variation of candle-power compared to variation of voltage, it is shown that a drop of 5 per cent. from normal voltage causes a reduction of 25 per cent. in the illumination received from the carbon-filament lamp, 19·5 per cent. in that received from the tantalum lamp, and only 18 per cent. in that given by the tungsten lamp. A rise of the same percentage above normal causes an addition to candle-power of 31 per cent. with carbon lamps, 23 per cent. with tantalum lamps, and 19 per cent. with tungsten lamps.

The increase in total watts is less with metal than with carbon-filament lamps operated above voltage. Burning at an electrical pressure 5 per cent. high, the energy consumed is increased 10 per cent. in a carbon lamp, 9 per cent. in a tantalum lamp, and 8 per cent. in a tungsten lamp.

The watts per candle do not vary as much with tantalum and tungsten lamps as they do with carbon when the voltage is changeable. Not only are the metal-filament illuminants far more efficient, but their percentage of change in watts per candle is much less when compared to carbon-filament lamps when run at a fluctuating voltage. Taking the specific consumption of the cellulose lamp as 3·1 watts per candle, the tantalum as 2·1 watts per candle, and the tungsten as 1·25 watts per candle at 100 volts, the respective specific consumptions would be 5·5 watts per candle, 3·8 watts per candle, and 1·76 watts per candle at 85 volts, and 2·23 watts per candle, 1·66 watts per candle, and 1·03 watts per candle at 110 volts.

When the electrical pressure is unsteady, the performance of both the metal-filament lamps mentioned herein is certainly most gratifying. The nearer the results obtained at varying voltage come to that secured at normal, the more the troubles will be diminished of the generating stations and of the persons using electricity for lighting purposes. With every recent development of a new lamp a marked improvement has taken place in this respect.

We can deduce the values of the coefficient n for the carbon, tantalum, and tungsten lamps, the results for which were given in the third table of the second of the above articles. For the carbon-filament lamp, the total percentage fluctuation in candle-power was $(131-75)=56$ per cent. for a pressure fluctuation of 10 per cent., or $n=5·6$.

For a 20 per cent. pressure fluctuation, the percentage fluctuation in candle-power was $(168-56)=112$ per cent., or, as before, $n=5·6$.

This confirms the law, deduced by Hirschauer, that the total percentage fluctuation in candle-power is equal to the product of the total percentage pressure variation and the exponent n for any percentage variation in pressure.

For the tantalum lamp the values of the exponent n are 4·25 and 4·2, and for the tungsten lamp the values are 3·7 and 3·7 for 10 per cent. and 20 per cent. total pressure fluctuation respectively.

Thus the results obtained from an analysis of Loring's table confirm the conclusion of Hirschauer for the above types of lamps, and, furthermore, the values of the exponent n obtained from the same table agree well with those values given by Hirschauer. The full-line curves in Fig. 3 are reproduced from the article by Hirschauer, but the dotted-line curves have been plotted from the results obtained by Loring. These curves show the total percentage fluctuation in candle-power (f) as a function of the percentage pressure variation (p), and the law for any one of these curves is $f=n\times p$, where n is the exponent of e in the formula for candle-power.

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ELECTRIC HEATING BY ALTERNATING CURRENTS

A SPECIFICATION of some interest amongst those published last Thursday by the British Patent Office is that numbered 25,411 of 1906 by Mr. A. F. Berry, describing improvements in electrically heated apparatus suitable for cooking, boiling, ironing and other purposes. The specification is given in a slightly abridged form below:—

This invention relates to electrical heating apparatus of the induced-current type, and particularly to that kind of apparatus in which heat is produced in a plate, support, oven wall or partition, heating screen or other like body (hereinafter referred to for brevity as a hot plate) by the action of alternating current flowing through the external current-carrying portion of a secondary circuit, the other or internal portion of which (hereinafter called for distinction the secondary element) is wound upon a magnetic core and has a secondary current induced in it by the action of a primary alternating current of higher voltage passing from a source of electric supply, such as ordinary supply mains, through a primary conductor wound upon the same core and hereinafter called for distinction the primary element. In apparatus of this kind, where the hot plate forms part of the secondary circuit, and this circuit forms a single turn of metal, so that the current flowing therethrough is of very great strength and low voltage, a considerable amount of heat is liable to be transmitted by conduction from the hot plate to the secondary element, and thence to the primary element through the connecting portion of the secondary circuit that is between the hot plate and secondary element, and which is necessarily of large section, whereby the resistance of the primary element is increased, and heat is also radiated from and so lost through the said connecting portion of the

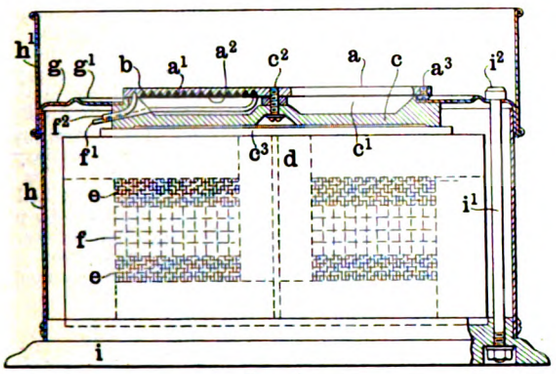


FIG. 1.

circuit, with the result that the efficiency of the apparatus is reduced, and the hot plate may also be less uniformly heated than is desirable.

Now an object of the present invention is to improve the efficiency of apparatus of the kind referred to, and to increase the uniformity of heating over the whole surface of the hot plate by modifying the external current-carrying portion of the secondary circuit, so that it can be made of reduced cross-sectional dimensions, thus minimising its heat-conducting and radiating powers, and, consequently, the heat loss referred to. Further objects of the invention are to improve the relative arrangement of the conductors forming the primary and secondary elements, so as to improve the power-factor of the apparatus, and also to so generally improve the construction of the apparatus as to render the same very durable in use. To this end, according to the present invention, a part of the current-carrying portion of the secondary circuit (hereinafter called for distinction the supplementary secondary element) connected in series with the secondary element of the apparatus is composed of a conductor which may be wound, coiled, or otherwise arranged in one or more layers in the closest possible proximity to, but insulated from, a plate, or a number of rings, of conducting metal arranged to constitute a tertiary circuit in which currents are induced by the alternating current traversing the supplementary secondary element, which thus becomes a primary element thereto, the said conductor being disposed so that the whole of the said plate, or the rings, becomes or become uniformly heated, or practically so. The cross-sectional dimension of the conductor is such as to lessen the tendency for heat to be conducted from the tertiary circuit through the supplementary secondary element to the connecting portions of the conductor, and thence through the secondary element to the primary element on the magnetic core whilst the apparatus is in use, and at the same time to permit the employment of comparatively large secondary currents at low voltage, say for example of the order of between five and ten volts, and still larger currents in the tertiary circuit. By casting the conducting metal constituting the tertiary circuit or hot plate of the desired shape, and with the metal suitably distributed, and so as to come into the closest possible proximity to the supplementary secondary element, the said tertiary circuit or hot plate will be heated both by current induced in it by the supplementary secondary element, and also by heat conducted to it from the supplementary secondary element, which may be covered in so as to protect it from the cooling and oxidising action of the external air, and to stiffen it mechanically.

The apparatus, which thus comprises primary and secondary elements on a magnetic core, and a heating portion consisting

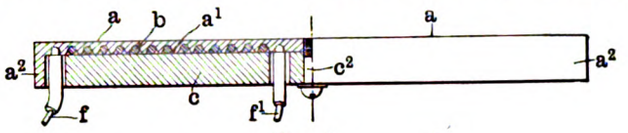


FIG. 2.

of a supplementary secondary element and a tertiary circuit or hot plate, may be constructed in various forms.

In the accompanying illustrative drawings, Fig. 1 is a central vertical section, with parts removed, showing one construction of apparatus embodying the present invention, and suitable for heating kettles, saucepans, and other vessels. The supplementary secondary element with the hot plate constitutes the tertiary circuit, with which it is combined. Figs. 2, 3, and 4 are part sectional elevations illustrating modified forms of the supplementary secondary element and hot plate in central vertical section and plan, another construction of hot plate with supplementary secondary element. Fig. 5 shows a construction of apparatus embodying the present invention suitable for use as a laundry iron, being a sectional elevation.

In the example shown in Fig. 1, the hot plate *a* consists of a thin, circular plate or disc, *a*, of conducting metal, as, for instance, muntz metal, but preferably of metal, for example, iron or steel, on the underside of which is located the supplementary secondary element *b*. This element consists of a spirally wound inductive coil or conductor comprising several convolutions, arranged in the same plane, and formed of wire of ordinary circular section, as shown in Fig. 1, or of strip material arranged with the sides of the metal strip at right angles to the plane of the disc *a*. The conductor forming the supplementary secondary element *b* may be wound or coiled outwards from the centre of the plate or disc *a*, or conversely from the centre towards the outer edge thereof.

For the purpose of maintaining the conductor of the supplementary secondary element *b* in proper relative position to the tertiary circuit, and for obtaining the maximum conversion of electrical energy therein into useful heat energy, the plate or disc *a* of the latter circuit may advantageously be formed on its underside, as shown in Fig. 1, as by casting or turning, with a spiral groove, a^1, corresponding more or less to the section or part section of the conductor *b* forming the supplementary secondary element, and into which groove the conductor can be wound and secured. A convenient manner of effecting this is to first insulate the conductor *b* with a covering of suitable material capable of withstanding heat, for example, with berrited asbestos, composed of a thin layer of asbestos paper saturated with the insulating material known

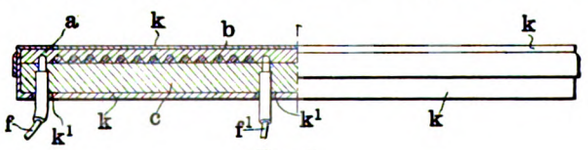


FIG. 3.

in commerce as "berrite," and then wind the same into the said grooves in a lathe with the aid of a guide plate comprising a number of spring sectors. Or it may be insulated subsequently to its being wound in place, as, for instance, by enamelling or coating it with a suitable composition; for the latter purpose the groove a^1 in the plate *a* in which the conductor is to be wound may be coated with some appropriate vitreous enamel or the like, and after it has hardened, the bare conductor is placed in position therein, and the remainder of the groove filled with the material constituting the enamel, and the whole raised to the requisite temperature to cause the conductor to be embedded in and secured in position by the enamel. Or the conductor may be embedded in the material constituting the enamel whilst the same is in a powdered condition, and within the groove, the said material being afterward fused by heat to securely fix the conductor in place and insulate it from the plate *a*.

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A protective plate, a^2, of sheet metal, for example, iron, steel, or the like, is then secured, as by screws a^3, to the lower side of the plate a, so as to hold the supplementary secondary element b firmly in place, and protect it from the cooling and oxidising action of the external atmosphere. The supplementary secondary element b thus constituted may be supported by an asbestos or asbestos-covered carrier, c. In the example shown in Fig. 1, the carrier c is shown as composed of a recessed block of insulating material, above which is directly located the plate a^2, the space c^1 between the said carrier c and plate a^2 being filled with material, for example, mica dust, that is a bad conductor of heat. The block c is secured to the hot plate a by a set screw, c^2, and the whole is firmly held upon the iron core d carrying the primary and secondary elements e and f by a stamped flanged metal ring, g, that is adapted to fit firmly over the outer portion of the block c, and tightly over the top of a casting, h, enclosing the said

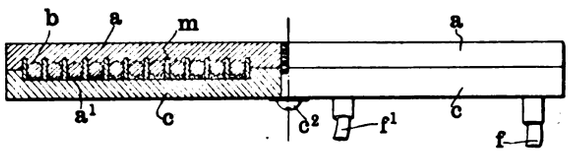


FIG. 4.

core with primary and secondary windings, the whole being secured tightly together and to a wooden or other base, i, by bolts, i^1. A ring, c^3, of asbestos or like badly-conducting material may be placed between the block c and core d, and the heads of the bolts i^1 are insulated from the ring g by washers i^2 of insulating material. The hot plate a extends a short distance above the ring g, which, when stamped to the shape shown, to impart strength thereto, has the annular recess g^1 therein filled with insulating material, for example, the material commercially known as uacolite, to form a smooth flat surface. The portions f^1, f^2 of the secondary conductor connecting the secondary element f to the supplementary secondary element b are led through the recess in the block c, and are preferably insulated as shown. e^1 is a switch for controlling the circuit of the primary winding e. h^1 is a draught excluder of thin sheet metal, arranged to closely fit the stamped ring or lid g. The plate a^1, instead of being made of sheet metal, may be made of thicker metal, say, of the thickness of the hot plate, a, so as to form a duplicate tertiary circuit, the two plates wholly embracing or surrounding the said supplementary secondary element b, so as to further enhance the efficiency of the apparatus.

In Fig. 2 the insulated supplementary secondary element b rests directly against the asbestos block or carrier c, and against the underside of the hot plate a, which is flanged at

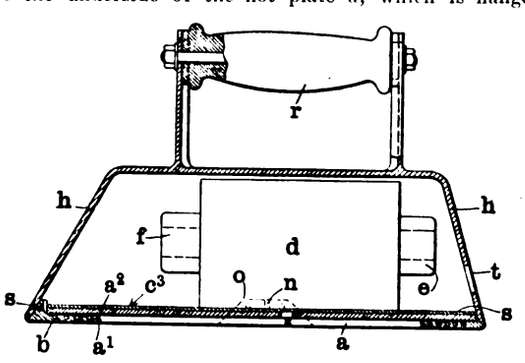


FIG. 5.

a^2 so as to embrace and confine the wound conductor and the block or carrier c in place. In Fig. 3 a hot plate, a, is shown, in which the conductor b is wound as above, and a carrier, c, of asbestos, fireclay, or the like then placed in position next to the conductor, and the whole confined within a divided metal casing, k, that may be polished or nickel-plated at the top, and the separate parts of which are brazed or soldered together whilst under pressure. The apertures k^1, through which are passed the leads f, f^1 that connect the supplementary secondary element b to the secondary element e in the case h (Fig. 1), may be left free to serve as blow-holes until after the apparatus has been tested, when they may be sealed in any suitable manner, such as by enamel. In the same way, a duplicate tertiary circuit may be provided and secured in place in lieu of the carrier c. As an alternative to the modes above alluded to, for constituting the spiral groove a^1, a spirally wound partition of strip brass may be employed, incorporated in a mould so that the top or tertiary circuit can be cast thereon. A hot plate thus produced is shown in section in Fig. 4, wherein m are the portions of the brass strip forming the partitions, a the hot plate cast thereon, and b the wire or conductor forming the supplementary secondary element. Or the wire b forming the supplementary secondary element may be threaded through brass or other metal tubing, which may be placed in or against the hot plate, or coiled to form a hot plate, as will be understood without illustration. The supplementary secondary element may comprise more than one layer of spirally-wound conductor, and in some cases the tertiary circuit, instead of being formed as a solid plate, may be perforated. Another figure (not reproduced here) showed a hot plate embodying both of these features, the secondary element comprising two layers of spirally-wound conductor. Also, for some purposes, as for a heat radiating screen or plate, the tertiary element may be formed of a series of metal rings, or rectangular or other shaped frames of different sizes spaced apart one inside the other, and connected together by connecting bars. The hot plate, instead of being a non-magnetic metal such as muntz metal or brass, or of unlaminated magnetic metal, such as iron or steel, surrounding, or partly surrounding, the supplementary secondary element as hereinbefore described, may be made partly of non-magnetic and partly of magnetic metal, as shown, for example, in Fig. 4 hereinbefore referred to, where the top portion of the plate a is of iron, and the lower portion, formed by the spiral partition, m, of brass.

In the further example of apparatus embodying the present invention shown in Fig. 5, the hot plate a is arranged to form the bottom or sole of a laundry iron, and is made of any usual shape in outline, its upper surface being formed with a continuous groove, a^1, for the reception of the insulated conductor forming the supplementary secondary element b, which is held in place by the protective metal plate a^2. To the upper side of the plate a^2 is secured a layer, c^3, of insulating material, such as asbestos or uacolite, upon which the core d carrying the primary and secondary elements e and f is secured, it may be by a winding of wire n passed around lugs o on the top of the hot plate a. The core with windings is enclosed in a casing h, for example, of cast aluminium, which is provided with ventilating holes q, and provided with a handle, r, the said casing being secured to the hot plate, as by screws s. t is a hole in the casing h for the reception of a nipple for attachment of a flexible cable to the primary winding of the apparatus. The primary and secondary elements e and f with magnetic core d may be common to a number of supplementary secondary elements with hot plates, as in the case of cooking apparatus designed for use as a boiler, griller, oven, and so forth, and of laundry irons, switches being provided for controlling the connection between the several supplementary secondary elements b thereof, and the main secondary element f. The main secondary element f in apparatus constructed as described may consist of several turns, and is or may with advantage be placed between two portions of the primary element e, or between two primary elements, so as to increase the power-factor of the apparatus. The details of construction can be variously modified.

The claims are as follows:—

1. Electrical heating apparatus of the induced-current type as herein set forth, wherein the current-carrying portion of the secondary circuit includes an element which is supplementary to the main secondary element upon a magnetic core, and acts as a primary element to a tertiary circuit forming the heating device proper, so that current flowing in the aforesaid supplementary secondary element will uniformly heat the tertiary circuit by induction as well as by conduction, substantially as set forth.

2. In electrical heating apparatus, according to the preceding claim, a hot plate of electricity and heat-conducting material, the under or upper surface whereof is subject to the uniform inductive effect and heat radiation of an insulated element wound and located in the closest possible proximity to the lower or upper surface thereof, substantially as set forth.

3. In electrical heating apparatus, according to the preceding claims, a hot plate in which the inductive winding or conductor is confined within a groove or grooves in the hot plate, fashioned in any of the ways hereinbefore described.

4. Electrical heating apparatus, according to the preceding claims wherein the conductor forming the element for heating the hot plate is wound within a spiral or other groove or recess formed in the hot plate, and is held in such groove or recess by a plate or cover that serves primarily to protect it from the action of the external air, substantially as described.

5. Apparatus, according to Claim 1, comprising primary and secondary elements on a magnetic core, and a heating portion comprising a supplementary secondary element in circuit with the first-mentioned secondary element and a tertiary circuit or hot plate, the whole combined to form a single heating block or device, substantially as described.

6. For electric heating apparatus, according to Claim 1, a combined hot plate and inductive winding in close contact therewith, constructed substantially as hereinbefore described with reference to certain of the accompanying drawings.

7. Electrical heating apparatus of the kind herein referred to having its several parts constructed, arranged, and adapted for use substantially in the manner hereinbefore described with reference to certain of the accompanying drawings.

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AN ITALIAN WATER-POWER STATION

THE large water-power generating station at Trezzo is one of the most important installations of its class in Italy, and embodies some distinctive features, especially as regards the arrangement of the hydraulic

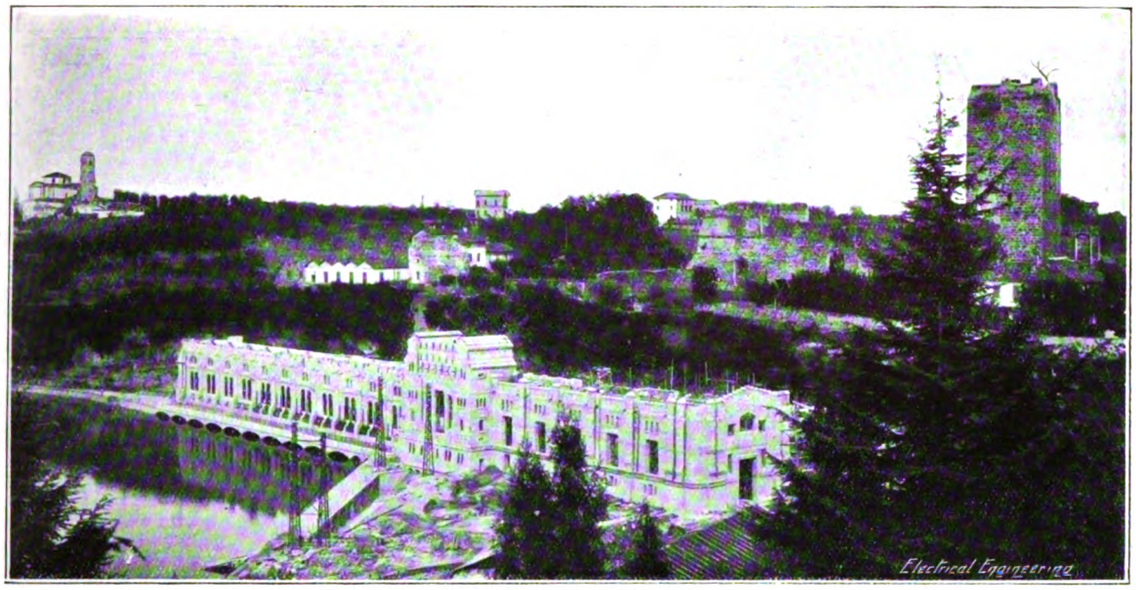


Fig. 1.—General View of Power-House.

portion of the equipment and the greater amount of attention paid than is often done to the architectural features of the power-house. The station building, which is shown in Fig. 1, is situated close to the old castle of Trezzo, on a narrow peninsular of land, round which flows in a sinuous course the river Adda.

In contradistinction to many water-power undertakings, there are no separate intake works, nor any intake canal nor pipe line, as the power-house is on the river bank itself, a short distance above the dam. The water, after having passed through the low fall turbines, is taken through a pair of tunnels about 100 metres in length, and discharges on the other side of the peninsular into the river. A fall of 6 to 8 metres is available. The dam, which it is unnecessary to describe in detail, lies obliquely across the river on the side of the peninsular where the power-house is situated, just above the sharp bend of the river, and a canal, 12 metres wide, with a lock, connects the upper and lower portion of the river for purposes of navigation. Just behind the power-house a discharge basin running its whole length has been excavated, of

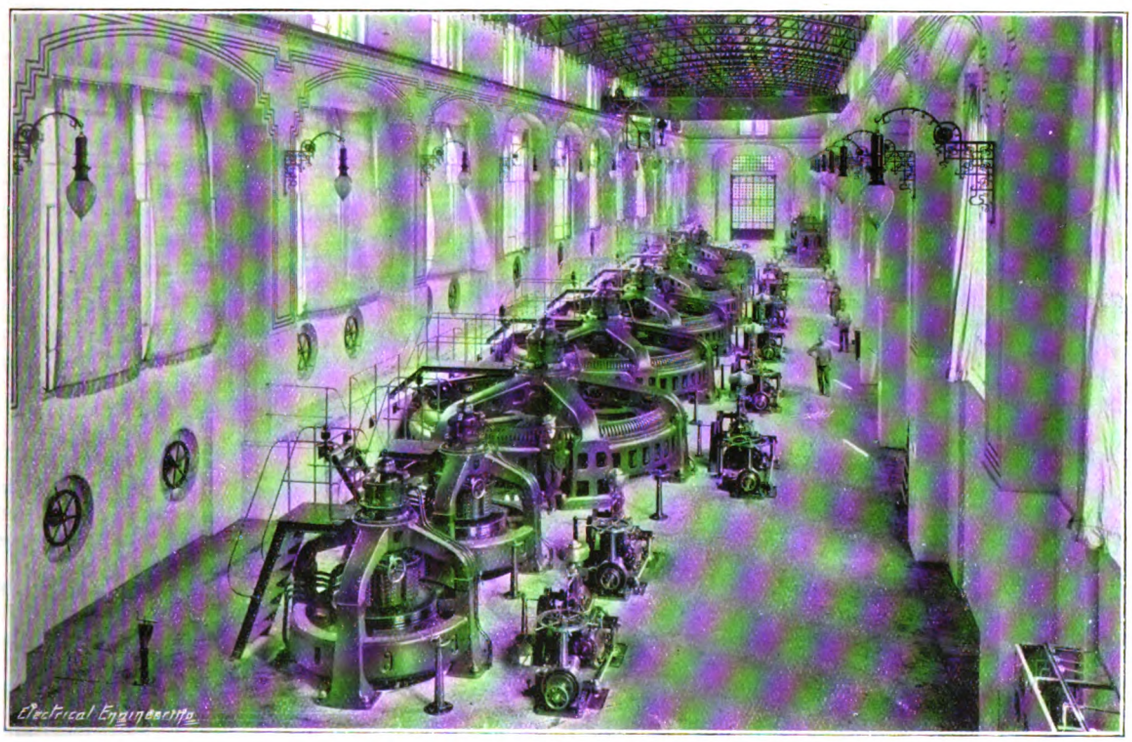


Fig. 2.—View of Part of Interior of Power-House from Switchboard Gallery.

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a width varying from 15 to 22 metres, in which the height of the water ranges from 2·5 to 5·5 metres. The discharge tunnels from the basin are 90 metres in length and 10 metres in diameter, and are 30 metres apart from centre to centre.

The initial equipment at the station comprises nine main 1,000 kw. generating sets, and the necessary separately driven exciters. When complete the station

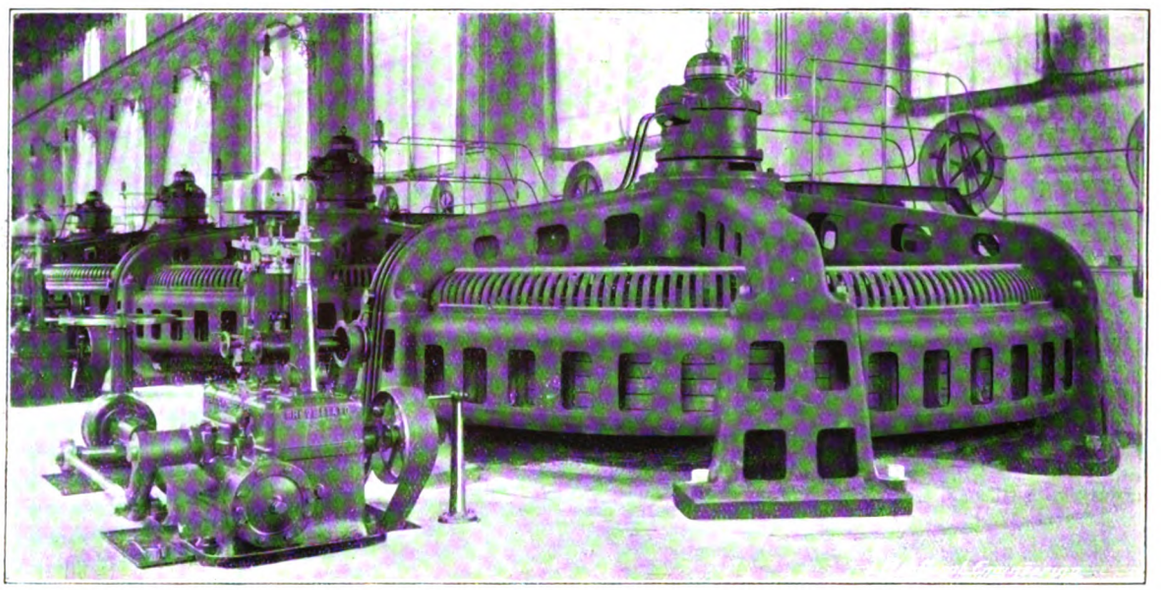


FIG. 3.—1,000 KW. VERTICAL SHAFT ALTERNATORS.

will contain twelve generators, of which ten will be for the supply of alternating current at 42 cycles, while the remaining two will be for a frequency of 50 cycles. These latter are intended for the supply of current to the Società Bergamasca d'Elettricità, and those of the lower frequency for the distributing network of the Hydraulic Power Co. of Trezzo. The water consumption of the large turbines is given as

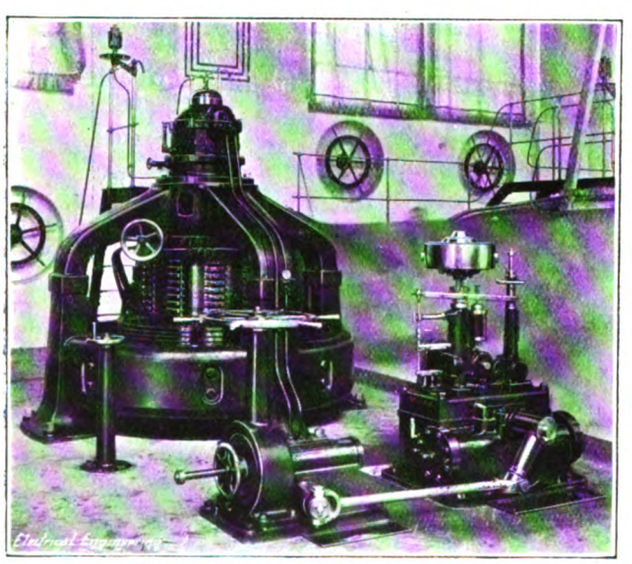


FIG. 4.—TURBINE DRIVEN EXCITER.

16,000 to 17,000 litres per second, and that of the exciter turbines as 3,000 to 4,000 litres per second. They run at speeds of 105 and 190 r.p.m. respectively, and are designed to develop their full load with a head of water varying from 6 to 8 metres. Each unit consists of two water-wheels, mounted one above the other on the same vertical shaft, a practice often made use of to facilitate obtaining a sufficiently high speed when only a low head of water is available. One of these wheels takes in water from below, and the other from above, so that they both discharge into a single channel between them. The lower wheel is subjected to the total head, and its reaction serves to take a part of the weight of the revolving system. The upper wheel, on the contrary, has the pressure of the water between its runner and the top of its case lightened by means of a syphon tube in communication with the discharge channel. Appropriate guides in the space between the wheels direct the water into the right direction.

The rotors of the alternators are coupled rigidly to the turbine shafts, and are supported from bearings at the top. A view of part of the interior of the machine room is seen in Fig. 2, and Fig. 3 gives a more detailed representation of the alternators. The appearance of the line of generators is undoubtedly imposing, and the general effect is distinctly enhanced by the simple but effective scheme of interior decoration of the building. The alternators were supplied by the Unione Elettrotecnica Italiana, and are of the internal revolving field type, with a stator diameter of 6 metres. The stator of each machine is constructed in two parts, and is carried on six feet mounted on reinforced concrete foundations. There are two bearings; that at the top, as already remarked, is a thrust bearing, while the lower one serves simply as a guide bearing. The total weight of the revolving mass is about 24 tons. The stator core is constructed with open slots. The 42-cycle alternators are wound for 13,800 volts, and the 50-cycle machines generate at 7,000 volts. The windings consist of former-wound coils retained in the slots by wooden wedges, and have all been required to withstand an insulation test of 20,000 volts between the conductors and earth.

The laminated poles of the revolving field are mounted on the heavy cast-iron body of the rotor, and carry windings of bare copper strip insulated with paper. The total moment of inertia of the revolving parts is given as 250,000 kgm². The upper bearing has a ball thrust, and runs in oil. It acts also as a guide bearing by means of a white metal bush, and is water cooled. The lower bearing, close to which are mounted the slip rings for the exciting current, is provided with a similar bush. Both bearings are lubricated from a lubricator mounted above, and the oil passes first through the upper bearing and then through a channel in the shaft to the lower bearing.

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There are two exciter sets driven by separate 240 h.p. turbines. One of these is shown in Fig. 4. They have eight poles, and are rated at 1,250 amperes at 130 volts at 190 r.p.m. The general arrangement of the bearings and their lubrication is similar to that of the large sets. The commutators are above the armatures for ease of access.

In addition to the hydraulic machinery described above, a supplementary steam plant is provided in the right-hand wing of the building, as seen in Fig. 1, consisting of four 1,000 kw. sets, driven by horizontal steam engines, and supplied by a battery of six boilers. The object of this plant is to make up in winter for the insufficiency of the flow of the river Adda. The switchboard gallery is placed in a raised position between the hydraulic and steam machine rooms, so that a good view of both can be obtained. The switchgear is naturally divided into two sections for the 42-cycle and 50-cycle plant respectively. It follows the usual cellular type of construction, in which the various bus bars, instrument transformers, high tension switches, &c., are separated from one another by cement partitions. The current from the 42-cycle generators passes through the machine oil switches and instrument transformers to a machine bus bar in the form of a ring, which can be sectionalised so as to cut out any one machine panel that may be required. The water and steam-driven 42-cycle machines are all connected up to this board, which has provision for 14 sets, including future extensions. From this ring machine bar connections are taken from two diametrically opposite points to what may be termed the distributing bus bars. By this means the distributing bars, which, however, are not laid out in the form of a ring, can be fed from either end, and here, again, provision is made to isolate any panel. A further coupling bar is provided, by which the two sets of feeding connections can be coupled together if required. It will be seen that this arrangement is very flexible, but it involves the use of a very considerable number of sectionalising switches. The control boards are of the "desk" type, with flush type instruments mounted in the inclined panels and the switch and rheostat handles in front.

Amongst the outgoing overhead lines radiating from the station one is for the transmission of energy to the electricity company of Monza, and terminates at a transforming station belonging to the Conti Co. Another line is carried in the direction of Gorgonzola, and branches out into three portions, leading respectively to Crema, Pioltello, and Crescenzo. An unusual feature of the system is the employment on certain short branch sections of the transmission lines of iron wires for the transmission. The branches in question are taken from the main 13,800 volt. They are only a few kilometres in length, and are only for the transmission of loads of less than 100 kw. Under these conditions the somewhat greater inductive drop due to the use of iron is not sufficient to be of consequence, and an appreciable economy in the cost of installation is obtained. Another distributing company supplied from the Trezzo station is the Società della Martesana, which was established solely for this purpose.

Electric Testing Stations in London.—The Highways Committee of the L.C.C. have received as a deputation the subcommittee appointed by the conference which was convened last year by the Hackney Borough Council to consider the arrangement of joint action before the Board of Trade relative to the intention of the L.C.C. to prescribe fees in respect of duties performed by their inspectors in visiting testing stations established in the County of London by electric light undertakers under the provisions of special Acts or Orders. The sub-committee was appointed to take all necessary steps to oppose the establishment of testing stations, principally on the ground of the large and unnecessary expense which would have to be incurred.

A NEW SURFACE-CONTACT SYSTEM

A NEW surface-contact system, for which considerable advantages are claimed, is being developed by Mr. D. Suchostawer, of Vienna, and an English syndicate is being formed in connection with the system. No actual line has as yet been equipped, but experiments have been conducted with a working model embodying the leading features. Full details of the working of the system are not available for publication at the present time, but we understand that the principal directions in which advantages are claimed are as follows:—

The danger of a "live" stud is reduced to a minimum by the use of a gravity pull-off, and by a complete leakage trap. The studs are of small area, and project very slightly above the paving, and the switching movement is very simple. The depth required for the stud or pick-up boxes and the line wire is but a few inches below the street surface, so that no special excavation is needed to accommodate them, the excavation for the tramway structure sufficing. The cost of the studs is low, every part being adapted to manufacture by simple machine tools on the interchangeable principle. The cost per mile of single line is said to compare favourably with that of a well-built overhead system, but for a double line it may be somewhat higher. The magnetising current needed for the pick-up is very small, owing to the employment of a good effective magnetic circuit in both stud and car magnet. The cost of maintenance may be expected to be low, because of the simple character of the movement, the substantial design of the parts, and the ease of examination and replacement thereof.

The system, which has been favourably reported on by Mr. H. M. Sayers, is claimed to be suitable for the third rail for railway work, as well as for street tramways.

Faraday House.—The annual dinner of the Faraday House Old Students' Association, which had been fixed for the 21st inst., has been indefinitely postponed in consequence of the death of the wife of the President-elect.

Institution of Electrical Engineers.—The following is the result of the ballot for new members at the Institution on Thursday:—*As Member:* Dr. E. Rosenberg, c/o British Westinghouse E. & M. Co., Ltd., Trafford Park, Manchester. *As Associate Members:* W. B. Bayliss, H. M. Boydell, L. G. Clark, J. E. Elliott, H. N. Fullarton, H. M. Fulton, E. W. Heather, S. M. Hopewell, A. H. L. Lucas, J. M. McGown, C. R. Whipple. *As Students:* H. Autton-Carter, H. A. Bailey, G. F. Barbour, B. G. Bellamy, D. Betts, J. R. Boyer, R. V. C. Brook, W. Brown, J. Cunliffe, A. R. Dunton, W. G. Edwards, A. Gardner, S. Ghosh, R. D. Gifford, A. Y. Jarrett, L. M. Jockel, J. H. C. Kann, V. Kilvert, N. Martin, A. Mizzi, B. F. Mulholland, S. G. Nottage, H. J. K. Osborn, H. L. O. Parish, C. A. Pilson, F. H. Pullum, A. W. Puttick, J. P. Quinn, N. S. Sim, L. Solomon, H. A. J. Stanton, M. Swift, F. E. Windross, M. W. Wood.

Wireless Telegraphy in the Navy.—According to the *Naval and Military Record* a considerable increase is being made in the staff of wireless telegraph operators in the Navy. At present there are, it is believed, about three hundred efficient wireless operators in the fleet, and another hundred are about to be placed under instruction. The course for these men on board ship after their preliminary instruction lasts sixty days. They begin by sending and receiving groups of letters and words, and have the instruments and their uses explained to them. After ten days they go on with twenty days of simple exercises in sending and receiving short messages on two days a week, the training class in one ship talking by "wireless" to the training class on board another ship in the same fleet. Cypher messages are also interchanged. Then for another twenty days they go into a more advanced lot of messages, and are taught how to get their instruments rapidly into adjustment, and how to maintain and repair them. They also start to read Poldhu messages, and to increase the pace of both sending and receiving until they are finally examined for their general fitness. A smart wireless telegraphist should be able to signal at the rate of about twenty-five words per minute after such a course, and this meets the needs of the fleet at present. A rearrangement of the telegraphist and signal ratings has been made in order to avoid the demand for wireless operators depleting the ordinary signal branch of the service.

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SOME NEW MOTOR SWITCH-GEAR

THE accompanying illustrations represent some special switchboards for the control of motors, which have recently been supplied by the Adams Manufacturing Co., of Bedford. In Fig. 1 a special board for the control of two large motors is shown.

It will be seen that for each motor a double-pole switch is provided, together with two single-pole porcelain handle fuses, an ammeter, and a motor-starting and speed-regulating switch. This latter is fitted with automatic no-volt and overload release, and is of the double-lever type, which permits of the motor being started, and its speed varied over a wide range, by means of shunt regulation with the use of only one handle. This method secures an absolutely perfect interlock between the starter and the field regulator, and effectually prevents the possibility of attempting to start the motor while any resistance is in series with the field coils.

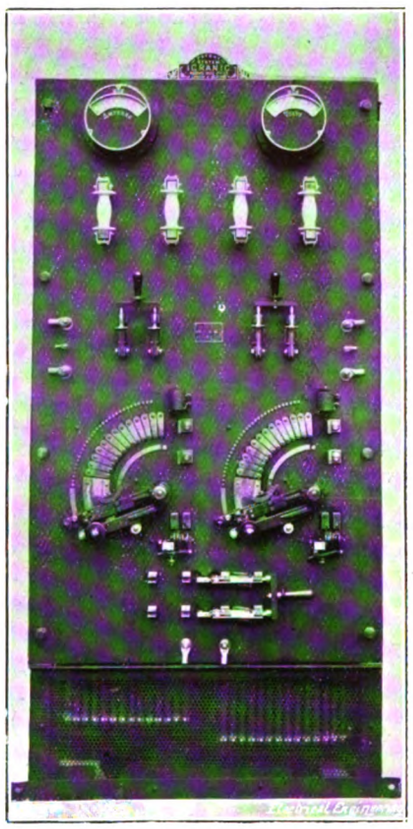


FIG. 1.—CONTROL PANEL FOR TWO MOTORS.

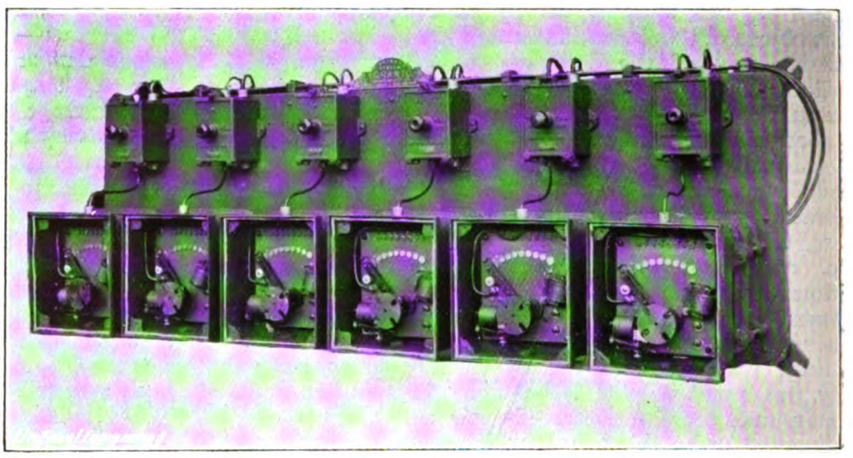


FIG. 2.—SPECIAL ENCLOSED MOTOR SWITCHES, WITH COVERS REMOVED.

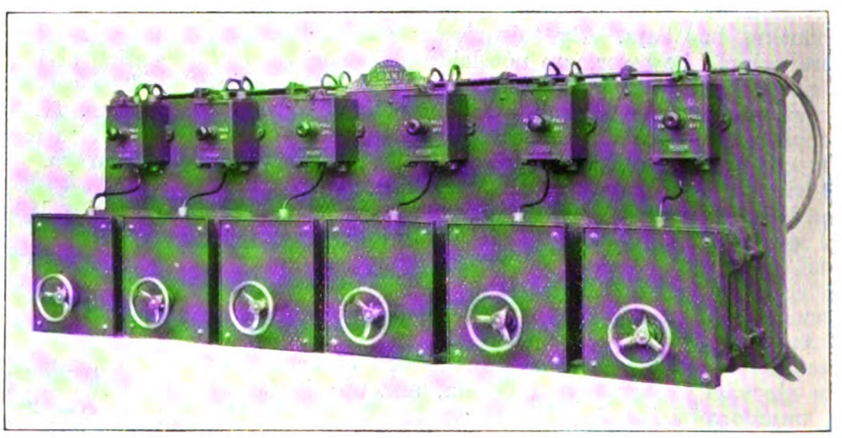


FIG. 3.—ENCLOSED MOTOR SWITCHES, WITH COVERS IN PLACE.

At the bottom of the panel is a double-pole change-over switch, whereby the load may be changed over from one motor to the other at will. The starting and regulating resistance is contained in a strong ventilated iron box, which serves also as a support for the panel. Figs. 2 and 3 show a group of six ironclad speed-regulating resistances of a new type, which the company have introduced to obviate the difficulties which are presented when series speed-regulating switches are required to be used in positions where it is necessary that they should be absolutely waterproof. In this apparatus the resistance is entirely enclosed in a cast-iron casing, fitted with gills, in order to increase the radiating surface. The resistance, therefore, does not depend at all upon a current of air through it to carry off the heat. As a matter of fact, the air never comes into contact with the resistance material at all, but only with the outer surface of the cast-iron case. As a consequence, this type of resistance may be installed not only in positions which are damp, but might be used even in positions where the resistance is liable to occasional immersion in water, or to have the water dashed over it, and this makes it peculiarly suitable for colliery work, and for breweries, and for mineral water manufacturers, as well as for use on shipboard.

The board illustrated has recently been supplied for use in the bottling stores of a large brewery, where water is even more plentiful than in other parts of a brewery. It will be observed that the switch is contained in one cast-iron box, which is provided with glands through which the connections can be made, while the resistance is mounted behind the switch-box, and consists of gilled cast-iron plates of the type described above.

Proposed Subways in Vienna.—According to the *Railway Gazette*, the Austro-Hungarian Ministry of Commerce is considering the construction of an underground electric railway for linking together the district post offices of Vienna, of which there are between 60 and 70. The proposal is for a tunnel 25 ft. below the surface, with a height of 5 ft. and a breadth of 4 ft. 6 in., the stations being situated, of course, under the post offices. A motor van and three cars, each of the same capacity as an ordinary post van, will form the train, which it is proposed to run at about 20 miles an hour.

Railway Electrification in Brazil.—According to an American Consular Report, the increase in suburban railway traffic of Rio de Janeiro has been so great as to call for some solution of the problem of providing adequate facilities for the large population which depends for transportation upon these trains. The number of passengers carried in the suburban trains increased from 12,600,000 in 1901 to 19,250,000 in 1906, an increase of about 52 per cent. It has been proposed that the suburban lines be electrified and plans are now being made to that end. The mileage will probably be about 20 miles, and the present estimate places the cost of the work at about $3,500,000, but it is thought probable that it cannot be done for less than $5,000,000. Three years is to be the time limit for the completion of the work. The plan specifies that trains are to run on a schedule providing a three-minute service, or 20 trains per hour, accommodating 40,000,000 passengers per year.

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THE LOSSES IN POLE SHOES DUE TO ARMATURE TEETH

A PAPER by Messrs. T. F. Wall and S. P. Smith, which was read and discussed last week at the Newcastle Local Section of the Institute of Electrical Engineers, described the results of some experiments made to determine the loss in dynamo-electric machines due to the pulsations of the flux set up in the pole shoe by the movement of the armature teeth across the pole face. The way in which these losses arise can be seen from Fig. 1, which shows the distribution of the flux in the air-gap when the machine is running light. From this figure it is at once obvious that the flux density at any point on the pole face will vary according to the position of the armature teeth relative to that point; consequently, as the teeth move across the pole face, the flux in the shoe will pulsate. The magnitude of these pulsations depends chiefly on the value of the mean flux density over the whole pole

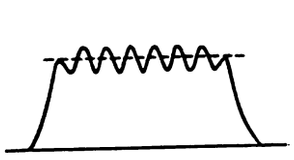


FIG. 1.—FLUX DISTRIBUTION ON NO-LOAD.

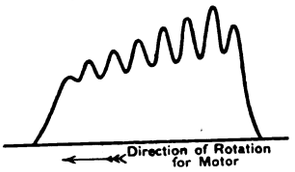
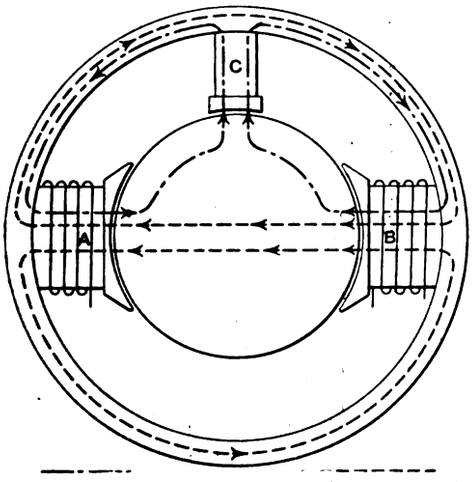


FIG. 2.—FLUX DISTRIBUTION ON LOAD.

surface, and on the relation between the slot-opening and the air-gap. The E.M.F.'s set up by the flux pulsations produce corresponding eddy currents, and these, in turn, tend to damp out the fluctuations. The damping action is mainly dependent on the frequency of the pulsations, the thickness of the laminations (if any), and the nature and temperature of the iron. Further, the presence of a current in the armature has a large influence on these losses, as may be gathered from Fig. 2, which illustrates the distorting effect of the armature current on the field and its corresponding effect on the magnitude of the flux pulsations.

Under the assumption that the flux pulsates according to a sine law, the calculation of these losses has been carried out by Potier and Rüdenberg. The flux pulsations are probably not sinusoidal, however,* and have, consequently, a larger form factor than a sine curve, whence it is to be expected that the theoretical formula given by these investigators would give results less than those obtained by experiment. It will be presently seen that this is actually the case.

The experiments made by the authors are based on the assumption that the whole of the energy loss, caused by the pulsating flux, is dissipated as heat, and the method consists in measuring the heat thus dissipated. This was done by determining the amount of energy—supplied from an external



Flux distribution when A and B have like polarity.

Flux distribution when A and B have unlike polarity.

FIG. 3.—DIAGRAM OF EXPERIMENTAL MACHINE.

and measurable source—that must be expended in order to obtain the same conditions of heating as when the actual losses are present In other words, the heating due to eddy currents is imitated by artificial heating. It was of the highest importance, therefore, to make certain that all other forms of heating were identical in the two cases. This was done as follows:—

The experimental machine was a 5-h.p. dynamo with commutating poles, and had four main poles. Two of the main poles, which were diametrically opposite, were used for the production of the flux, the other two along with all the commutating poles being removed. The experimental pole shoe was specially designed for these experiments. This was made of massive wrought iron, and so arranged that the gap could be varied at will. The experimental pole is denoted by C in Fig. 3, whilst A and B represent the main poles. Suppose now that A and B are excited in such a way that A becomes a N pole and B a S pole. The flux will then pass directly from A to B, and the *experimental pole* C *will be free from flux*, provided the magnet system is symmetrical with regard to it. Under these conditions, therefore, no eddy currents will be induced in the experimental pole shoe. Suppose now that the current in one of the exciting coils be reversed, the poles A and B will then have the same polarity, and the pole C will now form a return path for the flux issuing from A and B; further, whilst A and B have large pole shoes in comparison with C, it is at once obvious that the flux density in the experimental pole shoe may be made to assume high values.

In both the above cases, however, the heating due to the exciting current in A and B is precisely the same, provided the current is kept constant throughout. It will thus be seen that when A and B have unlike polarity, the heat in the pole shoe C is solely due to the heating of the machine; whilst when A and B have like polarity, the heating of the pole shoe C will be due to exactly the same causes as before, together with the additional heating caused by the eddies and hysteresis produced by the flux pulsations in the shoe. Hence it may

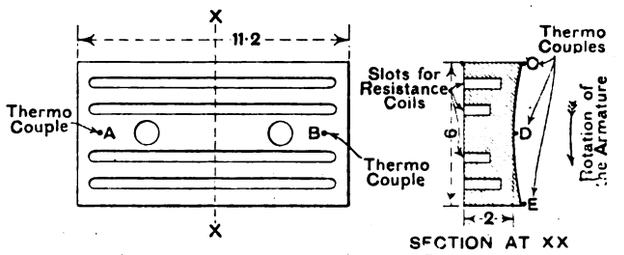


FIG. 4.—THE EXPERIMENTAL POLE SHOE. (DIMENSIONS IN CM.)

justly be concluded that the difference of temperature of the pole shoe in the two cases is due to, and is therefore a measure of, the losses caused by the pulsations of the flux in the shoe. The experiment, therefore, resolves itself into finding out to what dissipation of energy this temperature-difference corresponds. This was done as follows. In the experimental pole shoe, Fig. 4, slots were cut, and in these slots resistance coils were laid. Each slot contained two coils, which could be connected non-inductively in series or parallel, as desired. Further, since the plane of the coils was perpendicular to the pole face, any possible flux, due to the current in the resistance (or heating) coils, which may have been present, was in the worst possible direction for producing any effect which might vitiate the results when it was desired to heat the shoe artificially. When the main poles were of opposite polarity, and consequently no flux went through the experimental pole, current was sent through these coils, and, by suitably adjusting this current, it was possible to make the temperature of the shoe the same as that produced by the eddy currents when the main poles had the same polarity and the flux went through the experimental pole. When this equality of temperature was reached, the power supplied to the heating coils was measured, and this power was then taken as equal to the loss of energy produced by the flux pulsations—an assumption which the authors now proceed to justify.

From the drawing in Fig. 4, it will be seen that the resistance coils are completely embedded in the pole shoe, so that all the heat developed by these coils must be absorbed by the pole shoe, to be afterwards dissipated from its surface. To prevent as much as possible a transfer of heat, the pole shoe was insulated from its core by a sheet of mica. The temperature of the pole shoe was measured by means of thermo-couples, balanced on a potentiometer. There were five thermo-couples in all, which were made by simply soldering copper wires on the shoe, whilst an iron wire soldered to the shoe served as a common terminal to all the couples. In this way it was possible to explore the temperature-distribution over the whole

* G. W. Worrall and T. F. Wall, *Journal Institution of Electrical Engineers*, vol. 37, 1907, p. 148.

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shoe, both when it was heated by the losses and when it was heated artificially. This was important, since the validity of the equivalence of the artificial heating to the heating by the eddy losses depends chiefly on the distribution of the temperature being the same in the two cases.

The order of each experiment was as follows. The machine was allowed to warm up with flux (and therefore eddy currents) in the experimental pole shoe, then, after attaining a steady temperature, the E.M.F.'s of the thermo-couples were balanced. After this, the current in one of the exciting coils was reversed and at the same time artificial heating was applied by means of the resistance coils; then, after one to two hours, the temperature would have again become steady, and the thermo-couples could be balanced. This had to be repeated, by varying the heating current in the resistance coils, until sufficient points were obtained for drawing a curve containing the point corresponding to the potentiometer readings with flux in the pole shoe.

The first series of experiments was made to find the law connecting the eddy losses in the pole shoe with the flux density. The results are shown plotted in Fig. 5. The losses in each

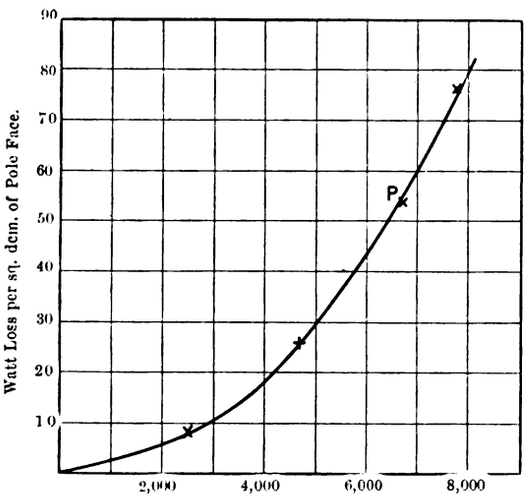


FIG. 5.—CURVE SHOWING RELATION BETWEEN LOSSES IN POLE SHOE AND FLUX DENSITY IN AIR-GAP.

Experiments A { Air-gap constant $\delta = 1{\cdot}9$ mm. Speed constant $n = 580$. Armature current = 0.

case have been reduced to the "losses per square decimetre of pole shoe face," and are given in watts (area of pole shoe face $= 1{\cdot}12 \times 0{\cdot}6 = 0{\cdot}67$ dcm.^{2}).

The equation for the curve is—

$$W_B = kB_l^{2\cdot1} \text{ watts per sq. dcm.}$$

where k is a constant.

If these losses are calculated from Potier and Rüdenberg's theoretical formula, they will be found to be considerably lower than the above. The following is an example of the method for determining a point, P, on the curve of Fig. 5. After four hours' running with a flux density in the gap of 6,700, readings were taken for the five thermo couples, and the average value was 26·9. The connections were then changed, and the shoe warmed by the resistance coils, and readings were taken at intervals of 1½ hours of the potentiometer and of the watts supplied. A curve was then plotted with the mean values of the potentiometer readings for the five thermo-couples as abscissæ, and the corresponding watts consumed in the resistance coils as ordinates. Thus a curve is obtained for the heating of the pole shoe, which now serves as the calibration curve for the particular experiment in question. Taking, then, the mean value 26·9 of the potentiometer readings after the four-hour runs with eddy losses, the corresponding watts from this curve are 36·5. Reducing this to the loss per square decimetre of pole face, we get for point P, when the flux density is 6,700 :—

$$\text{Eddy current loss} = \frac{36{\cdot}5}{6 \times 11{\cdot}2} \times 100 = 54{\cdot}3 \text{ watts per dcm.}^2$$

This point P is then plotted on the curve showing the relation between the losses and the flux density (see Fig. 5).

The second series of experiments was devoted to finding the relation between the pulsation losses in the pole shoe and the speed of the armature.

The several points were obtained in the same way as the points in the previous series of experiments, except that in the present case the only variable was the speed.

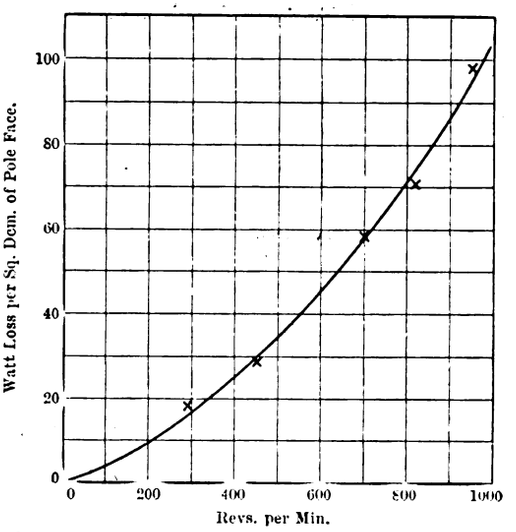


FIG. 6.—CURVE SHOWING RELATION BETWEEN LOSSES IN POLE SHOE AND SPEED OF ARMATURE.

Experiments B { Air-gap constant $\delta = 1{\cdot}9$ mm. Flux density constant $B_l = 5{,}800$. Armature current = 0.

The results of these experiments are shown by the curve of Fig. 6. The equation of this curve is—

$$W_n = k\left(\frac{Z\,n}{60}\right)^{1\cdot5} \text{ watts per dcm.}^2,$$

where Z = number of armature teeth = 53, n = speed in revs. per min., and k is a constant.

The object of the third series of experiments was to find the effect of the ratio of the length of the air-gap to the slot-opening on the eddy current losses in the pole shoes. To keep the flux constant whilst the gap was varied the following device was used. The exciting current in the field coils was kept constant throughout, and the gap was varied by inserting pieces of cardboard between the pole shoe and the pole core. By this means both the magneto-motive force and the reluctance of the

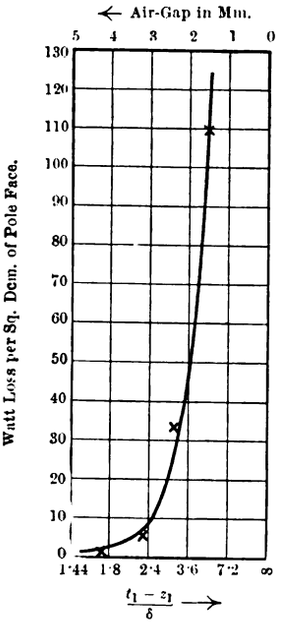


FIG. 7.—CURVE SHOWING RELATION BETWEEN LOSSES IN POLE SHOE AND RATIO SLOT-OPENING TO AIR-GAP.

Experiments C { Speed constant $n = 900$. Flux density constant $B_l = 6{,}000$. Armature current = 0.

magnetic circuit (neglecting any alteration in the leakage coefficient brought about by the above change) were kept constant, consequently the flux must remain constant. That this was actually the case was confirmed by the ballistic galvanometer.

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The gap was thus varied from about 6 mm. to a mean value of 1·5 mm., but it was found that the losses were imperceptible when the gap was greater than about 4 mm.

It is not of much interest, however, to know how the losses vary with the length of the air-gap without at the same time knowing the relation to the opening of the slot and the width of the tooth; for upon this relation the losses depend, as was stated before. The curve in Fig. 7 is plotted from the results of these experiments. The equation of this curve is—

$$W_\delta = k\left(\frac{t_1 - z_1}{\delta}\right)^{3\cdot5} \text{ watts per dcm.}^2;$$

where—

t_1 = tooth-pitch at armature circumference, z_1 = tooth-width at armature circumference, $t_1 - z_1$ = slot-opening at armature circumference, δ = mean length of air-gap (measured in same units at t_1 and z_1), and k = a constant.

An idea of the magnitude of the heating may be gained from the fact that, with the smallest gap (1·5 mm.), it became impossible to hold the hand on the experimental pole shoe after the machine had been running a few minutes.

All the previous experiments were carried out when the machine was running without current in the armature. It is also of importance, however, to know what effect the load has on the eddy losses set up in the pole shoes by the fluctuations in the field caused by the teeth.

The current was sent through the armature as follows: When running without flux in the experimental pole, the machine was driven by a motor, and current was simply passed through the armature from an external source. The armature being wave-wound, with the brushes at 90° (geometrical) apart, no E.M.F., of course, was induced between the brushes due to the rotation of the armature in the field, so that the armature winding acted simply as an ohmic resistance. When running with flux in the experimental pole shoe, the machine ran as a motor, and was loaded until the same current flowed in the armature, as in the previous case. The exciting current was maintained constant throughout.

The curve of Fig. 8, which is plotted from the results obtained from the fourth and last series of experiments, shows how the eddy losses in the pole shoe increase as the load increases, which is what we should have predicted on account of the distortion of the field.

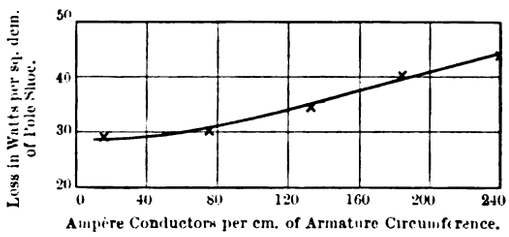


FIG 8.—CURVE SHOWING RELATION BETWEEN LOSSES IN POLE SHOE AND LOAD CURRENT.

Experiments D. { Air-gap constant $\delta = 1·9$ mm. Flux density constant $B_l = 4,700$. Speed constant $n = 600$.

The readings given by the thermo-couples in this series of experiments showed clearly the distortion of the field under the pole shoe by the fact that one of the pole tips (C) becomes much hotter than the other (E).

CONCLUSIONS.

Summarising the results given by the above experiments, the following equation is obtained for the losses in pole shoes due to eddy currents induced by the pulsations in the field set up by the armature teeth:—

$$W_p = k\left(\frac{t_1 - z_1}{\delta}\right)^{3\cdot5} B_l^{2\cdot1}\left(\frac{Z\,n}{60}\right)^{1\cdot5} 10^{-11} \text{ watts per sq. dcm. of pole face;}$$

where k is a constant depending on the iron, &c., and is equal to 0·046 in the present case.

Far more can be learnt from the curves directly, however, than from such an equation, which can be nothing further than a comparison. Moreover, it is much better to know how to avoid these losses than how to calculate them, and to this end the above curves form a comparatively safe guide. Undoubtedly, the most important of them all is the curve showing the relation between the losses and the ratio of the slot-opening to the length of the air-gap (Fig. 7). This curve—which was taken for a fairly high flux density in the gap (6,000) and a moderately high speed (900)—shows that, provided the ratio slot-opening to air-gap does not exceed 1·5, the losses in the shoe are practically zero. Even when this ratio is as high as 1·8, the eddy losses are only some 3 watts, and probably the designer's practical rule of keeping this ratio below 2 can be accepted as about right. At any rate, this may safely be taken as the limit at which it is necessary to discard solid pole shoes in favour of laminated. In other words, unless the gap is very small, or the flux density is very great, or the speed is very high, the use of laminated shoes is not necessary—for the small increase thereby gained in efficiency does not compensate for the increased cost of construction.

Finally, the authors take this opportunity of expressing their appreciation of the valuable advice and assistance which Dr. E. Arnold has at all times so readily given, and the facilities for research work placed at their disposal in the laboratories in the Electrotechnic Institute, Karlsruhe.

DISCUSSION AT NEWCASTLE.

Dr. W. M. THORNTON (Armstrong College, Newcastle) emphasised the remark in connection with Potier and Rudenberg's formula that the flux pulsations are probably not sinusoidal, by pointing out that the effects of hysteresis would make the wave-form far from a sine curve. It would be a "spiky" wave form. He asked whether the presence of the slots for resistance coils in the experimental pole shoe would not disturb the heat-flow, and whether the thickness of the shoe would not have some effect in this connection. The results in Fig. 5 were expressed in terms of watts loss per square decimetre of pole face; to convert into English units, watts per square foot, it was necessary to multiply by 9·3. A figure of half a kilowatt per square foot of pole surface was thus easily obtained—a most important loss in practice. Referring to Fig 8, the extended importance of this loss on a loaded machine was seen: presumably the pole-face loss was increased 50 per cent. at full load. It was curious to notice that heating occurred most strongly under the pole-tip, where the field is strongest. Previous to these experimental results it might have been argued that, as magnetic disturbance giving rise to eddy currents would occur with most freedom on the lower parts of the saturation curve, the heating would be most felt at the weakest portion of the field, but this view was upset by the experiments. He would think that the constant k in the author's last formula was almost entirely dependent on the conductivity of the pole-face iron. The statement concerning the relative cost of laminated and solid pole shoes might be challenged, as there was a widespread idea that laminated pole shoes were cheaper, not dearer, than solid. He would ask if any experiments were made on the influence of the shape of the pole shoe, and the number of teeth under the shoe. There was also the influence of the shape of the pole tips and the effect of ventilation of the spaces between the poles to be noticed.

Mr. C. TURNBULL (Tynemouth) wished for information about the humming of dynamos. Mr. Wall came from Stafford, and the Stafford firm had solved the question of humming exceedingly well. With reference to the question of the cheapness of laminated poles, it would be noticed in Fig. 7 that when the ratio of slot-opening to air-gap exceeded, say, 1·8, the watts lost in the pole shoe increased alarmingly. Now, some firms are keen on making the ratio considerably over 1·5, in order to keep their slots as open as possible, cutting down lost space due to winding-insulation, and also cost of cutting the teeth. They make up for this by laminating the pole faces, and this method is, to them, cheaper.

Mr. F. O. HUNT wished to know how the thermo-couples were actually arranged on the pole. He also wished to know whether any experiments were made to check the effect of the relative curvature of the pole-face and armature-face as the air-gaps were varied. He pointed out that the question of the relative cost of machines with laminated or solid pole shoes was complicated with considerations as to whether the pole pieces were to be laminated as well, in which case Dr. Thornton was, he believed, of the opinion that the eddies due to the influence of the armature teeth were not surface effects only, but that the tufting of lines proceeded to a considerable depth below the face, and that there was, therefore, an eddying or "boiling" effect under the surface. Dr. Thornton's own recent experiments would support this view.

Mr. NYBORG mentioned in connection with pole laminations that Messrs. Lahmeyer had laminated their poles to a depth equal to from 45 to 75 per cent. of the slot pitch.

Mr. CLAGUE raised the question as to whether it was correct to take the substitutional heat of resistances, *i.e.*, heat applied internally, as a fair measure of heat required from an external source by the metal of the pole face in the course of ordinary operation.

Mr. T. CARTER (communicated) thought that the authors were perfectly correct in saying that the most important set of experiments is that summed up in the curve given in Fig. 7. Their conclusion that the ratio of slot-opening to air-gap should be less than 2, if pole shoes are not to be laminated, seems almost to preclude the use of solid pole shoes altogether, at any rate in the smaller sizes of a range of machines. For to get the ratio less than 2, either the slot opening must be small or the air-gap

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large. The former means generally a large number of slots, involving great expense in notching, and a large amount of waste space in slot insulation; and the latter involves extra field copper. Mr. Carter, from his own experience, thought that the tendency is to arrive at values of the ratio increasingly in excess of 2, and so to make absolutely necessary the use of laminated pole shoes, or completely laminated poles. Mr. Carter stated that figures could be produced showing that laminated poles were actually cheaper than solid poles and pole shoes, as regards material and labour (given correct methods of manufacture). It must also be remembered that solid cast poles are very uneven in their surface, and very much more clearance between them and the field coils is required than in cases where laminated poles with accurately flat surfaces are used, so that the latter tend also to some saving in copper, other things being equal.

Mr. WALL, in reply, said that if Dr. Thornton's idea that the depth of the pulsations extended far below the iron surface was correct; then, of course, the method described fell to the ground, as no attempt at measurement could be made. The cost of laminated pole shoes appears to merge into a question of the whole of the design. As to humming, no definite experiments were made on this point by the authors, but he remembered that when the air-gap was exceedingly small the humming was excessive. This points to the fact that humming depends on the ratio of slot to air-gap. The actual arrangement of the thermo couples was as follows:—Holes were drilled at the exact centre, and the two lateral edges of the under face of the pole shoe and copper wire sweated in, a similar arrangement being followed for the upper face. The iron wire forming the common member of the six couples was fixed to one outer corner of the shoe.

A NEW CONDUIT JOINT

ONE of the chief difficulties in the design of a satisfactory conduit system has always been the provision for ensuring electrical continuity throughout the installation, and a great deal of ingenuity has been expended from time to time in devising methods which combine adequate protection in this respect with lower installation cost than can be obtained by the use of screwed conduit tubes. An inherent weakness in some of these inventions has often been that too much reliance has been placed for electrical continuity upon a close mechanical contact between two even surfaces, which was liable to be upset by



inequalities in diameter of the different fittings and such irregularities.

A new system has been brought forward by the Armorduct Manufacturing Co., under the patents of Mr. H. C. Pearson, with the object of providing reliable electrical continuity with a cost of installation not much exceeding that with ordinary socket-joint material. The accompanying illustrations show some applications of the system, which is designated as the "Witton Grip." A conduit fitting of the ordinary non-screwed type, and of the size ordinarily used, is slotted to part of its diameter, and a claw grip metal band, which is fitted with sharp projections or teeth, so as to engage the tube firmly when the binding screw is tightened home. In the closing and scraping movement which naturally results, the enamel, which would otherwise prevent electrical continuity, is automatically removed. A mechanical contact of great strength is secured, and electrical continuity is ensured.

Arrangements are being made by the company to adapt all standard conduit fittings to this principle, and at present all the ordinary fittings are available for the same.

Some tests of sample fittings have been made by the Electrical Standardising, Testing, and Training Institution, of Faraday House. In one case, five short lengths of enamelled steel tubing were connected together by two "T" pieces and two elbows, these being fitted with "Witton Grips," the total length of connected tube being 6 ft. 9 in., and its external diameter $\frac{5}{8}$ in. The resistance of this tubing, including the eight joints, was found to be as low as 0·0409 ohm, with a current of 12 amperes passing. To test the mechanical strength a 12 in. length of the same size tube was fitted with an inspection box at each end. One box was fastened and a tensile stress of 130 lb. was applied to the tube. The grip showed no signs of giving way. A further test was made on this sample to try the effect of torsion upon the joint. One box was gripped in a vice and the other twisted. It was possible to turn the latter through an angle of 270° before any slip took place in the grip.

ELECTROCHEMISTRY AND ELECTRO-METALLURGY

LAST March (Vol. I., p. 563) we published an article upon "Extensions of the British Aluminium Co." In it we referred to the large power scheme in course of construction in Inverness-shire and Argyllshire. A portion of this scheme was set in operation on Christmas Day (this Vol. p. 25), and we have now information that the Norwegian scheme at Stangfjord has also started operations. Including the old works at Loch Foyers the company have now three plants in operation for the manufacture of aluminium. They are therefore in a position to very largely increase their output. At the present price of aluminium, and even taking into account the low price of copper, for electrical purposes for equal carrying power aluminium is claimed to show a considerable saving as against copper. In electrical installations we may therefore look forward to a considerably increased employment of aluminium, and there is little doubt that the metal will be more and more largely used for manufacturing articles in which lightness of construction is of importance.

In the *English Patent* 13,696 (June 13th, 1907), a method for soldering aluminium and alloys containing aluminium is described. The surfaces of the aluminium or its alloys are first thoroughly cleaned, after which they are coated with ammonium stearate. In order to prepare this flux, stearic acid is melted, and then 30 to 40 parts of aqueous ammonia are slowly stirred into it. The surfaces to be joined, having first been covered with the stearate, are coated separately with a solder, which consists of 10 per cent. copper and 90 per cent. tin. After this the two surfaces can be soldered together either with this solder or with an ordinary solder. It appears not to be necessary for the proportions of the tin and copper in the solder to be exactly as described above.

The American production of aluminium in 1906 was 6,406 tons, valued at £1,076,250, and in 1907 it was 8,964 tons, valued at £2,393,750. Artificial graphite, which is another product of the electric furnace, was manufactured to the quantity of 2,173 tons, the value being £65,159; the production for 1907 showed a large increase, being 3,092 tons, and the value was £100,774. The total amount of copper produced in the United States in the year 1906 was 409,652 tons, valued at £37,625,070. In 1907 the production was slightly less, being 399,600 tons, but owing to the high price of copper the total value was rather greater, being £38,578,632. About 87 per cent. of the copper produced in the United States is electrolytically refined.

According to the *United States Patent* 869,114 (October 22nd, 1907), boron carbide can be produced by mixing a compound of boron, such as boron oxide, with carbon in excess, and heating it to the temperature of reaction in an electric resistance furnace. The escaping gases produce a pressure within the furnace, and this appears to help the formation of the carbide, which has a composition of B_6C. It has a metal-like fracture, and the specific gravity is about 2·7. If the temperature is not kept constant, various forms of the carbide can be produced. By slowly cooling the product contraction takes place, and caverns open up within the mass; in these large crystals may be obtained.

The ordinary etching of plates for printing is done by the action of ferric chloride and gelatine impregnated with chromic acid. There are, however, difficulties in employing the method, for example, with bronze, copper or zinc, bubbles of gas are given off, and these raise the chrome-gelatine so that sharp etchings are not obtained. It is now found that (*English*

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Patent 28.319. November 12th, 1907) the chrome-gelatine acts as a diaphragm. Consequently, by making the metal to be etched the anode in a bath of any acid electrolyte, the metal becomes etched, the diaphragm showing a different permeability to the electrolyte according to whether it has a long exposure to light or not. The current employed should not be of too low a density, and should vary from 0·35 amp. per square centimetre to 2 amperes. It is also stated that the E.M.F. of the bath should not be too low, which it would hardly be with a current density of the magnitude of 2 amperes per square centimetre.

ELECTRICAL SCIENCE

British and American

Demagnetisation of Iron.—An elaborate investigation of the principal points of interest arising in connection with the method of "demagnetisation by reversals" for the purposes of magnetic testing, is described very fully in the January *Bulletin* of the Washington Bureau of Standards. The author, C. W. Burrows, used in nearly all his experiments two parallel specimens about 50 cm. long, with their adjacent ends joined by wrought-iron yokes. The magnetising coils were two long coils of 400 turns. The secondary coil was uniformly wound over the middle part of one specimen. Transformer iron, common iron, low-carbon steel, and high-carbon steel were all experimented with. The author's first endeavour is to find a satisfactory criterion of perfect demagnetisation. With this in view, the following experiment was carried out:—A specimen was demagnetised as thoroughly as possible, and then submitted for a moment to a known magnetising force, which gave it a known residual induction. Then the "apparent" induction of the substance in this state was measured; that is, the throw of a ballistic galvanometer was observed on reversing suddenly a definite small field applied merely for the purpose of the test. These operations were repeated with increasing magnetising forces, and the author demonstrates that the existence of residual magnetism in a specimen diminishes the apparent induction; and thus establishes the proposition that the criterion of perfect demagnetisation is that the induction shall be a maximum. The author now proceeds to the study of what he calls the "polarisation effect." This is the difference between the induction throw given by a completely demagnetised specimen and that given by a specimen possessing residual magnetism, the testing field reversal being the same in both tests. The polarisation effect is thus in some degree a measure of the incompleteness of any previous demagnetisating process imposed upon the specimen. In the first set of experiments the neutral iron was submitted to a field of 100 gausses, and this field was applied and removed several times without reversal. After this the apparent induction was measured, various measuring fields being used on various occasions. The conclusions are that the polarisation effect is always positive, that it increases to a maximum and diminishes to zero as the magnetising force used for measurement increases, and that the point at which the polarisation effect vanishes is rather higher than the point of maximum permeability. This critical point is shown to be an important point of the magnetic diagram by another series of experiments, in which the original strong magnetising field is given in turn different values. The author next turns his attention to the wide-spread assumption that a necessary condition for perfect demagnetisation by the method of reversals is that the demagnetising current must carry the iron from an induction greater than any previous one it has experienced down to a vanishingly small one. His experimental process consists in demagnetising a strongly, definitely magnetised specimen by a series of reversals, whose initial amplitude is taken lower and lower in different experiments, the final amplitude being always extremely small. The apparent induction was measured after each demagnetising series at that field value which was known by previous experiments to give the maximum polarisation effects. The author found, for all the materials he used, that there is a critical force for the amplitude of the initial demagnetising reversal. There is no advantage, in respect of perfection of demagnetisation, in carrying the reversal fields higher than this critical demagnetising force, whatever value the original high magnetising force may have had. The author finds a very similar theorem for demagnetising reversals that start at the same initial amplitude, but are stopped short of vanishing amplitude at different values of field. The Paper then proceeds into an investigation of the effect of varying the frequency of the magnetising reversals, and many diagrams are given summarising the observations. The author's principal conclusion is that the effects recorded are in great measure due to the magnetic shielding effects of the eddy currents induced in the outer layers of the specimen.

Continental

Damping and Resistance in Condenser Sparks.—The laws governing the relation between p.d. and effective current in sparks are discussed by A. Heydweiller, in the *Annalen der Physik*, No. 1. The generally accepted approximate law is $v=a+b/i$, where v is the d.p., i the current, and a and b constants. In oscillating discharges through a low resistance, a is the decisive term, and its measurement is of considerable importance. When the resistance is high, a becomes negligible. The author protests against the misuse of the terms "resistance" and "apparent resistance" in connection with sparks. The former can only mean the resistance of an equivalent solid conductor, and this may be defined either: (*a*) from the damping, or (*b*) from the joule effect, or (*c*) from the relation between v and i. The "apparent resistance," again, has a well-known meaning in alternate-current engineering, and cannot be applied to sparks without ambiguity. The various definitions do not give consistent results. Thus, in air, the damping due to a spark is independent of capacity, and inductance, but not so in a solid conductor. As regards practical questions, the author recommends large, slightly curved electrodes, with a gap of 1 or 2 cm. This gives little damping when the "spraying" is suppressed. . .

Motion of Electrons.—In No. 1 of the *Annalen der Physik* G. A. Schott discusses the mass of electrons and the manner in which it varies when the acceleration varies in a very sudden manner. At low speeds, the mass is practically constant, but a greater mass is associated with an electron when its speed is very high, and this increase of mass may exert a disturbing and complicated effect upon the equations of motion. The theory of Abraham and Sommerfield does not give a clear definition of this mass. If quite sudden changes of speed are excluded, Lorentz's theory gives an exact expression for the mass, not only when the electrons are regarded as rigid, but also when they are flattened out in a direction at right angles to their motion. The usual expression for the radiation pressure applies when speeds beyond the velocity of light are excluded. Otherwise every sudden change of acceleration, or of the curvature of the path, produces subsequently a change in the radiation pressure. The latter is only calculable when the previous history of the electron is known, since it depends upon waves previously emitted. Discontinuities of an order higher than the first produce no effect on either the mass or the radiation pressure. But all this supposes that the electron has left the place of discontinuity by at least a few diameters.

The Interpretation of Spectrum Lines. W. Ritz develops his theory of spectrum lines further in *Bulletin* No. 271 of the French Physical Society. He acknowledges that acceleration cannot be the factor which governs spectrum lines, since, as Rayleigh has shown, it affects the square of the frequency, whereas the observed laws of spectrum lines only imply the frequency itself in the first power. The latter condition may be fulfilled either by supposing that only the speed and the displacement ("elongation") intervene, which is very improbable, or that the determining factors are the acceleration and the speed, but not the displacement. This would make the force proportional to the speed, a relation with which we are familiar in the electron theory of magnetism. Assuming the theory of the internal molecular field produced by magnetic filaments of different lengths, Balmer's law, and the structure of the series is immediately explained. A simple field gives the hydrogen lines. A new parallel field gives a new set of frequencies differing from the old frequencies by a constant amount. This relation is very exact, and may be carried to the fifth or sixth decimal. An external magnetic field produces the Zeeman effect, and triplets, quadruplets, and even Lohmann's sets of 15 components may be deduced from considerations of motion of the molecules.

Magnetic Hysteresis in Rotating Fields.—According to Baily, there is no hysteresis in a rotating magnetic field when that field is very strong. This important result has been confirmed in a more elaborate manner by P. Weiss and V. Planer, who describe their experiments in *Bulletin* No. 271 of the French Physical Society. They used the method adopted by Blondel and Carpentier, but substituted for the permanent magnet an electromagnet, and operated upon a thin iron or nickel disc suspended parallel or at right angles to the axis of rotation of the field. Thus they were enabled to measure both the rotational and the alternating hysteresis. The hysteresis, as usual, was found to be proportional to the couple exerted, and independent of the speed. The field was as intense as 10,000 gauss. In iron and nickel, the rotational hysteresis passes through a maximum and then decreases to zero as the field is increased. At the maximum, the rotational hysteresis is just half the maximum alternating hysteresis. In feeble fields, on the other hand, the rotational surpasses the alternating hysteresis. It is not simply twice the latter, as alleged, but varies from four times down to zero. A field of 7,300 gauss suffices to annul the rotational hysteresis in pyrohotine. This field is also the "chief demagnetising field."

Bournemouth Tramway Purchase.—With reference to the proceedings in the High Courts between the Bournemouth Corporation and the Poole and District Electric Traction Co. (ELECTRICAL ENGINEERING, Vol. II., p. 623), the Corporation has decided to appeal to the House of Lords against the decision of the Court of Appeal (given in ELECTRICAL ENGINEERING, January 30th, p. 170).

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published Feb. 6th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from abroad.

1906 Patents

25,411. A. F. BERRY. Electrically-heated apparatus for cooking. This specification is printed in full on page 235.

28,628. F. CLARK & J. VLASTO. A controller or starting switch for electric motors, in which the starting resistances are arranged on the axis of the controller, in order to provide the field for the magnetic blow-out and to obviate the use of connections to external resistances. Special arrangements for cooling are provided. Five claims, six figures.

1907 Patents

6,266. THE BRITISH ELECTRIC PLANT CO. & OELSCHLÄGER. Relates to an arrangement of commutating poles on dynamo-electric machines, in which the magnetic circuit of the commutating poles consists of a ring concentric with, and close to the armature, and on which the compensating winding is wound, so as to produce consequent poles at each neutral zone, where short pole-shoes are attached. Magnetic leakage is decreased, and ventilation improved by this device. Three claims, six figures.

7,279. ANGOLD & MAXIM ELECTRICAL COMPANY. An improvement on the type of arc lamp, described in Spec. No. 23,012, 1906. (This specification was printed in full in ELECTRICAL ENGINEERING, Vol. II., page 634.) To obtain a better contact the carbons are gripped by spring-pressed contacts in the feeding tubes, and are thrust down mechanically instead of being allowed to fall by gravity.

9,337. B. NORTH & R. POHL. Improvements in electrolytic meters, in which the quantity of current passing is measured by the change in volume of the electrolyte decomposed by the current. Two or three liquids are used in a two-arm tube; an electrolyte, a measuring liquid, and, if necessary, a separating liquid between the two. The liquids in contact, which must not affect each other chemically, are kept from mixing only by their difference in specific gravity. The measuring tube is inclined for the purpose of increasing the length of scale for a given vertical height. Other minor improvements are included. Seven claims, four figures.

1,003. THE LANCASHIRE DYNAMO & MOTOR CO., LTD., F. G. WARBURTON & A. H. KELSALL. Relates to the field control of flywheel buffer machines for equalising the load on a generator. The armature of the auxiliary machine is connected directly across the mains, but its field winding is in series with the main circuit, and is provided with a diverted shunt, the value of which is automatically altered by variation of main load or speed of auxiliary machine. On a sustained overload this prevents the auxiliary machine from taking an increased current from the generator, and also gives a higher accelerating rate on diminished load. Four claims, three figures.

16,251. A. P. HINSKY. A tubular conduit for electric wires, composed of fibrous material, impregnated with an insulating and preservative substance, and with the outside corrugated circumferentially to render flexible. Two claims, four figures.

20,948. SIEMENS BROS. DYNAMO WORKS, LTD. (*Siemens Schuckertwerke Ges.*). The use, in transmission systems, of a special earthed conductor, which is connected to the middle or neutral point of the generators or transformers, and is carried in proximity to the line wires. The bare wire is electrically connected to the iron poles or iron insulator pins, or is buried under the poles. It is claimed that the advantages of earthing are obtained without the usual disturbances in adjacent telephone lines, due to leakage currents taking place, as all leakage currents are taken up by the said wire. Two claims, two figures.

24,028. WOLFRAM LAMPEN AKT. GES. Tungsten filaments are decarbonised by heating them in a mixture of dry hydrogen and dry air or oxygen, *i.e.*, a dry process instead of a wet one as formerly. The amount of oxidation of the tungsten itself is lessened. One claim.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Names in brackets indicate communicators of inventions from abroad.

Summaries of the more important of these patents will appear in our next issue.

1906 Patents

22,920, HATFIELD. Electrolytic cells.
23,016, MACKIE. Dynamo-electric machines for train lighting.
24,084, SMITH. Magnetic compasses.
28,724, OLIVER. Mechanical cars for electrical traction purposes.

1907 Patents

1,197, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Treatment of boron.
1,264, MIURA. Electrical accumulators.
1,356, GANZ & CO. EISENGIESSEREI UND MASCHINENFABRIKS AKT.-GES. Devices for regulating pressure of alternating-current generators.
1,457, MILCH. Control of induction motors.
1,517, MORCOM & WALSHE. Choking coils for testing.
1,608, RADCLIFFE & RADCLIFFE. Mechanical stokers.
1,699, PRATT. Treatment of copper for refining the same.
1,713, ECKSTEIN & HEAP. Fuses.
1,759, RAYMOND-BARKER & AMALGAMATED RADIO-TELEGRAPH CO. Radio-telegraphy.
1,765, PARSONS & CARNT. Methods of securing strips in grooves.
1,781, RAVENSHAW, MIDDLETON & TOWNSEND. Magnetic clutches.
1,866, DRUMMOND. Steam generators.
2,138, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Brush holders for dynamo-electric machines.
2,294, BROWN. Rotary steam generators.
2,417A, CHAMBERS & BENNETT. Electric ignition switches.
2,459, WALKER. Dynamo-electric machines.
2,815, BEST. Safety terminals for electric accumulators.
2,937, CHAMBERS & BENNETT. Apparatus for making and breaking the current in explosion engines.
3,254, VENNER & GRIESBACH. Time switches for electric circuits.
3,483, ELECTRIC IGNITION CO. & HALL. Ignition coils of automobiles.
3,915, REYNOLDS. Electrical-heating apparatus.
4,158, MONARD. Apparatus for operating points and signals.
4,182, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Protective devices for electric circuits.
4,574, OPPERMANN. Secondary batteries.
4,738, ALLGEMEINE ELEKTRICITÄTS-GES. Electric rock drills.
5,066, HANN, INGLE, & DRAKE & GORHAM, LTD. Electric couplings or connections.
5,219, ROYAL-DAWSON. Commutators in internal-combustion engines.
5,334, EISENSTEIN. Production of undamped electrical oscillations.
5,575, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Manufacture of incandescing bodies in electric lamps.
6,057, BILL. Overhead conductors for electric tramways.
6,242, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Systems of electrical distribution employing vapour rectifying devices.
6,716, SIEMENS BROS. DYNAMO WORKS, & WILSON. Dynamo-electric machines.
6,929, SIEMENS & HALSKE AKT.-GES. Electric telegraphy.
7,726, BLACK & THOMPSON. Incandescent vapour lamps.
7,785, KITSEE. Duplexing telegraph lines.
8,205, FOSTER. Relay mechanism for indicating instruments.
8,240, DAMSEAUX. Sockets for incandescent electric lamps.
8,788, RILEY, SEYMOUR, & PERKINS. Automatic signalling.
9,851, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Maximum demand indicators.
10,007, SIEMENS BROS. DYNAMO WORKS & POYNDER. Method of altering the working speed of polyphase motors.
11,072, MARGULIS. Plates for electrical accumulators.
11,673, VON AMMON. Commutators for electrical machines.
13,175, WATKINS, BOLSTER, & GOODSELL. Electric selecting apparatus for telephones.
14,221, MALSON. Electric fuses for use in blasting.
17,947, FALLEK. Automatic electrical gong-ringing device for electrical street railway cars.
19,626, SIEMENS BROS. & CO. (*Siemens & Halske Akt-Ges.*). Electrical locking apparatus for railway signalling.
20,947, SIEMENS BROS. DYNAMO WORKS (*Siemens Schuckertwerke Ges.*). Method of inserting former wound coils of flat copper into slotted iron cores.
23,641, HANWELL. Electric-light pendants.
25,298, DE BRAAM. Arrangements for operating automatic warning and indicating apparatus for stopping trains.
25,402, WHITNEY. Telegraph sounders.

Complete Specifications open to Public Inspection before Acceptance, under the Patents Act, 1901.

1907 Patent

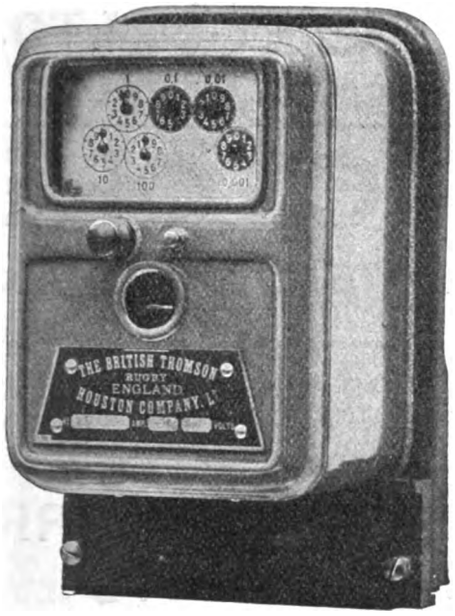
5,508A, LAMME. Connection system for dynamo-electric machines.

1908 Patents

1,344, SALZER. Electrolytic deposition of chromium.
1,364, SOC. ANON. D'EXPLOITATION DES APPAREILS RATEAU. System of automatic pressure control for power installations comprising steam turbines in combination with reciprocating steam engines.
1,547, LANGE. Radio-telegraphy.

For LOCAL NOTES, &c., see pp. 247 to 254

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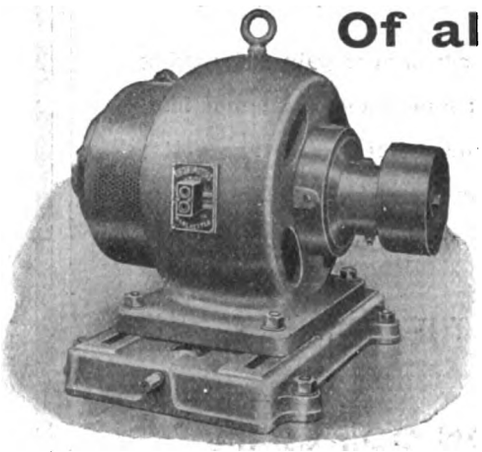
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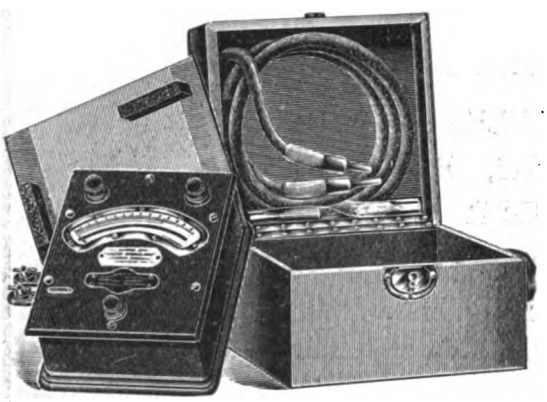
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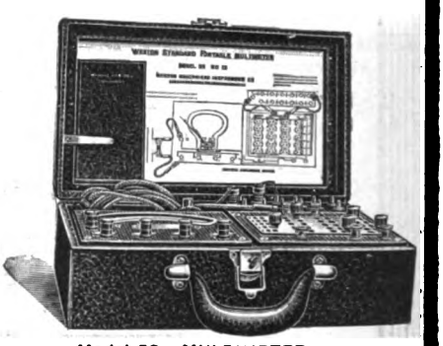
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LOCAL NOTES

ARGENTINA: *La Plata Tramways.*—The *Review of the River Plate* states that an application has been made to the La Plata municipality for a concession for fifty years for working electric tramways in that city. This new application will, it is stated, cause further delay with regard to the petition for electrification presented by the existing companies.

Telephone Extension.—The La Plata Government has given permission to the Sociedad Co-operativa Telefonica to extend its lines from Quilmes to La Plata, on the understanding that the wires will be placed underground in La Plata within a period of six years.

ASHTON: *Electricity Supply.*—Arrangements having been made with the St. Helens Corporation for the supply of electricity in this district, the current was switched on last week. At present the electrical energy is used for street lighting in a portion only of the district.

AUSTRALIA: *Large Water Power Scheme.*—The *Australian Mining Standard* states that since 1881 a scheme has been in progress for the construction of a dam below the Trawool Railway Station on the Tallarook and Mansfield line across the Goulbourn River, for the purpose of generating electricity in connection with an extensive irrigation scheme. Early in December Mr. W. H. Merz, during his visit to Australia in connection with the electrification of the Melbourne Suburban Railway, made an inspection of the river. The dam will be 1,700 ft. long and 180 ft. high, and will be sufficient to provide a depth of water of 120 feet. An inland lake will thus be formed, with an average depth of 60 ft. covering an area of 25,000 acres. The cost of the scheme is estimated at £230,000, and it is proposed that the Government shall carry out the work.

Prahran-Malvern Electric Tramway Bill.—This Bill, which has been passed by both the Victorian Legislatures, proposes the incorporation of a trust for the construction of tramways in Prahran and Malvern. The cost of the scheme will be about £76,260, but powers to borrow up to £100,000 are provided for in the Bill. The Trust is to consist of five members, a chairman (not a member of either Council) at a salary of £250 per annum, and two Councillors from each municipality, with a remuneration not exceeding £75 to be divided amongst them.

Commonwealth Telephone Service.—A proposal is now being considered by the Government to put the telephone service of the Commonwealth under one permanent head, with a view to securing greater efficiency.

BELFAST: *Whitewell & Cavehill Tramway Bill.*—The result of the poll of the ratepayers of Belfast as to whether the Bill of the Corporation for purchasing the Whitewell & Cavehill tramway undertaking as agreed for £60,000, shall be proceeded with, was a majority in favour of proceeding of 12,158. The actual figures were: for the Bill, 24,733; against the Bill, 12,575.

BOURNEMOUTH: *Trunk Telephone Service.*—At a meeting of the General Purposes Committee last week, a letter was read from the secretary to the General Post Office regarding the trunk telephone service between Bournemouth and London. It was stated that the Postmaster-General had given special attention to the unsatisfactory working of the circuits between London and Bournemouth, which, it was ascertained, was due to branches of trees having blown down on to the lines. The letter also stated that the question of providing additional trunk circuits was also receiving attention.

BRIGHTON: *Safety of Southwick Works.*—At the last meeting of the Brighton Council, the following resolution was on the agenda:—"That it be an instruction to the Lighting Committee to prepare at once and present to a special meeting of the Council a Report as to what steps have and are being taken to meet the wishes of the Shoreham Harbour Trustees in connection with the Electricity Works at Southwick, and the general safety of the building and works." When this was reached, however, it was stated that negotiations were going on, and that any resolution in the Council at the moment might have an effect upon the negotiations. The motion was therefore withdrawn.

BRISTOL: *Tramways Company's Bill.*—The Parliamentary Committee, reporting upon the Bristol Tramways Company's Bill which has been deposited in Parliament this session, points out that only one of the six tramways authorised by the Company's Act of 1904 has as yet been constructed, and that the powers under this Act will expire, as to part of the tramways on August 15th, 1908, and as to the remainder on August 15th, 1909. The present Bill seeks an extension of these powers to August, 1911, and August, 1912, respectively. The committee are of opinion that, as the companies have failed to exercise the powers conferred by their Act of 1904, the further powers now asked for, especially in relation to those areas within the city, should not be granted except on terms and conditions adequate for the protection of the Corporation. The committee, therefore, recommend opposition being made to the Bill. Among the points upon which revision of the existing terms is required is the question of purchase.

BURNLEY: *The New Tramcars.*—The recommendation of the Burnley Tramways Committee to purchase five cars similar to the recent new cars, at an estimated cost of £800 each, was strongly objected to at the Town Council meeting on Thursday. This type of car, it was stated, was known throughout the town as the "screaming car." An amendment to refer the matter back for consideration was carried by 16 votes to 15.

CANNOCK: *Provisional Order Transfer.*—The deed of transfer with respect to the Council's Electric Lighting Provisional Order has been completed and signed, and the purchase money, amounting to £450, has been paid by the syndicate acting for the Shropshire, Worcester, and Staffordshire Electric Power Company.

COLCHESTER: *Exhibition Balance Sheet.*—In a special report concerning the recent electrical exhibition, the electrical engineer said that the expenditure amounted to £200, and the receipts to £171, leaving a deficit of £29.

Vibration from Electricity Works.—Complaints having been received from the tenants of premises near the electricity works of annoyance from vibration, the Corporation has instructed the Electricity Committee to reply, that they do not admit any liability in respect of this.

CROYDON: *Tramway Supply.*—It has been found that the meters for registering the current supplied to the tramways have been working inaccurately. The current shown by the meters as being used was 1·006 units per car mile, whereas it should have been 1·29 units per car mile. The difference will amount, it is estimated, to something like £4,000 per year. At the last meeting of the Council a long discussion took place upon this matter, in the course of which it was pointed out that the great seriousness of the question lay in the fact that they had taken over the trams from the British Electric Traction Co. on the basis of the 1·006 units per car mile. One or two members raised the question as to whether the British Electric Traction Co. could not be made to pay for the extra current which they had used, and which had not been registered by the meters. In the result, no definite action was taken, but it is understood that the Electricity Committee will be approached, and asked to modify the prices at which they are now supplying the current.

DERBY: *Tramway Contractors' Penalties.*—The Tramway Committee reports that under the contract for the construction of the Ashbourne Road and Uttoxeter Road tramways, the Borough surveyor extended the time for the completion to October 24th, 1907, but, as the work was not completed until November 28th, the penalties due from the contractors amounted to £1,465. This sum has been deducted from an instalment due to Messrs. R. W. Blackwell & Co., the contractors in question.

DUNDALK: *Electric Lighting.*—A ratepayers' meeting has been held to consider a resolution urging the Council to proceed with an electric lighting scheme under its Provisional Order. The matter has been discussed for several years past now, and the resolution in question was unanimously carried.

DUNFERMLINE: *Electric Lighting Provisional Order.*—The following are the terms upon which the Fife Electric Power Company will take over the Council's Provisional Order:—(1) The Power Company to pay the Council for their Electric Lighting Provisional Order the amount of expenses incurred by them in connection with the same so far as approved by the Board of Trade. (2) The Power Company would make application for a Provisional Order authorising the transfer of the existing Provisional Order to the Fife Company; the whole costs in connection with the transfer Order to be borne by the Fife Company. (3) The Company would agree to insert a maximum price of 6d. per unit in the transfer Order, and agree on a schedule of rates to be charged consumers for lighting. (4) Detailed terms to be adjusted between Sir Alexander Kennedy, acting for the Corporation, and the Fife Company; failing agreement, subject to arbitration of the Board of Trade. Sir A. Kennedy regards this offer as a reasonable one, and recommends its acceptance subject to the approval of the Board of Trade.

EASTBOURNE: *Osram Lamps.*—The following paragraph appeared in the report of the Electrical Engineer to the Electric Lighting Committee last week:—"The result of the use of 'Osram' lamps has been to reduce the consumption of some consumers using them in place of the ordinary carbon filament lamps in a very marked degree during the past quarter. Taking the average of 17 consumers, the total number of units consumed during the past quarter was 5,297 as against 7,775 for the corresponding quarter last year, a reduction of 32 per cent.; and at the same time the light obtained has been increased by 100 per cent. or more. No doubt the use of such lamps will increase very largely, and as soon as a 200-volt lamp is placed on the market the use of such lamps will increase still more. The result will be that for a time the income will be reduced, but this will be off-set by an increased number of connections following upon the reduced cost of electric lighting."

EAST HAM: *Arc Lamp Hiring Scheme.*—The Electrical Engineer has drawn up a scheme for the hiring of arc lamps under which the Council will provide the lamps, execute the necessary wiring, supply current, and maintain the installation subject to the consumer entering into an agreement to take the current for

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two years and paying the sum of £2 2s. per quarter per lamp in advance. The committee have adopted the scheme, and have decided to give it a trial. £500 is to be provided for the purpose.

EDINBURGH: *Electricity Works Assessment.*—The dispute between the Corporation and the Edinburgh Parish Council regarding the poor and school rates on the electric lighting undertaking has been settled upon the basis that the undertaking shall be assessed in respect of these rates in the future upon a deduction of 35 per cent. of the total valuation from the annual value of the undertaking. The dispute arose upon the point as to whether the Corporation should be allowed to deduct future depreciation of the plant before making the valuation, whereas the Parish Council contended that the Corporation could only deduct the average amount for depreciation in the past. The parties went to law over the matter, when it was decided that the Corporation's contention was correct. It is in consequence of this decision that the above settlement has been arrived at.

FARNHAM: *Electricity Supply.*—A communication has been received from the Board of Trade to the effect that the revocation of the Farnham Electric Lighting Order, 1905, has been postponed for three months from January 30th. Negotiations are going on between the Council and the Farnham Electric Light Company with regard to putting the order in force, but an obstacle seems to be the proposition of the company to employ overhead wires.

GLASGOW: *Tramway Extension.*—A deputation from the Coatbridge Town Council has waited upon the Glasgow Tramways Committee urging an extension of the Glasgow tramway lines to the centre of Coatbridge. Parliamentary powers will be necessary before the proposed extensions can be made.

GREENOCK: *Opening of Combined Dust Destructor and Electricity Works.*—Last Friday, a combined dust destructor and electricity works was formally opened by Provost Denholm. The destructor is a six-cell one of the Horsfall make, and the hot gases from it are carried through the combustion chamber of a B. & W. water-tube boiler, which is supplemented by coal-fired boilers. The steam pressure is 200 lb. per sq. in. D.C. current is generated by two 250 kw. Belliss-Westinghouse sets, one of which is a three-wire 2×250-volt machine, and the other generates at 500 volts. Two rotary converters are used to supply A.C. current to an outlying district. The station is also connected by trunk cables to the main electricity works, the output of which during last year was about three million units. Mr. J. A. Robertson is consulting and resident engineer to the Greenock Corporation, and the work has been carried out to his specification. We hope to publish a fuller description of the works in our next issue.

HULL: *Resignation of the Chairman of the Electricity Committee.*—At the monthly meeting of the Hull City Council on Thursday, a discussion took place upon the minutes of the Electric Light Committee, which recommended the purchase of three Lahmeyer dynamos. An amendment was moved recommending that the electrical engineer be authorised to prepare a specification for the dynamos required, and that tenders should be invited only from British firms. This amendment was carried by two votes, and, in consequence, Mr. Hanger, the Chairman of the Electric Light Committee, expressed his intention of resigning. Subsequently, Mr. Hanger agreed to remain in office until the question of installing the new machines has been settled.

KIRKCALDY: *Tramway Intercommunication Results.*—Since the scheme for mutual running powers between the Kirkcaldy tramway system and the Wemyss Tramway Co. was put into force on November 17th, 1907, 30,000 additional passengers have been carried upon the Kirkcaldy tramway service up to January 22nd than had been carried during the corresponding period of last year. The receipts have increased by £145, and the saving in expenses owing to the lower car-mileage was £180, making a total increase of £325.

LEEDS: *Municipal Reserve Funds.*—At a meeting of the Corporation on Thursday, a resolution was moved that a Committee be appointed to consider what amount of reserve should be provided in addition to the sinking fund in connection with the tramways, electricity, and other undertakings of the Corporation, the committee to have power to obtain expert opinion and visit such places as they might deem advisable, and to report to the Council. An amendment was moved that the power to call in expert opinion and to visit other places be deleted. Other amendments having been proposed, the original resolution was carried by 27 to 19 votes.

LITTLE HULTON: *Provisional Order Transfer.*—The District Council have decided that the Lancashire Electric Power Co. be permitted to supply electricity to Messrs. E. Bennis & Co.'s works, subject to the completion of the Council's proposed transfer to the company of their Provisional Order.

LONDON: *London County Council.*—At its meeting on Tuesday, the Council decided to proceed with the electrification of the Brixton Road to Camberwell Green tramways, on the overhead system, at a cost of £34,910, of which full particulars were given in our last issue. The Highways Committee stated that they hoped to undertake the electrification of the tramways from Nine Elms Lane to East Hill, Wandsworth, during the financial year 1908-9. The cost of road work is estimated at £158,050, and the committee desired that expenditure amounting to £7,000 be now authorised, in order to facilitate diversions of mains, &c. Under standing orders the report was adjourned for one week.

Hackney: The Draft Home Office Regulations.—The Electric Lighting Committee have received a letter from the Fulham Borough Council asking what action is proposed to be taken with reference to opposing the Home Office regulations for the use of electrical energy in factories and workshops, and being represented at the proposed inquiry to be held at the Caxton Hall, Westminster. The committee report that objections to these rules and regulations have already been lodged with the Home Secretary on behalf of the Council, and that the Town Clerk and Borough Electrical Engineer will represent the interests of the Council at the inquiry.

Islington: London Electric Power Bills.—The Parliamentary and General Purposes Committee recommend petitions being lodged against the London and District Electricity Supply Bill, the London Electric Supply Bill, and the Great Eastern Railway (General Powers) Bill. They hold that the latter should be opposed with a view to preventing the supply of electrical energy by the company at any future time along the line of the Tottenham and Hampstead Junction Railway, of which the Great Eastern Company are joint owners. The Borough Council has endorsed the committee's views on these Bills, and also adopted the proposal that a petition should be presented against the L.C.C. (Tramways and Improvements) Bill, with a view of securing an amendment for a road widening. It has further been decided to petition against the Highgate Hill Tramway Bill, on the ground that the rights of the Council as the highway authority are entirely ignored.

Lambeth: London Electric Power Bills.—The Borough Council decided at the meeting on Thursday to take no action in regard to the three London Electric Bills.

Marylebone: Consulting Engineer's Fees.—The Electric Supply Committee report that the commission paid to Mr. Arthur Wright, consulting engineer, up to date, is £24,614.

Poplar: Oil, &c., Costs.—At the meeting of the Borough Council on Thursday, the electrical engineer reported that the total cost for the current year for oil, waste, engine and boiler house stores will not exceed £155, which is no more than was expended when the undertaking was supplying 3,000,000 units per annum less. The figures for the current year in this respect, with the addition of water, will be 0·01d. per unit, which is unique for this item, and is only achieved by five local authorities and three companies in the United Kingdom.

LOUGHBOROUGH: *Half-year's Statistics.*—The report of the Electricity Committee for the December half-year shows a loss upon the net revenue account of £335. The expenditure amounted to £1,215, and the receipts to £880.

MIDDLESEX: *Edgware-Willesden Tramways.*—The final section of the Middlesex County Council tramways from Edgware to Willesden Junction Station has been completed, and the Board of Trade inspection will take place shortly.

MONMOUTH: *Condition of Distributing Mains.*—Mr. A. W. Blake, the Borough Electrical Engineer, has presented a report in which he recommends that a complete and careful test of each existing section of the low-tension distributing network be made as soon as possible, and records taken of each test, in order to find out definitely where the faults are, and the best way to repair them. He points out it is quite possible that in many places the faults may be repaired without much expense, but in other places he anticipates that complete renewal of the cable will be the only cure for the present unsatisfactory condition of affairs. It is impossible for him to give reliable estimates, but he will endeavour to do so when all the tests have been obtained. Meanwhile he suggests that £200 worth of new cable should be purchased, although the amount required might possibly be greater.

NELSON: *Electricity Supply Charges.*—At a meeting of the Electricity Committee on Thursday representatives of the Brierfield District Council attended and made an application for a reduction in the charges for electricity supplied to their district. The committee agreed to consider the application at the end of the financial year.

ORMSKIRK: *The Electric Lighting Order.*—A letter has been received from the Board of Trade pointing out that, as the Council's Electric Lighting Order granted in 1900 contains no provision for the transfer of the powers, the Board is not prepared to approve of any arrangements for such a transfer. The letter added that, unless the Council could satisfy the Board of Trade that the powers under the Order will shortly be exercised, the Order will not be allowed to remain in force any longer.

SLEAFORD: *Electrical Exhibition.*—An electrical exhibition, which has been organised by the Electricity Department, will be held on February 19th, 20th, and 21st.

WALSALL: *Tramway Accounts.*—The annual accounts of the Walsall Corporation tramway undertaking show a net profit for the year ended December 31st, 1907, of £4,305, which it is recommended shall be transferred to the reserve fund, which already stands at £10,986. The total revenue was £27,356, and

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the working expenses £15,265. The number of passengers carried was 4,860,764, the average revenue per car mile 10·63d., and the working expenses 6d. per car mile.

Electricity Accounts.—The balance sheet of the electrical department for the past year shows a loss of £89, compared with a profit of £703 during the previous year. The increased price of coal is given as the main cause of this result, other contributory factors being increased payment on capital account, and the reduced price of current.

WEDNESBURY: *Electricity Supply.*—At a meeting of the Town Council last week, the action of the Electricity Committee in its negotiations with the Midland Electric Corporation for Power Distribution, reported in our last issue, was approved.

WEST HAM: *London Electric Power Bills.*—The Legal and General Committee recommend that petitions be presented against the London and District Electricity Bill, the London Electric Supply Bill, and the Great Eastern Railway Bill. In regard to the first-named measure, the electrical engineer reported to the committee that there were still, with as much force as ever, the old arguments. Relative to both Bills, the tramways manager reported the necessity of protection as to the breaking up of the tramways and compensation for any dislocation of tramway traffic. In their report on the Great Eastern (General Powers) Bill, the Council's solicitors said it was entirely outside the purpose for which a railway company was incorporated that it should have power to sell electricity. The provisions would give the company power to compete extensively with the Corporation's electricity undertaking, and, further, as the company could not be compelled to give a supply to anyone, it was safe to assume that they would only supply in cases where a profit would be likely to be made, leaving the unprofitable supplies to be given by the authorised electrical undertakers.

WESTHOUGHTON: *South Lancashire Tramways.*—The South Lancashire Tramways Co. has offered to transfer to the Council the powers which the company possesses to construct tramways in Westhoughton, and which will otherwise expire in July. A sub-committee has been formed to confer with the Bolton tramways committee concerning the proposition.

WORCESTER: *Hiring Out of Motors, &c.*—The Electricity Committee recommend that the Corporation should join the Hastings Corporation in urging the necessity of legislation enabling local authorities owning electricity undertakings to hire houses upon the hire-purchase system, as also to hire out motors.

YORK: *Electricity Accounts Deficiency.*—At the last meeting of the City Council, the Lord Mayor in reply to questions regarding the deficit of £8,809 upon the electricity undertaking, stated that the major portion of it arose in connection with the working, and the remainder was an overdraft upon the banking account through credit being given to consumers.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ABERTILLERY.—The Local Government Board inquiry into the application of the District Council to borrow £10,000 for electric lighting purposes was resumed on Thursday. Mr. Lloyd, of Messrs. Medhurst & Lloyd, consulting engineer, said it was proposed to erect 191 street lamps, and to employ overhead wires wherever practicable. The estimated cost of the scheme was £10,362, and he anticipated that the receipts would balance the expenditure at the end of the first year. In fact, he anticipated it being necessary to apply for an additional loan in about eighteen months' time. There was some opposition on behalf of the ratepayers' association. The inquiry was concluded.

ASTON.—A scheme for the extension of the electricity works at a cost of £25,213 has been approved.

Tenders are invited for a 2,000 kw. turbo-alternator with condenser, air, and circulating pump. Full particulars from Mr. R. Foster, Borough Electrical Engineer, fee £1 1s., returnable, and tenders to the Town Clerk by February 17th.

AUSTRALIA.—The *Australian Mining Standard* states that the Commonwealth Treasurer announces that the Postmaster-General has made urgent appeals to him for additional funds, amounting to £102,418, for development in telephone and telegraph services. In New South Wales ordinary telephone extensions call for £34,000; special trunk lines from Sydney to Wollongong, Katoomba, and Gosford, £6,598; and Sydney-Tenterfield extension of telegraph line to meet the Queensland line, £11,960—a total of £52,558. Victoria requires £33,240 for underground telephone extension; Queensland wants £5,526; and South Australia £11,094.

BARKING.—The Council invite tenders for the supply and delivery of electrical sundries, carbons, meters, &c. Full particulars from the Electrical Engineer's office, East Street, and tenders to the Town Clerk by February 25th.

BELFAST.—Tenders are invited by the Corporation for the supply of low-tension cable during the twelve months ending March 31st, 1909. (See advertisement this week.)

In connection with the alternative schemes which have been received by the Belfast Board of Guardians for the lighting of the Abbey Sanatorium at White Abbey, Mr. W. W. Lackie, electrical engineer to the Glasgow Corporation, has received permission to advise.

BLACKBURN.—The Electricity and Tramways Committee invite tenders for the supply of the following stores during the year ending March 25th, 1909:—General stores (including paints, varnishes, &c.), iron brass castings, bolts, bars, &c.; timber; glass; insulating material; tools, brushes, &c.; oils, &c.; wrought-iron pipes; house service fuse boxes, switches, &c.; motors; motor starting switches; screwed tubes for inside wiring. Specification and forms of tender from the Borough Electrical Engineer, and tenders to the Chairman of the Electricity Committee by February 15th.

Montague Street Baptists, Blackburn, have decided to erect a new church. Mr. F. J. Parkinson, of Blackburn, is the architect, and electric lighting will be adopted.

BOURNEMOUTH.—An additional electric lift is to be provided on the West Cliff.

BRISTOL.—The Docks Committee invite tenders for the supply, delivery and erection, and maintenance for 12 months after they have been in use, of electric cables for the supply to Avonmouth Docks. The tenders are also to include the construction, delivery, erecting in place, fitting, completion, and testing and the maintenance for 12 months after they shall have been taken into use of the electric lighting installations, complete in all details, for the various buildings, railway yard, wharves, &c., at the Royal Edward Dock, now in course of construction at Avonmouth. Specifications, &c., from the Secretary of the Docks Committee (fee £5, returnable), and tenders to 19 Queen Square, Bristol, by February 17th.

BURNLEY.—At the Town Council meeting on Thursday, the Chairman of the Electricity Committee submitted a resolution, which was passed without criticism, that a 750 kilowatts steam generator at a cost of £6,835, and a motor-driven centrifugal pump for cooling and condensing purposes at a cost of £265, be obtained. The Town Clerk was also directed to apply to the Local Government Board for their sanction to the borrowing of the necessary money, and to the repayment of the money within a period of twenty-five years.

DARWEN.—The tender of Mr. O. C. Burnley for advertising on the Darwen electric cars shortly expiring, the Council have decided that fresh tenders be obtained.

GRAVESEND.—Stores are required by the Electricity Department as follows:—Small coal, engine stores, oil stores, lamp stores, carbons, and meters. Specifications, &c., from the Borough Electrical Engineer, and tenders to the Town Clerk by February 17th.

GLASGOW.—The Tramways Department invite tenders for the supply and erection of two movable bridges over the Forth and Clyde Canal at Dalmuir and Kilbowie. Full particulars from the General Manager, 46 Bath Street, Glasgow, and tenders to the Town Clerk by April 13th.

HANDSWORTH.—Tenders are invited for (*a*): 315 kw. generating set, (*b*) feed-pump economiser and pipe work, (*c*) switchgear for 315 kw. generating set. Full particulars from Messrs. Kennedy & Jenkin, 17 Victoria Street, fee £3 3s., returnable, and tenders to the Town Clerk by March 4th.

HOLYHEAD.—A Local Government Board inquiry was held last week into an application by the Urban District Council to borrow £3,000 for electric lighting purposes. In dealing with the figures relating to the works, the inspector pointed out that whereas the loan sanctioned amounted to £20,000, the capital expenditure was £24,213. There was a bank overdraft of £998, but he could find no reference to the remaining £215. As none of the officials appeared to be in a position to give an answer to this question, and the electrical engineer stated he did not know, the inquiry was adjourned, the inspector stating that he would come down again when a proper statement had been prepared for him.

ILFORD.—Tenders are invited for the supply and delivery of a 1,000-kw. steam generator, watertube boiler, &c. Particulars from the Council's Electrical Engineer, and tenders by February 28th.

LEEDS.—Tenders are invited for the supply of steam coal for the generating set for six, nine, or twelve months' supply. The consumption is approximately 500 tons per week; also for the supply of household coal and delivered at the various offices and depôts as required. Particulars may be obtained from the General Manager, at the Tramway Offices, City Square, Leeds, and tenders should be sent to the Town Clerk not later than February 21st.

The tramways Committee invite tenders for the supply and erection of steel and currugated iron buildings at their depôt in Sovereign Street. Full particulars from the General Manager (fee £2 2s., returnable).

LEIPSIG.—The Town Council has decided to erect electric lighting and power works at a cost of £1,000,000.

LONDON: *Bermondsey.*—Tenders for the supply of the following stores during the year ending April 1st, 1909, are invited:—Arc lamp carbons and brushes, cable and fuzing

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material, conduits, electricity meters, demand indicators, and main fuses, engine oils, meter boards, street frames and covers and joint boxes. Full particulars from the Electrical Engineer, and tenders to the Town Clerk by February 17th.

Battersea.—The Council invite tenders for the supply of stores as follows, for the year ending March 31st, 1909 :—Oils, engine room stores, coal, carbons for arc lamps, electricity meters, service joint boxes, ironmongery, tools, &c. Particulars from the Electrical Engineer, Electric Light Station, Lombard Road, Battersea, and tenders to the Town Clerk by February 18th.

Hammersmith.—The following stores are required for the Electricity Department during the twelve months ending March 31st, 1909 :—Arc lamp gloves, &c., brooms and brushes; electrical goods; files; fire bricks; clay and lime; gauge glasses; insulated wires; metals; meters; oilman's goods; packing and jointing materials; screws and tools. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by February 19th.

Fulham.—The Guardians invite tenders for electrical requisites, among other supplies, for the year ending March 31st, 1909. Samples and patterns can be inspected at the Guardians' offices, 129 Fulham Palace Road, Hammersmith, between 10 and 12 and 2 and 4 o'clock. Tenders to the Clerk not later than February 27th.

Islington.—The Borough Council invite tenders for the supply of the following stores during the year ending April 1st, 1909 : Engine-room stores, &c., arc lamp carbons and globes, oil, transformers and accessories, &c.; electricity supply meters, prepayment meters, cables; electrical sundries; lamps, brushes, arc lamp parts, &c.; terminal service and network boxes. Particulars from the Town Clerk, to whom tenders by February 18th.

Tenders are also invited by February 25th for (*a*) one 1,500-kw. steam-turbine alternator, &c., (*b*) water-tube boiler, conveyor, &c. (See advertisement this week.)

Southwark.—The Borough Council decided at its last meeting to extend the feeder cable in Walworth Road to the end of Sutherland Place, at a cost, including provision of pillar and switchboard, of £180, and, having regard to the low price of copper, to invite tenders at once.

LOUGHBOROUGH.—An application is to be made to the Board of Trade for sanction to borrow £5,000 in respect of the electricity undertaking.

MANCHESTER.—The Electricity Committee invite tenders for the supply, delivery, and erection at the Stuart Street generating station of four water-tube boilers and accessories. Full particulars may be obtained from the Secretary of the Electricity Department at the Town Hall, fee £1 1s. returnable, and tenders to the Chairman of the Department by February 25th.

NELSON.—The Town Council has decided to obtain tenders for the supply of oilskins for the light railway drivers and of uniforms for inspectors, drivers, and conductors. A sub-Committee was appointed with full authority to act.

NEWCASTLE EMLYN.—The question of providing an electrical installation is under discussion by the council.

RAWTENSTALL.—Tenders are invited for the supply, delivery, and erection at the Electricity Works of an overhead travelling crane, and of a battery of accumulators, automatic reversible booster, and accessories. Particulars and tender forms may be obtained from the offices of Messrs. Lacy, Sillar & Leigh, 2 Queen Anne's Gate, Westminster, S.W., fee £2 2s. returnable, and tenders to the Town Clerk by February 21st.

REDDITCH.—A Local Government Board inquiry was held last week into an application by the Council to borrow £1,500 for the extensions to the electricity undertaking. £1,000 is for cables, and £500 for meters.

SALFORD.—An application is to be made to the Local Government Board for sanction to borrow £20,000 for tramway purposes.

The Tramways Committee invite tenders for an additional electric light installation at the Central Depot in Frederick Road, Pendleton. Full particulars from the General Manager, 36 Blackfriars Road (fee £1 1s., returnable), and tenders to the Town Clerk by February 17th.

STALYBRIDGE.—The Stalybridge, Mossley, Dukinfield, and Hyde Joint Electricity Board have decided to apply for sanction to borrow £20,223 for additional plant at the generating station, and £5,000 for the purchase of transformers to meet the increasing demand.

SWANSEA.—Tenders are invited for the supply and delivery of motors and starting switches during the ensuing year. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by February 21st.

SWINDON.—The Electrical Engineer has reported with regard to the advisability of extending the plant at the generating station in order to meet the increasing demand, and the committee have instructed him to prepare plans, specifications, and estimates of the proposed extensions.

TORQUAY.—In consequence of the increased demand of the tramway company, the council is in doubt as to whether it will be possible to extend the present electricity works. The only alternative seems to be the revival of the scheme put forward a year or two back for a new station at Upton, which, it is estimated, will cost about £20,000. A report is being prepared by the Corporation's Consulting Engineer.

WIMBLEDON.—The Corporation invite tenders for the supply and erection of the undermentioned plant at their electricity works, and are prepared to accept tenders subject to the sanction of the Local Government Board being obtained for the necessary loan :—(*a*) A 1,000 kw. turbo-alternator, with condensing plant; (*b*) two water-tube boilers, economisers, pipe-work, and feed pump; (*c*) high-tension main switchboard and switchboard gallery. Forms of specification and tender, with the general conditions, may be obtained from Mr. H. Tomlinson-Lee, the Borough Electrical Engineer, Electricity Works, Durnsford Road, Wimbledon (fee £1 each specification, returnable), and tenders to the Town Clerk by February 18th.

WORCESTER.—A Local Government Board inquiry has been held into the application by the City Council to borrow £10,000 in connection with the electricity undertaking. During the proceedings, it was stated that this sum was required for extensions to the boiler-house, and to a smaller extension in connection with the pump-house. The boiler-house extension, however, it was not proposed to carry out this year. The inspector thereupon stated that the Local Government Board was not prepared to sanction a loan for the boiler-house extension until it was necessary to carry out the work, but asked for the expenditure upon the two sections to be worked out, and that upon the pump-house to be submitted to him.

TENDERS RECEIVED AND ACCEPTED

"ARON" TAXIMETERS.—The General Electric Co., Ltd., have received through the Federation of Associated London Cab Proprietors a contract for the supply of one thousand taximeters for horse-drawn cabs, and during the present month a number of these instruments will be seen on vehicles plying for hire on the London street. This taximeter is made by the manufacturers of the well-known electricity meter, and has been approved by Scotland Yard, besides passing the severe tests of the National Physical Laboratory. The General Electric Co. have also received a number of orders for these taximeters from other cab proprietors in London and the provinces. Special arrangements have been made at the company's works at Southwark, Hammersmith, and Kilburn for the fixing and adjusting of the instruments.

DERBY.—The tender of the Otis Elevator Co., Ltd., has been accepted for the supply and erection of an elevator at the new power station at £150.

LONDON: *London County Council.*—The Council has received the following tenders for the laying of cable ducts in connection with the electrification of the Caledonian Road tramways :—Dick, Kerr & Co., Ltd. (accepted), £3,375 17s. 8d.; Clift Ford, £3,754 14s. 10d.; W. Muirhead & Co., £3,748 4s. 1d.; D. R. Paterson, Ltd., £3,804 8s. 11d.; Westminster Construction Co., Ltd., £3,881 10s.; John Mowlem & Co., Ltd., £4,069 4s. 5d.; Greig & Matthews, £4,196 19s. 5d.; Callender's Cable & Construction Co., Ltd., £4,200 11s. 3d.; Reed Bros., £4,559 7s.; Fry Bros., £4,741 15s. 3d.; J. A. Ewart, £4,811 3s. 10d. For the supply of low-tension cables required for the work, the following tenders were received :—Johnson & Phillips, Ltd., £4,020 18s. 4d.; British Insulated & Helsby Cables, Ltd., £4,056 18s. 3d.; Western Electric Co., £4,070 2s. 2d.; Siemens Bros. & Co., Ltd., £4,093 17s. 9d.; W. T. Henley's Telegraph Works Co., Ltd., £4,118 16s. 10d.; Callender's Cable & Construction Co., Ltd., £4,148 16s. 3d.; W. T. Glover & Co., Ltd., £4,401 16s. 11d.; Union Cable Co., Ltd., £4,768 18s. 10d.

The Council has also accepted the tender of Pfeil & Co. at £94 10s. for a power-driven lathe for the electricity undertaking.

Chelsea.—The Borough Council has accepted the tender of the Alliance Electrical Co., Ltd., to carry out quarterly inspections of the electric light installation in the pubic baths for 10s. 6d. per annum.

Holborn.—The Board of Guardians has accepted the tender of J. W. Gray & Son for the following work :—To repair, reinstate, and keep the telephonic installation in working order for twelve months from the date of completion as per specification, £36 net; to provide and fit extra 15-line switchboard in the apartments of the workhouse master, £2 10s.; to undertake, after the expiration of the first year, the maintenance of the installation, £5 5s. per annum.

Hackney.—The Public Libraries Committee have received the following tenders for inter-communicating telephones at the Central Library :—Higgins & Griffiths, £53 10s.; Fryer & Co., £40; J. H. Golding, £33 7s.; Smith & Co. (provisionally accepted), £26 18s.

Stepney.—The Borough Council has placed an order with

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W. & T. Henley's Telegraph Works Co., Ltd., whose tender was recently accepted for the annual supply of cable, for a size not specified in the contract (7/18 concentric paper insulated lead-covered cable) at £98 per mile, subject to the rise and fall in the market prices of copper and lead.

EAST HAM.—The Town Council have received quotations from the United Car Co. and Milnes, Voss & Co. for providing and fitting roof coverings to five or alternately ten tramcars, and have accepted the quotation of Milnes, Voss & Co. for covering ten cars at £90 per car.

GLASGOW.—The Electricity Committee recommend the acceptance of the tender by Messrs. Willans & Robinson, Ltd., of £32,043 for two 400 kw. turbines with "Centraflo" condensers and Dick-Kerr alternators.

SWANSEA.—The tender of Messrs. J. & D. Jones, of Swansea, has been accepted for the erection of a stores and test-room at the electricity works.

WORCESTER.—The following tenders have been accepted:—The Electric Construction Co., 400 kw. generator, with Bellis & Morcom engine, £2,262; W. H. Allen, Son & Co., condenser, air, and circulating pumps, £925; Phœnix Dynamo Manufacturing Co., balancer, £125.

COMPANIES' MEETINGS AND REPORTS

ANGLO-AMERICAN TELEGRAPH.—The half-yearly report shows that the total receipts from July 1st to December 31st, 1907, including the balance of £24,142 19s. 3d. brought forward from the last account, amounted to £235,935 4s. 9d. The traffic receipts show a decrease of £7,798 as compared with the half-year ended December 31st, 1906. The working expenses of the half-year amounted to £73,456 11s., being a decrease of £3,049 12s. 10d. as compared with the corresponding period of 1906. The sum of £20,000 has been added to the renewal fund, leaving a balance of £142,478 13s. 9d. Quarterly interim dividends of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, were paid on November 1st last, absorbing £52,500, leaving a balance of £89,978 13s. 9d., out of which the directors recommend the proprietors to declare final dividends of £1 5s. per cent. on the ordinary stock, £1 10s. per cent. on the preferred stock, and £1 per cent. on the deferred stock, payable on February 8th, amounting together to £87,500, making a total distribution for the year ended December 31st, 1907, of £3 10s. per cent. on the ordinary stock, £6 per cent. on the preferred stock, and £1 per cent. on the deferred stock. The balance of £2,478 13s. 9d. will be carried forward to the next account. The renewal fund has been debited with £90,000 as a provision on account of depreciation of the securities, and this sum has been deducted from the cost of "sundry securities" in the balance sheet and carried to a depreciation account.

At the meeting on Friday the report and accounts, given in our last issue, were adopted. With reference to the loss in traffic receipts of £8,000, Mr. F. A. Bevan, the chairman of the company, who presided, said that whilst commercial receipts had diminished, there was a very large increase in Press news. Referring to wireless telegraphy and the fact that the Marconi Company now accepted private messages at 7½d. per word as against 1s. per word charged by the Anglo-American Company, the chairman stated that he was not informed how much business was transacted; and although it was early to judge of results, they appeared to have suffered no diminution in consequence. Even assuming that the Marconi Company could deal with their traffic as quickly as the cable companies, he pointed out that there were sixteen cables across the Atlantic, each of which could send messages from both ends at the same time. He did not believe that the Marconi Company could work at this rate; and even if they could, they could only deal with 1/32 of the whole traffic.

BRUSH ELECTRICAL ENGINEERING.—A general meeting of the 4½ per cent. perpetual debenture-holders was held on Thursday to approve a resolution approving the scheme for consolidating the company's debenture stock, which, as pointed out last week, at present consists of £125,000 first and second debentures into £237,000 new 4½ per cent. consolidated stock, and the issue by public subscription of a further £112,500 of similar stock. Owing to the absence of the necessary quorum, the meeting was adjourned for a week. A meeting of the holders of the £125,000 4½ per cent. second stock was afterwards held, and after some discussion it was decided to adjourn this meeting also for one week in order to ascertain the decision of the first debenture-holders.

CENTRAL LONDON RAILWAY.—The ordinary general meeting was held on Wednesday last, Sir Henry Oakley, chairman of the company, presiding. The report and accounts given in our issue for January 30th were adopted. In going through the accounts, the chairman stated that there had been no alteration in the capital powers, although they anticipated having to spend about £50,000 upon the completion of works already undertaken; but this expenditure would not be incurred at present. There was, however, the question of dealing with the £25,300 which stood in the accounts as Parliamentary expenses. This sum had been incurred in connection with the various proposals before Parliament to extend the line, but the Board had now come to the conclusion that, for the present, it was not expedient to go on with this proposition. He thought the amount in question was clearly a revenue charge, and must be so allocated. Fortunately, they had put on one side about £10,000 per annum as a reserve fund, and the Board proposed that the amount of £25,300 should be charged against this, thus leaving a balance of £72,000. With regard to the loss upon the sale of the original locomotives, the Board had decided to treat this as a capital loss, and as part of the original construction of the line. Dealing with the loss in the number of passengers carried, Sir Henry Oakley said this had puzzled the Board so much that they had conferred with all the best men available in order to see whether it could be assigned to any special cause. Eventually the omnibus companies were negotiated with, and arrangements come to that if the Central London retained its twopenny fare, the fares upon the omnibus routes would be increased so that they did not encroach upon the company's main business, namely, the twopenny fare. So far their experience of this arrangement showed indications that they were regaining a portion of their passengers previously carried to and from Tottenham Court Road, and which they presumed had been transferred to the omnibus companies by the attraction of the penny fare. This was one step they had taken towards improving their business. Another step was an arrangement with the Baker Street and Waterloo Railway, and the Charing Cross, Euston, and Hampstead Railway, for through booking. These arrangements had practically opened a new source of traffic, for the number of passengers carried from off these lines amounted to from 10,000 to 12,000 per day. They were also in treaty with the City and South London Company for a similar arrangement, and also the Great Northern, Piccadilly, and Brompton Railway. In connection with the latter, however, there were physical difficulties at the Holborn station which would involve a large expenditure before the arrangements could be carried out. Under all the circumstances he thought that the small diminution of £4,000 in their net result was not, on the whole, to be very much deprecated.

CITY & SOUTH LONDON RAILWAY.—The ordinary general meeting was held on Tuesday, Mr. Stuart Wortley, K.C., M.P., presiding. He stated that the half year under review was the first during which the extension to Euston had been opened, and their traffic receipts showed an increase of £6,376. Against this, however, had to be set items of £1,135 for extra debenture interest, £3,750 for new interest on the 1903 preferred stock, and £1,381 interest on other borrowed money. In addition, they had ceased to receive the interest from the contractors on money raised by the company, making a sum of £9,592 extra charges, which they had to meet in consequence of the opening of the new line. The number of passengers carried had increased by 18 per cent., and the receipts per passenger had been 1·78d. against 1·79d. for the corresponding period of last year. The rate of increasing traffic during the first weeks of the opening of the new extension had not been maintained, but this he attributed to the wet summer of last year, and the fact that in consequence people were not tempted to take advantage of the facilities for visiting the open country, which the Euston extension afforded in connection with the other railways which it joined up with. Further, the electrification of the London County Council tramways in the north of London must lead them not to expect so great a share of this traffic in the future as they had had in the past, especially in respect of traffic created by the exhibitions at the Agricultural Hall. He hoped, however, that they had now seen the worst effect of municipal competition between Moorgate and Islington. The report and accounts given in our last issue were adopted.

DUBLIN UNITED TRAMWAYS.—At the meeting last week the report and accounts, given in our issue for January 30th, were adopted. The chairman, Mr. W. M. Murphy, stated that the gross receipts were £170,851, compared with £138,818 of the corresponding half-year of 1906, an increase of more than 23 per cent. The cost of working had increased by only 16 per cent. He had to point out, however, that they had now nearly reached the end of their cheap coal contract, entered into more than two years ago, and that for future supplies they would have to pay an increase of 5s. per ton. The balance of revenue over working expenses was nearly £20,000 more than in 1906, namely, £86,348, which, together with the £1,200 brought forward, left an available balance for distribution of £21,200 in excess of the balance available in the second half of 1906. The net sum available, after all charges were made, was £13,000. In order to provide for the reconstruction of a portion of the line to Blackrock it was proposed to appropriate £10,000. Dealing with the complaint of overcrowding during the rush hours of the day, Mr. Murphy, in order to dispose of any feeling that the public of Dublin were not as well provided for as they ought to be, pointed out that there was more tramway accommodation in Dublin in proportion to the population than existed in any other city in the United Kingdom.

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GREAT NORTHERN & CITY RAILWAY.—The report and accounts, given in our last issue, were adopted at the half-yearly meeting on Thursday. The Earl of Lauderdale, chairman of the company, who presided, stated that for the first time since the line had been opened it had failed to show a steady progress in receipts and passengers carried. The falling off in passengers was 358,749 compared with the corresponding half-year, and the gross receipts had been decreased by £785. Whilst not attempting to disguise their disappointment at the set-back in the company's progress, the directors wished to state that nothing had occurred in the system or its working to account in any way for the falling off; the diminution was almost absolutely due to the opening up of new routes. While the Great Northern, Piccadilly Brompton Railway and the City & South London Railway to King's Cross were partly responsible, the most important factor had been the competition of the London County Council tramways. In July, 1907, the electric tramway service to Highbury had been inaugurated, and from that date onwards there had been a steady decline in the number of passengers carried. The fares had been increased, but it had only resulted in checking the decrease in revenue. Had they continued at the old fares they would have had a loss of £2,000 instead of £785. The one unsatisfactory feature of the competition by the London County Council tramways was the feeling that the undertaking was not carried on upon a commercial basis, and that too low fares were being charged. He did not think the company could increase its fares in the face of the present competition, but he could only hope that they had seen the lowest point of their passenger traffic.

LONDON, BRIGHTON & SOUTH COAST RAILWAY.—At the ordinary general meeting on Wednesday last week, the chairman, Lord Cottesloe, was asked what attitude the company intended to take up with regard to the conversion of electric traction of the East London Railway, of which undertaking the London, Brighton & South Coast Railway is a lessee. The chairman replied that he thought the Brighton Company had quite enough to do at present in connection with their own electric scheme, especially as this might possibly lead to further work of this description upon their own lines in the future.

NATIONAL TELEPHONE.—The report of the half-year to December 31st, 1907, shows that the income amounts to £1,387,189, as compared with £1,241,843 for the corresponding period of 1906, being an increase of £145,346. The working expenses for the half-year amount to £780,332, compared with £710,492 for the corresponding period of 1906, an increase of £69,840. The net result for the half-year (after deducting the Post Office royalties amounting to £132,621 2s. 2d. is a profit balance of £474,236, as compared with £412,851 for the corresponding period of 1906, or an increase of £61,385. The rentals carried forward for unexpired terms of running contracts amount to £1,168,389, compared with £1,057,806 at the corresponding period of 1906, an increase of £110,583. Out of the available balance of £369,888 shown by the net revenue account, the board recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 6 per cent. per annum on the deferred stock and new shares, less income tax in all cases. It is also proposed to transfer £145,000 to the reserve fund account, and to carry forward the balance of £10,438. The sum of £545,752 has been expended on capital account during the half-year in the erection of 18,405 additional exchange and private stations, and in the construction of underground works. The meeting will be held on the 20th inst.

NORTH-EASTERN RAILWAY. The half-yearly report for the period ended December 31st, 1907, shows expenditure upon electric train working of £17,467, compared with £17,035 during the corresponding period of 1906. No separate figures are given for receipts from the electrically-worked lines.

SMITHFIELD MARKETS ELECTRIC SUPPLY.—The report for the year 1907 shows gross profit amounting to £5,195, compared with £5,135 8s. 8d. of last year, and net profit £3,337, compared with £3,172, an increase of £165. This balance it is proposed to carry to the general reserve fund. The directors regret that they are still unable to recommend the payment of a dividend for the reasons already given at the last meeting of the shareholders. [This refers to the uncertainty as to the attitude of the City Corporation at the expiry of the company's Provisional Order.] The output of the station shows an increase over the previous twelve months, but the high price of coal during the latter half of the year has had a material effect on the profits. The directors have been successful in obtaining a reduction of £700 in the rating of the company's generating station, the full benefit of which will accrue during the current year. The meeting will be held on the 21st inst.

SOUTH-EASTERN & CHATHAM RAILWAY.—At the half-yearly meeting last week, the Chairman, Mr. Cosmo Bonsor, stated that the passenger receipts continued to decrease considerably. During the half-year to December 31st, 1907, they had carried 2,250,000 fewer passengers than in the corresponding half-year of 1906, and the reason for this was the competition of the electric trams in the London suburban district, where the decrease in traffic mainly took place. He was afraid they would have to recognise that they could not meet this competition, and, consequently, the only thing to do was to make economies.

PARLIAMENTARY INTELLIGENCE

BELFAST CORPORATION AND CAVEHILL TRAMWAYS.—In the House of Commons on Monday, Mr. Devlin asked the Chief Secretary to the Lord Lieutenant of Ireland a number of questions regarding the proposed purchase of the Cavehill and Whitewell Tramways Co.

Mr. Birrell, in a printed reply, said that the Local Government Board had no information in regard to the matters of fact alleged in the question, but it had been furnished by the Town Clerk of Belfast, with the following statement on the subject:—A plebiscite was taken in regard to the proposed purchase of the Cavehill and Whitewell tramways, and it resulted in favour of the confirmation of the agreement for purchase by a majority of 12,158 votes. The Corporation have no information as to any connection between Messrs. White & Company and the British Electric Traction Company, and all dealings of the Corporation in reference to the purchase of the tramways were with the Cavehill and Whitewell Tramways Company alone. The cost of reconstruction and electrification had been estimated at over £40,000, in addition to the £13,523 paid for the old horse line. Two members of the Council are shareholders in the Cavehill and Whitewell Tramways Company. One of them, Mr. Robert Dunlop, is a director of that company. Neither he nor the other shareholder took any part or voted in the Council on the negotiations for the purchase by the Corporation. Mr. Nance was chairman of the Cavehill and Whitewell Tramways Company previous to 1904, but then resigned his chairmanship and parted with his shares, severing his connection with the company. The last balance sheet of the company showed the capital outlay on the old line as £13,523 odd, but did not state the traffic receipts for the 48 weeks ending December 6th last. When the line is worked by the Corporation, in conjunction with their own tramways, it is expected that there will be a considerable increase without corresponding additional outlay, and that the line will be a paying one. Mr. Birrell continued that the matters referred to in the questions would be rather for the consideration of the Parliamentary Committee before whom the Bill would come than for the Board.

DUBLIN AND CENTRAL IRELAND ELECTRIC POWER BILL.—The Dublin Corporation has decided to petition against this Bill, in spite of the fact that there is a protecting clause already in it.

LONDON ELECTRIC POWER BILLS.—The London and District Electricity Supply Bill was read a second time in the House of Lords on Monday. The Barking Urban District Council has petitioned against this Bill. *The Times* states that the London Liberal members of Parliament have decided to form sub-committees, one of which is to deal with the question of electric power supply in the metropolis.

NATIONAL PHYSICAL LABORATORY.—In the Parliamentary papers last week a notice appeared stating that a copy has been presented of the report of the Committee appointed by the Treasury to inquire generally into the work now performed by the National Physical Laboratory, together with a Treasury minute dated February 1st, 1908, recording their lordships approval of the recommendation contained in the report of the majority of the Committee.

PETITIONS AGAINST BILLS.—The Lancashire Electric Power Co. have petitioned against the Burnley Corporation's Bill.

PROGRESS OF ELECTRIC BILLS.—The Doncaster Corporation Bill, and the Leeds Corporation Bill were read a second time in the House of Commons on Monday. The following Bills have been read a first time in the House of Lords:—South Wales Electrical Power Distribution; the Keighley Corporation; King's College, London (transfer); London and District Electricity Supply; London County Council Tramways.

RADIO-TELEGRAPHIC CONVENTION.—In reply to a question in the House of Commons by Mr. Arthur Lee on Wednesday last week, The Postmaster-General stated that the formal ratification of the Radio-Telegraphic Convention on behalf of Great Britain had not yet been deposited. It would be necessary, however, in order that advantage might be taken of the provision as to the exemption of stations, that notice of the reservation of the right of exemption should be given before March 31st. He saw no reason why the decision of Great Britain to ratify the Convention should be modified, in view of newspaper statements as to the possible action by other countries. As a matter of fact, there was an understanding that the Convention would not be ratified without simultaneous ratification by certain other Powers, but these did not include the United States.

The British Association.—The following are among those who have been elected by the Council of the British Association to be presidents of sections at the meeting of the Association to be held in Dublin in September next, under the general presidency of Mr. Francis Darwin, F.R.S.:—Section A (Mathematical and Physical Science), Dr. W. N. Shaw, F.R.S., Director of the Meteorological Office; Section B (Chemistry), Prof. F. S. Kipping, F.R.S., Professor of Chemistry in University College, Nottingham; Section G (Engineering), Mr. Dugald Clerk, M.Inst. C.E.

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MISCELLANEOUS CITY NOTES

BUENOS AYRES GRAND NATIONAL TRAMWAYS.—An interim dividend of 2s. 6d. per share, less income tax, has been declared upon the 5 per cent. cumulative preference shares.

MONTREAL LIGHT, HEAT & POWER CO.—Subscriptions are being invited for $400,000 4½ per cent. first mortgage bonds. The bonds are for $1,000 each, and are payable, principal and interest, at the Bank of Montreal, London. The list closes to-morrow.

OXFORD ELECTRIC CO.—The directors recommend a dividend of 7 per cent. for the year 1907, including the interim dividend of 2½ per cent. paid in September.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO.—The transfer books and register of members of this company will be closed from the 15th to the 28th February (both days inclusive).

S. P. SYNDICATE.—A prospectus has been issued of this company, inviting subscriptions for £6,500 in £1 shares. We give some particulars of the objects of this company on another page. The list closes on February 21st.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO.—A dividend of 10 per cent., together with a bonus of 2½ per cent., in addition to the 5 per cent. (already paid), making 7½ per cent. for the year 1907, has been declared.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.—A statement has been issued to the effect that an Advisory Committee, consisting of Mr. Edwin Waterhouse (Chairman), Mr. Spencer Phillips, Mr. Marlborough Pryor, Mr. Thomas Skinner, and Mr. John Akroyd, with Mr. Lynden Macassey as secretary, has been formed for the purpose of considering, in conjunction with the board and Messrs. Speyer, a scheme dealing with the profit-sharing secured notes and the financial requirements of the Underground Electric Railways Co. of London (Ltd.). A similar committee has been formed in Amsterdam, and it is further understood that one is being formed in New York. The board hope to be able to publish the scheme at an early date.

NEW PUBLICATIONS

"Proceedings of the American Institute of Electrical Engineers," February. (New York: The Instutution.) 50 cents.

"Science Abstracts," Section A Physics, Section B Electrical Engineering, January, and Index. (London: E. & F. N. Spon, Ltd.) 1s. 6d.

Leeds Local Section of the Institution of Electrical Engineers.—A very successful smoking concert was held by the section on Thursday last at the Hotel Metropole, Leeds. Mr. G. D. Aspinall Parr was in the chair, and an excellent programme of music had been arranged by Mr. T. Harding Churton.

Breach of Contract for Electricity Supply.—On Tuesday, in the King's Bench Division of the High Court, Mr. Justice Ridley delivered judgment on the legal point as to defendants' liability, raised in the case of Bourne and Another v. the Marylebone Borough Council (see ELECTRICAL ENGINEERING, February 6th, 1908, page 204). His lordship said that it was not for a breach of the statutory obligations that the action was brought, but for breach of the alleged contract. It was for not performing a contract for which due consideration was given, namely, that current at 240 volts should be supplied by the defendants to the plaintiffs by the first week of September, 1905, and for not performing another contract for providing current at 200 volts. On the finding of the jury, he held that the plaintiffs were entitled to judgment for the agreed sum of £500 and costs.

Telegraph Traffic.—For the third time this year we have to announce the interruption of the cable between Trinidad and Demerara, in consequence of which the latter colony is entirely cut off from telegraphic communication. The Indo-European land lines were down between Kertch and Odessa on the 6th inst., and were repaired on the same day. Another interruption occurred between Berlin and Warsaw on February 7th, and this was put right on the 8th inst. The Hanekin route ceased working, but was restored on the 10th inst. The Fao and El Arich routes have also again given out. On the 10th of this month, we learned that the cable between Tangier and Cadiz and between Pathurst and Bessao were not working. Owing to the revolutionary conditions in Hayti, telegraphic messages for towns inland cannot be accepted. Owing to the unfortunate occurrences in Portugal, the Telegraph Conference, which was to have been held in April, has been postponed till the 1st of May, but the exact date of assembly will be notified later. The message to Congress of the President of the United States contained a recommendation to prohibit the use of the mail, telegraph, and telephone service for gambling operations in stocks. Captain Larnder is now in command of the cable-ship *Mackay-Bennett*, belonging to the Commercial Cable Company. The late commander was Captain Schenk. The cable steamer *Henry Holmes*, belonging to the West India and Panama Telegraph Company, was last heard of at Jamaica. Telegraph offices have been opened at Brookin, Surrey; Canvey Island; Forncett St. Mary, Norwich; Alexandra Park, Glasgow; Hundred House, Brecon; Medomsley, Newcastle-on-Tyne; Levenhall, Musselburgh; St. Tudy, Bodmin; East Harnham, Salisbury; and at Yeolmbridge, Launceston.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night, was £61 10s. to £62 10s. per ton (last week £63 to £63 10s. per ton).

CABLE MAKERS' ASSOCIATION.—Messrs. Charles Mackintosh & Co., Ltd., 1 and 3 Golden Lane, London, E.C., inform us that they are now members of the Cable Makers' Association.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—At the Court House, Wandsworth, last week, William Robert Pether, consulting engineer, 94 Fernlea Road, Balham, London, and 124 Chancery Lane, W.C., was up for public examination. The unsecured liabilities were stated at £468, and there were said to be no assets. He ascribed his failure to being unable to realise money on shares which he held in the X Electric Accumulators Co., Ltd., which company was promoted by a Mr. Oppermann. The company had not been a success. It had not paid a dividend, and the shares were not of marketable value.

The Electric Installation Co. is to be wound up voluntarily. The liquidator is Mr. J. Mather, 8 King Street, Manchester.

Notice is given of an intended dividend in the bankruptcy of Albert Dickinson, electrical engineer, 3 Barden Grove, Armley, Leeds. The last day for receiving proofs is February 28th, and the trustee is Mr. J. Bowling, 24 Bond Street, Leeds.

APPOINTMENTS AND PERSONAL NOTES

A discussion took place in the Cheltenham Town Council upon the recommendation that the salary of the City Electrical Engineer, Mr. W. J. Bache, be increased from £400 to £500 per annum. After several amendments had been moved the question was referred back to the committee.

At the annual dinner of the staff and employees of the Swansea Improvements and Tramways Co., last week, the General Manager, Mr. David James, was presented with a gold watch by the employees.

TENDERS INVITED.

CORPORATION OF DUNDEE.

ELECTRICITY SUPPLY DEPARTMENT.

E.H.T. 3-Phase and Direct Current Switchboards, Sub-Station Converting Machinery and Apparatus.

New Carolina Port Main Generating Station and Sub-Stations.

THE ELECTRICITY COMMITTEE OF THE CORPORATION OF DUNDEE are prepared to receive Tenders for the SUPPLY and ERECTION complete of the following:—

Section (a)—E.H.T. and D.C. Switchboards, for Carolina Port Main Generating Station.
,, (b)—Converting Machinery and Apparatus for Carolina Port Main Generating Station.
,, (c)—E.H.T. Switchboard for Dudhope Sub-Station.
,, (d)—Converting Machinery for Dudhope Sub-Station.
,, (e)—E.H.T. and D.C. Switchboards for Clepington Sub-Station.
,, (f)—Converting Machinery for Clepington Sub-Station.
,, (g)—E.H.T. and L.T. Switchboards for Lochee Sub-Station.
,, (h)—Converting Machinery for Lochee Sub-Station.

Copy of General Conditions, Specification, and Forms of Tender, together with drawings, may be had on application to the undersigned on deposit of a sum of Three Guineas (£3 3s.) and a deposit of One Guinea (£1 1s.) for each extra copy if required. Deposit fees will be returned only on receipt of complete specifications and drawings sent.

Only Tenderers quoting for complete sections will be considered.

Tenders endorsed, "Tenders for E.H.T. and L.T. Switchgear and Converting Machinery" to be forwarded to W. H. Blyth Martin, Esq., Clerk to the Corporation, City Chambers, Dundee, and to be in his hands by first post, Monday, 2nd March, 1908.

The Corporation do not bind themselves to accept the lowest or any tender.

H. RICHARDSON, M.I.E.E.,
Engineer-in-Chief.

Corporation Electricity Department,
Dudhope Crescent Road,
Dundee.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. 1906	DIVIDEND PAID. 1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ld.	10	7	5/-*	10⅞—11½	
Do. 4½% Cum. Pref.	10	4½	4½%*	10—11	
Do. 6% Cum. Second Pref.	10	6	6%	10½—11	+⅜
Do. 4½% Debenture, Red.	Stock	4½	4½%	100—103	
Bromley (Kent) E.L.& Power Co., Ld.	5	5½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	95—98	
Brompton & Kensington E. S. Co., Ld.	5	10	4½%*	7—8	
Do. 7% Cum. Pref.	5	7	7%*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	97—100	
Ch. Cross. W. E. & City E. S. Co.	5	5	5%*	4⅜—4⅝	+⅛
Do. 4½% Cum. Pref.	5	4½	2½%*	4¼—5	
Do. 4% Deb. Red	Stock	4	4%	97—100	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%*	4⅜—4⅝	+⅛
Chelsea Electric Supply Co., Ltd.	5	4½	2/-*	3⅝—4⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	5%*	10—11	
Do. 6% Cum. Pref.	10	6	6%*	11½—12⅝	
Do. 5% Deb. Red	Stock	5	5%	120—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	98—101	
Cty of Durham E. P. Dis. Co.	5	4	2/1½*	3⅛—4⅛	
Do. 5% Pref.	5	5	5%*	4⅝—4⅞	
County of London Elect. Sup. Co. Ld.	10	5	4%*	7—7⅝	
Do. 6% Cum. Pref.	10	6	6%*	11⅛—11⅝	+⅛
Do. 4½% Deb. Red	Stock	4½	4½%	105—108	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	96—99	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅜—⅝	
Do. 6% Cum. Pref.	5	3½	—	⅜—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	70—80	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4⅝—5⅛	
Do. 5% Cum. Pref.	5	5	2/6*	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6⅛—6⅝	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%	95—98 xd	
Kens. & N't'ng Hill E.L. Cos. Db. Rd.	Stock	4	4%*	99—103	
London Electric Supply Corporation	3	4	2/4½d*	1½—1⅝	
Do. 6% Pref.	5	6	6%*	4⅝—5⅛	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	91—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	5⅞—6⅜	−⅛
Do. 4½% Cum. Pref.	5	4½	4½%	4⅞—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	104—108	+2
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. Db.	100 & 500	4½	4½%	98—101	+1
Newcastle & Dist. E. L. Co., £9 paid	10	5	3/7½d.*	9½—10½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6½—6⅝	
Do. £2 Pm.	5	8	1/4⅞d*	6½—6⅞	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5⅛	
Do. 10/- Pm.	5	5	1/4⅞d	5—5⅛	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	6%*	11½—12½	
Oxford Electric Co., Ltd.	5	7	2/6*	5⅜—6¼	+⅛
Do. 4% Deb. Red.	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ld.	5	10	5/-*	7⅜—8⅝	
Do. 7% Non-Cum. Pref.	5	7	3/6*	6⅜—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅜—1½	
Do. 4% Deb. Red	Stock	4	4%	70—74 xd	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2⅜—3	
South Metropolitan E. L. & P. Co.	1	2½	6d*	⅜—⅝	
Do. 7% Cum. Pref.	1	7	8½d.*	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	101—104	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1⅝—2⅛	
Do. 5% Cum. Pref.	5	5	2/6*	2—2⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	5%*	8—9	
Do. 4½% Cum. Pref.	5	4½	4½%	5—5½	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	87—90	
Central London	Stock	4	3%	65—68	
Do. 4% Preferred	Stock	4	4%*	84—86	
Do. Deferred	Stock	4	—	43—46	
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	74—77	
City and South London Cons.	Stock	2½	2½%	40—42	−1
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%*	116—119	
Do. 5% Perp. Pref. 1896	Stock	5	5%*	114—117	
Do. 5% Perp. Pref. 1901	Stock	5	5%*	113—116	
Great Northern & City Pref. "A"	10	4	11½d.	1⅛—1⅜	
Gt. Northern, Piccadilly & Brompton	10	4	4/-*	4—5	
Do. 4% Perp. Deb.	Stock	4	4%	84—87	+2
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1%	37⅛—38⅛ xd	
Do. 3½% Preference	Stock	3½	3½%	86—89 xd	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79 xd	
Do. 3½% Convertible Pref.	Stock	3½	3½%	72—75 xd	
Metropolitan District	Stock	nil	—	10—11	
Do. 6% Perp. Deb.	Stock	6	6%	108—113	+2
Do. 4% Pref. Deb.	Stock	4	4%	68—73	−2
Do. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½%	46—51 xd	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	36—40	
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅜—¾	−1/16
Do. 5% Cum. Pref.	1	5	5%	⅞—1⅛	
Do. 4½% Deb. Red.	Stock	4½	4½%	90—95	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1⅜—1⅞	+3/32
Do. 6% Cum. Pref.	10	6	6%*	4½—5⅜	+3/32
Do. 5% Perp. Deb.	Stock	5	5%	96—100	+⅜
Do. 4½% 2nd Deb.	Stock	4½	4½%	72—76	+2
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4¼—4¾	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	96—99	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. 1906	DIVIDEND PAID. 1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%			
Dublin United Trams Co.	10	6	6%*	12½—13⅜	
Do. 6% Pref.	10	6	6%*	12⅜—13⅜	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅝—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	−1
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7½—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	95—98	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—⅛	
Do. 5% Cum. Pref.	1	5	6d*	⅛—⅜	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	95—98	+1
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—¾	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅜—1⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9½d*	¼—⅜	
Do. 5% Cum. Pref.	1	5	5%*	⅜—½	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4⅛—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	1/1½	⅞—1⅛ xd	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	60—70	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1⅛	
Do. 6% Cum. Pref.	5	nil	—	3½—3¾	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅜	30/-	57—60	
Do. 6% Pref. Ord.	Stock	6	3%	101½—103½	
Do. Def. Ord.	Stock	1¾	—	15½—15⅞	−⅜
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	87—90	+2
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3½	
Do. 10% Cum. Pref.	5	10	5/-*	8½—9½	
Do. 4½% Debs.	50	4½	4½%	99½—102½	+1½
Direct United States Cable Co. Ltd.	20	4½	4⅜%	13¾—14	−¼
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101 xd	+1
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12½—13	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102 xd	
Eastern Telegraph Co.	Stock	5⅜	5%	130—135	
Do. 3½% Pref.	Stock	3½	3½%	84—87	
Do. 4% Mort. Deb.	Stock	4	4%	100—103	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	32—34	−1
Indo-European Telegraph Co. Ltd.	25	13	65/-	53—56	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅝—1¼	−1/16
National Telephone Co., Ltd., Pref.	Stock	6	6%*	110½—112½	−½
Do. Deferred	Stock	5½	6%*	111—113	+1
Do. 6% Cum. 1st Pref.	10	6	6%*	11—13	
Do. 6% Cum. 2nd Pref.	10	6	6%*	10½—12½	
Do. 5% 3rd Pref.	5	5	5%*	5⅜—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	97—99	
Do. 4% Deb. Red.	Stock	4	4%	100—102	+½
West African Telegraph Co. Ltd.	10	4	4/-	10—10¼	
Western Telegraph Co., Ltd.	10	7	6%	13—13½	+½
Do. 4% Deb.	Stock	4	4%	98½—101½	+½
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	−½
Do. 6% Cum. Pref.	1	6	7½d	1/16—1/8	
Babcock & Wilcox, Ord.	1	20	1/7½*	3½—3⅝	
Do. 6% Pref.	1	6	7½d	1/16—1/8	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6⅜—7⅛	
Do. 6% Cum. Pref.	5	6	6%	5⅜—6 xd	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	101—104	+1
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%*	85—89	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅝—1	
Do. 4% Mort. Deb. Red.	Stock	4	4%	41—46	+1
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	1/16—⅛	+1/16
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	79—82	−3
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10½—11½	+½
Do. 5% Cum. Pref.	5	5	5%	5½—5⅝	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106—108	+2
Consolidated Electrical Co., Ltd.	1	3	8½d*	7/16—⅜	
Crompton & Co., Ltd.	3	5	5%	1⅝—2	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1—1⅛	
Do. 6% Cum. Pref.	1	6	7½d	1—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	99—102	
Edison & Swan United "A," £3 paid	5	4½	2/6	⅜—1	−⅛
Do. do. (fully paid)	5	4½	4/2	1½—2⅜	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	3/16—¼	
Do. 7% Cum. Pref.	2	7	—	1⅛—1⅜	
Do. 4½% 1st Mort. Deb.	Stock	4	4%	65—69	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅞—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	11½—12½	+½
Do. 4½% Cum. Pref.	5	4½	2/1*	5—5½	+½
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	106—108	+1½
I. R. & G. P. Co., Ltd.	10	10	10%	14⅜—15⅜	
Do. 4% Deb. Red.	100	4	4%*	98—100	
Tel. Const. & Maintenance Co.	12	15	5%*	29—31	
Do. 4% Deb. Bds. Red	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3½—3¾	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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SUMMARY

REVIEWS of the following books appear in this issue: "Steam and Exhaust Pipes," by R. McGregor; "The New Matriculation Light," by R. W. Stewart; "The Metric and British Systems of Weights, Measures, and Coinage," by F. Mollwo Perkin; "Notes on the Use of Electricity for the Garrison Artillery," by J. R. J. Jocelyn; "Electric Light and Power," by E. E. Brooks and W. H. N. James; "Electric Wiring and Fitting for Plumbers and Gas-fitters," by S. F. Walker; "The B. I. Handbook"; "English Prices and French Equivalents," by H. P. McCartney. (Page 259.)

AN electrically-driven scene-shifting equipment has been installed recently at Wyndham's Theatre. A single motor is employed, which drives a long shaft at a constant speed. The separate winding drums by which the cloths, &c., are raised and lowered derive their motion from this shaft by an arrangement of clutches and gearing. (Page 261.)

AN article by a contributor describes a system which he recommends for house wiring departments of small central stations, dealing particularly with the way in which the work should be booked and the various repairs entered up. (Page 262.)

A NEW combined refuse destructor and electricity works in Greenock embodies some new features in destructor design, among which is a device for automatically opening and closing the charging door of the destructor furnace—so that the charging is accomplished without manual labour and with an absence of dust—and a well-designed system for supplying the furnaces with forced draught and ventilating the clinkering floor. The new works contains coal-fed boilers as well as destructor boilers; at present the plant capacity is 1,500 kw., and the station, which will eventually supply the greater part of the load at Greenock, is capable of considerable extension. (Page 263.)

A SMALL gas-engine-driven generating station has been opened recently at the "First Garden City," Letchworth. (Page 267.)

AN article by Mr. C. C. MONCKTON calls attention to the need for the accurate standardisation of wave-lengths in view of the impending international control of wireless telegraphy, and describes a method for their measurement. (Page 268.)

A POWER installation in the south of Sweden, remarkable for the special construction of the supports for a long span in the transmission line, is described. (Page 269.)

A LONG and somewhat detailed appendix dealing with the electrical industry in Spain is attached to a Consular Report, just issued, upon the trade and com-

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merce of Spain during 1906. Attention is drawn to the absence of any noteworthy British enterprise in the application of electricity in Spain, the whole of the business being practically in the hands of Germany, Switzerland, France, United States, and Belgium. A strong appeal is made to British financiers and investors to give greater attention to the still numerous opportunities afforded for the remunerative investment of capital, and a suggestion is made that the Institution of Electrical Engineers or some representative combination of British manufacturers should take steps to have an investigation made by someone acquainted with Spain, into the great openings which that country undoubtedly affords. (Page 270.)

MR. J. S. PECK'S Paper on Protective Devices for High-tension Circuits, on which reports of the discussions in London and at Manchester have already been given, was further discussed at the Dublin Local Section of the Institution of Electrical Engineers last Thursday, when experiences in dealing with voltage surgings in lines of various descriptions were given by central station, tramway, and telephone engineers. One of the speakers described a special form of Wurts arrester for continuous-current circuits. (Page 271.)

IN a further discussion, in Glasgow, of Mr. J. F. C. SNELL'S Paper on the cost of power supply for industrial purposes, several additional figures of the costs of private plants were quoted. Mr. STOTHERT stated that the cost of electric power at Messrs. Babcock & Wilcox's Renfrew works was 0·45d. per unit, including an allowance for depreciation. Mr. NEWINGTON gave a case in which the cost of running a suction-gas plant came to 1·13d. per unit (including all capital charges, but not rent) as against 1·2d. charged by the Corporation previously. Mr. J. A. ROBERTSON pointed out that the total cost of electric energy in a shipyard, whether the energy was bought or from a private plant, came to but a small percentage of the wages bill; in a particular case in Greenock the wages came to £135,000 annually and the power only £4,000. Mr. Snell, in the course of his reply, said that since writing his Paper more than a year ago, the price of oil fuel had risen from 42s. 6d. to 82s. 6d. per ton. (Page 272.)

A NEW petrol-electric railway car is being taken into use on the Delaware and Hudson Railway in America. An eight-cylinder petrol engine drives a specially constructed interpole generator, which supplies current to two traction motors mounted one on each truck. A feature of the control is the variation of the generator voltage. (Page 273.)

THE accounts of the Central Electric Supply Co. for 1907 show a surplus of £5,042; those of the Kensington & Knightsbridge Electric Lighting Co., £9,854; the St. James's & Pall Mall Co. has a surplus of £28,375; the London Electric Supply Corporation, £34,613; the Notting Hill Electric Lighting Co., £11,000; and the Westminster Electric Supply Corporation, £28,313. (Page 274.)

A PAPER was read by Mr. B. HOPPS last Thursday, before the Rugby Engineering Society, on the London motor omnibus problem, in which attention was drawn to the petrol-electric system designed by the British Thomson-Houston Co. (Page 275.)

A LARGE electric lift has been constructed in New York for taking cars in and out of the new tunnels under the Hudson River. (Page 276.)

AN article in an American contemporary by BELA VALATIN compares the performance of a certain American single-phase 15-cycle experimental locomotive with that of the 3-phase locomotives of the Italian State Railways. (Page 277.)

THE annual dinner of the General Electric Co. was held on Saturday last. (Page 278.)

A PAPER read by Mr. E. F. ALEXANDERSON recently before the American Institute of Electrical Engineers described a new form of single-phase traction motor, to which the name of series-repulsion motor was given. The windings resemble those of a series motor. When starting, the armature is short-circuited, and the full secondary voltage of the transformer is impressed upon the "inducing" and exciting stator windings, but when running part of the power is introduced in the stator, and part in the rotor. (Page 279.)

A SHORT article reviews the controversy occasioned by the action of the Board of Trade in suggesting that the official Board of Trade audit of electricity supply companies' accounts should be dispensed with. (Page 281.)

A VERY complete equipment for measuring the horse-power at the road wheels of automobiles has been installed by the Automobile Club of America. (Page 282.)

Under ELECTROCHEMISTRY and ELECTROMETALLURGY, we abstract two articles which show how the advent of electrical energy made the artificial production of diamonds possible, and incidentally helped to throw light upon the manner in which they are formed in nature. A multi-voltage dynamo for electroplating purposes, with two commutators, each connected with half of a double winding on the armature, is described. Each set of brushes may be connected with separate plating tanks, which can thus be operated independently. To increase the voltage, the two sets run in series. Reference is also made to the reduction of nitrates with copper electrodes, to an improvement in the electrolyte of the alkaline accumulator, and to the dividend announcement of the Electrochemische Werke of Berlin. (Page 283.)

Under ELECTRICAL SCIENCE, in the British and American Section, are notes on some new experimental data regarding positive electrons in atoms, and on some formulæ for self-inductance. In the Papers abstracted in the Continental Section, CLERC and MINET describe a new electric furnace, CATHIARD shows how to use a flame as a rectifier, and DUFOUR brings forward some more magneto-optic anomalies suggestive of positive electrons. (Page 284.)

AS the result of a decision in the courts last week, the purchase by the Corporation of the horse tramways in Oxford will take place upon "old iron" terms, and not upon the basis of a going concern. The arbitration proceedings, which were interrupted on the first day for this point to be determined, will shortly be resumed. (Page 284.)

The new patent specifications published last Thursday by the Patent Office include two relating to filaments for electric lamps by the BRITISH THOMSON-HOUSTON Co., and another by the same firm describes a new type of overload cut-out. GANZ & Co. have patented a device for the pressure regulation of alternating-current generators, and Mr. MILES WALKER has a new method of reducing the voltage between adjacent commutator bars of armatures of high-speed machines. (Page 285.)

THE Bournemouth Corporation have rejected the auditor's recommendation that a reserve fund should be established in connection with the tramways. Arrangements for permanent tramway intercommunication between Bradford and Leeds, using Mr. Spencer's extensible gauge truck, are now under consideration. The accounts of the Dublin Corporation Electricity Department for the year ended March 31st, 1907, show a debit balance of £1,720, after providing for £23,700 repayment of loans and interest. The Ealing Corporation has instructed the Borough Surveyor and Electrical Engineer to submit an estimate of the cost of constructing a short length of tramway upon the Dolter surface contact system. The Finchley Corporation has rejected a recommendation instructing the Finance

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Committee to inquire what the annual amount would be for a reserve fund in connection with the electricity undertaking. The accounts of the Liverpool Corporation lighting and tramways undertakings show a net surplus of £27,500 and £27,793 respectively, after meeting capital charges, both of which amounts it is proposed to transfer to the Borough fund. At the Court of Common Council last week it was stated that although there are about 9,000 electric lighting street boxes in the City of London, only three small accidents have occurred in connection with them during the past three years. The arrangements at Edinburgh in connection with the use of sewage water for condensing purposes at the McDonald road power station are now practically complete. The Sunderland Corporation have discontinued the supply of electrical energy to the works of Sir J. Laing & Sons, in consequence of there being a debt of £2,300 for current. (Pages 287-289.)

The date for receiving tenders for cable, &c., in connection with the supply of electrical energy to the Avonmouth Dock district by the Bristol Corporation has been extended to February 27th. The following Corporations intend making applications to the Local Government Board for loans for electricity works extensions:—Burslem, Dartford, Stoke-on-Trent, and Wigan; the Hull Corporation invite tenders for three 500-kw., 2,250-volt, continuous-current generators; the Handsworth Urban District Council require a 350-kw. generating set; and the Manchester Corporation require four water-tube boilers and accessories for the Stuart Street generating station. (Page 289.)

The Hastings and District Tramways Company's report shows a balance of £13,767 available for distribution. At the meeting on Monday the Chairman stated that although very little was known of the Dolter surface contact system when the company adopted it, the line was now working in such a manner as to lead the directors to hope for fairly good results. The net profit of the Imperial Tramways Company in 1907 amounted to £26,125; the Lanarkshire Tramways show a sum of £15,252 available for distribution; the Newcastle & District Electric Lighting Company have made a net profit of £19,922; and the Bristol Tramways and Carriage Co. have a net revenue of £85,347. An adjourned meeting of the debenture holders of the Brush Electrical Engineering Co. was held on Friday, when the resolution to modify the Company's debenture stock was declared to be lost. A poll is to be taken on the 27th inst. At the meeting of the Metropolitan District Railway Co. last week, Sir George Gibb stated that the directors' proposals with regard to capital were the only ones which would put the company upon a sound basis again. In order to dispel any idea that the working costs on the District Railway were extravagant or excessive, he gave some figures of the working expenses on other London tube railways. At a special general meeting of the South Wales Electric Power Distribution Co. last week, the Bill now before Parliament dealing with the transfer of the company's stations, &c., was approved. At a special meeting of Edmundson's Electricity Corporation, a special committee of shareholders appointed last July was presented; the acceptance of the resignation of the present Board, and the issue of £250,000 prior lien debentures is recommended; the co-operation of Mr. J. S. Highfield and Mr. Stanley Beeton is also advised. A circular has been issued by Messrs. Bruce Peebles & Co. informing the shareholders that it has become necessary to call a meeting for the purpose of putting the company into voluntary liquidation with a view to reconstruction. (Pages 290-294.)

Sir John Gavey, C.B., has been appointed Consulting Engineer to the Post Office. The salary of Mr. A. L. C. Fell, Chief Officer of the L.C.C. tramways, has been raised from £1,500 to £1,750. (Page 292.)

The announcement that Messrs. Bruce Peebles and Co., Ltd., have decided to go into voluntary liquidation has probably given more occasion for surprise to the shareholders of that company than to the electrical engineering public generally. The reports and accounts of the company for the year 1906 showed a net profit, available for distribution, of nearly £46,000; 6 per cent. dividend was paid on both the preference and ordinary shares, and sums were also carried to a special preference shareholders' reserve fund, and the general reserve account, which brought these funds to totals of £11,556 and £27,000, respectively. The previous year's dividends had been 6½ per cent. on both classes of shares, but this slight falling off could hardly have been taken as presaging a disaster in a year's time. A closer examination of the position of the company, however, showed that the amounts outstanding in unpaid accounts on both sides of the balance sheet were extremely large, and it was clear that there was some lack of working capital, as the issue of £100,000 in debentures was decided upon. For this purpose the borrowing powers of the company were increased to £200,000, and as the share capital was £300,000, the total would have represented half a million. It is now evident that further working capital must have been needed very urgently, for, as a consequence of their inability to make the further issue of debentures owing to the stringency of the money market, the company has been obliged to go into voluntary liquidation. It has been currently reported for some time, in electrical engineering circles, that a fair proportion of the company's capital was locked up in shares in other companies, received in part payment for contracts, and the admission is now made that it is not possible to realise advantageously the securities in which the company is interested. At a meeting of the company on Monday the shareholders will be asked to appoint Mr. A. W. Tait (one of the directors) and Mr. J. A. Robertson Durham (the nominee of the creditors) as joint liquidators. The directors have done wisely in selecting Mr. Tait for this arduous task, as it was largely due to his energies as one of the liquidators of Ferranti, Ltd., that this old firm was satisfactorily reconstructed a few years ago. Doubtless, Messrs. Bruce Peebles will continue for many years to manufacture the small motors and the La Cour motor-converters with which they have been so successful, and will show more restraint in the future in entering on the more ambitious form of contracts to which apparently their present unfortunate position is to no small extent attributable.

Combined refuse destructors and electricity works had at one time fallen into disrepute with electrical engineers, chiefly on account of the dust arising from the refuse itself, and from the products of combustion as they were raked out of the furnace. Another criticism levelled against destructor stations was the unavoidable variations in the calorific value of the refuse, and the uncertainty of the steam supply in consequence. Both of these objections are to a large extent overcome in the dust destructor station at Greenock described in this issue. It represents a great improvement in destructor design. Each cartload of refuse is emptied into a charging tub as it comes in, and this can be raised by an electric crane, and either emptied directly into the furnace, or kept for a time on the charging

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platform. The action of charging takes less than a minute, and practically no dust is evolved. On the clinkering floor a certain amount of dust is unavoidable, but this is at some distance from the engine-room. From the chimney itself there must also be some dust, but by ensuring proper combustion this can also be reduced to a minimum, and the system of forced draught employed in the Greenock destructor should assist in this direction. The use of these forced draught fans should also be of help in endeavouring to keep the steam pressure regular. At Greenock, as the steam which the destructor will furnish will ultimately be only a small proportion of the whole steam required, it should be possible to burn the refuse as it comes in, and to keep the destructor always working at an even load throughout, leaving the coal-fired boilers to take the peaks. When used in this way, if the new plant comes up to anticipation, the question of economy is easily settled. It is admitted that a destructor is the best way to dispose of town refuse, so that the question to be decided is whether the interest and sinking fund on the cost of fitting boilers to the destructor plant, to which must be added a percentage for depreciation, and the cost of maintenance, is less than the value of the steam delivered to the engines of the electric power plant. If so, the combined plant at Greenock should prove a success. The results of the first year's working will be awaited with interest.

WE regret to hear that Mr. Hall-Edwards, Surgeon-Radiographer to the Birmingham General Hospital, has suffered amputation of an arm in consequence of serious X-ray burns. This deplorable occurrence serves to draw attention once more to the dangers which menace all those who, in the practice of their profession, have to spend part of each day in the neighbourhood of X-ray tubes in action. It is necessary to distinguish between the acute inflammation of the skin which can be produced by a single excessive dose of the rays, and the chronic, slowly developing condition which results from often-repeated exposure to small doses. It is the latter which is the special bane of X-ray workers; the former is nowadays almost unheard of, as a result of a better appreciation of the magnitude of dose at which danger begins to threaten. The pain and suffering experienced by the subjects of chronic X-ray dermatitis are very serious; the fingers become cracked and ulcerated, and no ointment or other application seems to have the least good effect in healing these sores. Subsequently the tissues of the fingers waste, the knuckles become stiff, and the hands are rendered useless. In bad cases the sufferer cannot wash or dress himself, and becomes almost helpless, while the intense pains continue night and day. Unfortunately, there are many medical men all over the world who have suffered and are suffering more or less seriously from the results of exposure to X-rays. At the Congress of Physical Therapeutics, held at Liège three years ago, we were much impressed at seeing that there was hardly a member of the X-ray section of the Congress who did not carry scars or wounds produced by chronic exposure to X-rays. Since these dangers have been more fully realised, precautions of a systematic kind have been adopted, and have tended to reduce the dangers very considerably. Gloves and aprons of dense material, lead or glass screens for the tubes have now come into general use, but there are many instances of injury to the hands which developed in the earlier days of X-rays, and now are beyond repair.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, FEBRUARY 20TH.

Royal Society.

4.30 p.m. Meeting at Burlington House, Piccadilly, W. Among the Papers down for reading is the following:—"Effects of Self-Induction in an Iron Cylinder when traversed by Alternating Currents," by Prof. Ernest Wilson.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at 25 Great George Street, Westminster, S.W. Papers to be read:—(1) "Electrical Power in Railway Goods Warehouses," by H. Henderson. (2) "Electric Power in Docks," by C. E. Taylor.

FRIDAY, FEBRUARY 21ST.

Electro-Harmonic Society.

8 p.m. Concert (ladies' night) at the Bechstein Hall, Wigmore Street, W.

Institution of Mechanical Engineers.

8 p.m. Annual General Meeting at Storey's Gate, St. James's Park, London. The following Paper will also be read and discussed:—"Tests of a Live Steam Feed Water Heater," by Prof. John Goodman.

Royal Institution.

9 p.m. Evening Discourse by Sir Oliver Lodge on "The Ether of Space."

SATURDAY, FEBRUARY 22ND.

Birmingham and District Electric Club.

7 p.m. Meeting at the Municipal Technical School, Suffolk Street, Birmingham. Paper to be read:—"The Electrodeposition of Silver," by T. J. Baker.

Central Technical College Old Students' Association.

7.15 p.m. Annual General Meeting and Dinner at the Trocadero Restaurant, Piccadilly, W.

MONDAY, FEBRUARY 24TH.

Institution of Electrical Engineers: Students' Section.

7 for 7.15 p.m. Annual Dinner at the Holborn Restaurant, London.

Institution of Electrical Engineers: Newcastle Local Section.

8 p.m. General Meeting at the Armstrong College, Newcastle-on-Tyne. Paper to be read:—"Electric Power in Docks," by C. E. Taylor.

Liverpool Chamber of Commerce.

8 p.m. Address on Wireless Telegraphy by Signor G. Marconi.

TUESDAY, FEBRUARY 25TH.

Institution of Electrical Engineers: Manchester Students' Section.

7.30 p.m. Meeting at the Municipal School of Technology, Whitworth Street. There will be a discussion in conjunction with the Manchester and District Junior Gas Association upon "Gas v. Electricity for Illuminating Purposes."

WEDNESDAY, FEBRUARY 26TH.

Institution of Electrical Engineers: Students' Section.

7.30 p.m. Meeting at 92 Victoria Street, Westminster. Paper to be read:—"Wattmeters and their Connections," by J. C. Connan.

FRIDAY, FEBRUARY 28TH.

Physical Society.

5 p.m. Meeting at the Royal College of Science, Imperial Institute Road, South Kensington. Paper to be read:—"Contact Potential Differences Determined by means of Null Solutions." By S. W. J. Smith and H. Moss.

SATURDAY, FEBRUARY 29TH.

Institution of Electrical Engineers: Students' Section.

10 a.m. Visit to the Brimsdown power station of the North Metropolitan Electric Power Co.

Destruction by Fire of the Eiffel Tower Wireless Telegraph Station.—On Tuesday afternoon the shed containing the wireless telegraph apparatus at the foot of the Eiffel Tower was destroyed by fire. It is stated that the outbreak was due to a short circuit which occurred during some experiments that were in progress. The tower itself and the aerial are uninjured, but as the apparatus has been destroyed, communication with Casa Blanca will be interrupted for some time. The building was a temporary one, and a decision had already been arrived at to replace it by a permanent underground station at the base of the tower.

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REVIEWS OF BOOKS

Steam and Exhaust Pipes. By R. McGregor. 22 pp. 9¼ in. × 12 in. 39 illustrations. (London: *The Electrical Times.*) 1s. 6d.

Modern power-stations, although of good design and construction as regards their boilers and engines, are frequently defective as to the steam distribution, and the author of this book brings before his readers some typical examples of what he considers should be the true methods to be adopted when arranging the steam-pipe system of generating stations. In the preliminary chapters, the drainage of the steam range is fully considered, and the best methods of ensuring freedom from water in both the steam piping and engine cylinders. Superheated steam has a most important bearing on the drainage requirements of a steam range, as with a dry superheated steam there is not so much danger of getting water in the pipework, but still efficient means must be taken to provide for what water there does happen to be, and this is obtained by the placing of steam traps in front of every stop-valve on the range, and also the provision of separators at convenient intervals. Steam piping subjected to great temperatures will elongate so much as ⅜ in. in 10 ft., and due provision for this must be made in the range by means of expansion stuffing boxes in some cases, or by the more modern practice of placing bends at some suitable position. When vibration occurs in a pipe range, it may be due to instability of the engine and cylinders, or to the pulsating flow of the steam causing a surging action to take place; so sharp bends should be avoided, and the steam-pipes arranged so as to get as straight a flow as possible.

With the general arrangement of the pipework, the author deals very fully. He does not approve of the practice of double and ring steam mains, and advocates that when the boiler-house runs parallel to the engine-room, the steam range can act as an equaliser, and its dimensions be kept down; but the steam range must be 15 to 20 per cent. larger in diameter than the maximum engine or boiler branch. "Minor" details of design—the subject of lagging, radiation losses, scale in the pipes, isolating valves, and general arrangement of drains and blow-down pipes, and the feed-water service—are dealt with, but some of these details are so important that it would have been better if more emphasis had been given to them. The general arrangements advocated in the book are extremely well advised, and, if adopted by station engineers, there should be far fewer blown-out joints and accidents than at present. The writer has given prominence to features which are frequently overlooked in everyday work, and are not usually referred to in text-books. In practical work, arrangements are generally a matter of compromise, and the best method is that which contains the fewest imperfections, but certain vital points admit of only one treatment, and the author endeavours to point these out. The low price of the book is in its favour.

The New Matriculation Light. By R. W. Stewart. 282 pp. 7 in. by 5 in. (London: W. B. Clive.) 2s. 6d.

This is a very good introductory text-book of light. It contains the ordinary matter found in all the elementary text-books on the same subject—mirrors, prisms, lenses, simple optical instruments, photometry, and dispersion—but the matter is not treated in quite the ordinary way. In fact, an attempt is made to blend practical work with the theoretical, and to this end simple experiments illustrative of the text are suggested to the student and fully described. These experiments require nothing more than spectacle lenses, bits of looking-glass, and pins, and if the home student will only do them, as well as read about them, they will make preparation for the matriculation examination rather less of a cram than it usually is. Quite apart from examination preparation, the clear diagrams of the rays through optical instruments, and the pages on colour and dispersion, will be helpful to those requiring for any purpose just a little knowledge of light.

The Metric and British Systems of Weights, Measures, and Coinage. By Dr. F. Mollwo Perkin. 83 pp. 5½ in. by 8½ in. 17 illustrations. (London: Whittaker and Co.) 1s. 6d.

As Dr. Perkin says in his preface, this exposition of the metric system is the outcome of experience in teaching the use of that system of units, and is intended to be placed in the hands of students of chemistry, physics, engineering, or general elementary science. Whatever be our views upon the practicability of an immediate adoption of the metre and the gramme in this country, to the exclusion of existing cumbrous methods, it is undeniably essential that every student should acquire a good working knowledge of the system. It would probably be much easier to teach children to think in metric units before they had acquired a familiarity with British measures, but as things are there is ample demand for a book such as this before us, intended to introduce the conception of these units at a later stage. The treatment of the subject is clear, and, in addition to tables, some curves (or rather straight lines) for conversion of British and metric quantities are given which should prove of use. The book, however, contains more than this, as chapters are also included on methods of finding specific gravities, which, in addition to familiarising the student with some of the more elementary methods of making measurements of the quantities he has been dealing with, presents excellent examples to enable him to realise the relations of the different kinds of units. Although not, strictly speaking, coming under the head of the metric system, information is also given as to the relation of the three thermometric scales in common use, and the conversion of English money into foreign decimal currencies, and here again useful diagrams are given. An excellent series of tables involving even the most out-of-way units is contained in an appendix. We note here that "knot" is used as synonymous with the nautical mile, although we believe this word, strictly speaking, signifies the unit of speed for ships, and the spelling "naut" should be employed as an abbreviation indicating the unit of distance. The units adopted by the United States Bureau of Standards are also given with their metric equivalents. We do not often see these equivalents in handbooks, and such literature among the usual conversion tables, and we do not think it is very generally realised that the British and American units are slightly different. The equivalent of the two kinds of inches, for example, are respectively 25·39954113 mm. and 25·4001 mm. The different thermal units are also explained, but, naturally, electrical quantities do not come within the scope of the work.

Notes on the Use of Electricity for the Garrison Artillery. By Col. J. R. J. Jocelyn. 227 pp. 7¼ in × 4⅜ in. 160 illustrations. (London: Wyman & Sons). 1s. 6d.

This book is designed for the use of regimental officers and non-commissioned officers whose duties may bring them in contact with electrical appliances. It commences with several sections on elementary principles, which are then followed by practical informa-

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tion as to the general uses to which electricity is adapted to the artillery, descriptions of the gun-plug, firing-key, and the Webb charge and discharge key, which are all used in connection with guns fired by electricity. The different kinds of batteries, electric tubes, and firing gear, searchlight and incandescent lights, and telephone receivers are also dealt with. The book is well written, and comprises a deal of matter which should be useful for the purposes for which it is intended.

Electric Light and Power. By E. E. Brooks and W. H. N. James. 372 pp. 7½ ins. by 4¾ ins. 230 illustrations and 17 plates. (London: Methuen & Co.) 4s. 6d.

THIS book is primarily intended for students of electrical engineering. The commencing chapters deal with magnetic lines of force, and the student is shown in a simple manner the effect of magnetism and its relation to electric currents. A number of experiments are described, and illustrations are given to enable the student to obtain a clear impression of what may be called the first steps in theoretical electrical knowledge. Following the subject of magnetism, the authors deal with the electric circuit, and show how different electrical measuring instruments act under the influence of the current, and define the different terms used in electrical science. In Chapter 4 the subject of resistance is considered, and its measurement and effect are discussed. The subject of Chapter 6 is induction coils and transformers, and their general construction and action are clearly defined. The authors then proceed to deal with continuous current generators. They do not in this chapter introduce the unnecessary difficulties which characterise the terminology of many writers, but keep prominent the two distinct ideas of magnetisng force and magnetic field. These chapters show the action of the brushes and their relative positions on the commutator, in relation to the load and voltage of the machine. The subject of lighting circuits, with all their different methods of connection and requirements, is fully dealt with, together with the construction of different kinds of incandescent and arc lamps. Chapter 11 deals with the construction of different kinds of measuring instruments and methods of testing circuits, whilst the concluding chapters consider primary cells and accumulators, including the construction of their electrodes, method of charging, and general instructions for their testing and maintenance. This work is founded on the actual experiences of the authors, gained by some years of technical instruction, and clearly expresses in a manner which is easily grasped the more simple facts connected with electrical phenomena and their applications.

Electric Wiring and Fitting for Plumbers and Gasfitters. By Sydney F. Walker. 157 pp. 7¼ in. by 5¾ in. 94 illustrations. (London: Scott, Greenwood & Son.) 5s.

IN the unlikely event of our employing a plumber or gasfitter for electric wiring and fitting, we should give the preference to one who had not read Mr. Walker's book.

The B.I. Hand-book. 568 pp. 7¼ in. by 4¾ in. (Prescot: British Insulated and Helsby Cables, Ltd.) 7s. 6d.

IN this new publication a great deal of general information is included which is likely to be of use to the electrical engineer, as well as a description of the principal manufactures of British Insulated and Helsby Cables, Ltd. Much of the general information is, of course, already public property, and is simply repeated in a convenient form, but a quantity of hitherto unpublished matter of a technical nature is also given. About 100 pages are devoted to particulars and specifications of cables and wires of all sorts, and here the details are much fuller than in the average cable manufacturer's catalogue. A number of forms of feeder pillar fuse-boxes, &c., are illustrated and described, including the "Prescot" pillar (described in ELECTRICAL ENGINEERING, Vol. I., p. 519). Succeeding sections deal with tramway poles and overhead material, noiseless paper pinions, electric welders (see ELECTRICAL ENGINEERING, Vol. I., p. 791), annealing furnaces, and hydraulic pumps. Particulars are also given of the Mordey-Fricker electrolytic prepayment meter, of which the company are the manufacturers, a considerable number of patterns of insulators for overhead lines are illustrated. Details are also given of all kinds of material and tools for overhead line construction. Other articles dealt with are mine exploders, golf balls, and telephone and telegraph apparatus. The second portion of the book commences with data required for the calculation of transmission systems, including well-arranged tables, formulæ, and graphic methods for ascertaining losses. A very full description is given of the Merz-Price patent protective gear, and the tables of the Engineering Standards Committee for insulation of cables are reproduced, together with very complete tables of copper conductor and wire gauges. A good deal of information regarding overhead lines and poles is given which is not found in the ordinary pocket-book. A few pages are devoted to suggestions on the best method of arranging apparatus and wiring a telephone exchange, and a digest of the new Patent Act (reprinted from ELECTRICAL ENGINEERING, September 19th, 1907), is given. The Institution wiring rules are also reprinted, and all the Board of Trade and Home Office Regulations affecting electrical engineering are given. A good deal is included that is not in the ordinary pocket-book, while much of the useless matter which is inserted into most pocket-books from a mistaken idea of completeness has been wisely omitted. The printing and binding are excellent, and a well-arranged index enhances the utility of the publication.

English Prices with French Equivalents. By H. P. McCartney. 95 pp. 4 ins. by 3 ins. (London: E. & F. N. Spon.) 1s.

THIS pocket-book consists entirely of a series of tables giving the equivalents in francs per 100 kilos of prices per lb. in English money. The rates per lb. advance by sixteenths of a penny up to one shilling, by farthings up to five shillings, by halfpennies up to ten shillings, and by pence up to one pound. Another column gives corresponding rates in £ s. d. per ton, and the equivalents in francs (gold) per 100 kilos are given in separate columns for seven different rates of exchange, varying from 25 to 25·30 francs per £. The tables should be of use to those preparing quotations for export.

Water Power Schemes in Japan.—According to the *Electrical World*, the first 60,000-volt hydro-electric plant in Japan has just been put into service, after having passed the rigid inspection which is required by the Japanese Government of all electrical installations. Power is obtained by impounding the Ugigawa, a narrow and swift but deep river, such as is often found in the mountainous portions of Japan. The normal rating of the main station, which is 18,000 kw., is furnished by six 3,000-kw., 50-cycle, 6,600-volt water-wheel-driven alternators. The generator voltage is stepped up to the line E.M.F. of 60,000 volts through three banks of three single-phase, water-cooled, 2,000-kw. transformers, at which potential energy is transmitted 25 miles to the Waseda sub-station just outside the city of Tokio. In this main sub-station water-cooled, 1,800-kw. transformers decrease the E.M.F. to 11,000 volts, at which potential energy is transmitted underground through lead-armoured cables to 11 distributing sub-stations situated in various parts of the city. In each of these smaller sub-stations oil-cooled transformers of 250-kw. rating reduce the E.M.F. to 2,000 volts, the line potential of the city circuits.

The Physical Society.—A dinner of the society was held on Tuesday last, the 11th inst., at the Hotel Cecil, London, when the chair was taken by the President, Prof. J. Perry, F.R.S. Those present included Sir David Gill, Sir William Ramsay, Sir William White, Sir J. Denison Pender, Rear-Admiral Sir H. B. Jackson, Sir Arthur W. Rücker, Sir Joseph Swan, Col. R. E. Crompton, Prof. W. G. Adams, Mr. Shelford Bidwell, Dr. C. Chree, Mr. W. Duddell, Prof. Carey Foster, Dr. R. T. Glazebrook, Prof. Reinold, Mr. J. Swinburne, Prof. S. P. Thompson, and Dr. W. Watson. Sir Arthur Rücker, in proposing the toast of "Our Guests," remarked that it was, perhaps, a little difficult to understand why all the guests that evening were not already Fellows of the Society. Sir David Gill, in responding, referred to the foremost position hitherto occupied by Great Britain in the world of physics, as shown by the honoured names of Faraday, Maxwell, Kelvin, and others, whose traditions were now being handed down by such men as Lord Rayleigh and Prof. J. J. Thomson. Sir William Ramsay, in responding to the same toast, dwelt on the relations of physics and chemistry. In response to the President, Prof. E. B. Rosa, of the National Bureau of Standards, Washington, expressed his pleasure at being present. He had been interested in visiting the National Physical Laboratory. At the National Bureau of Standards they were making satisfactory headway, and he hoped that the laboratory would shortly be equal to any national laboratory in the world. Sir William White, in proposing the toast of "The Physical Society," congratulated the Society on accomplishing so much in a comparatively short life. Physics was the basis of many of our societies, but however comprehensive a society might be, new societies sprang up from time to time, and individually we had to be content with a small corner of knowledge. In responding, the President dwelt on the importance of research. At the present day there were many science teachers and many compilers of books who did no research. They were well up in the letter of science, but not in the spirit thereof, with the result that their meetings lacked a most essential quality which could be gained only by actual research. Dr. Chree, the President elect, also responded to this toast, and in conclusion, the President proposed the health of the honorary secretaries, to which Mr. W. R. Cooper and Prof. W. Cassie responded.

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SCENE-SHIFTING BY ELECTRICITY

A NEW electrically-driven equipment has recently been installed at Wyndham's Theatre in connection with the scene-shifting arrangements for raising and lowering cloths, sky borders, curtains, &c. The device is an extremely simple one, and it is surprising that the idea was not worked out years ago. For the benefit of the uninitiated it may be explained that, with the exception of wings and heavy pieces of scenery, all scenes are "set" and "struck" from the "flies." The flies consist of two galleries running from the front to the back of the stage about on a level with the top of the proscenium, and it is possible to cross the stage at this giddy height by means of a narrow gangway. Men are prevented from falling off the flies on to the stage by means of a very substantial wooden railing, to which are attached the ropes for dealing with the cloths, &c. These ropes pass over pulleys secured to the gridiron, which, as its name implies, is a cross hatching of beams situated at a distance from the flies rather greater than the flies are above the stage. Hence the cloths are simply drawn straight up well out of sight of the audience. The drawing-up process, however, is not quite such a simple matter as would appear at first sight. Even on a small stage it requires at least three men to raise a cloth, and others have to preserve a sharp look-out to prevent the canvas catching on some projections and thus getting torn. Moreover, owing to the size of ropes which must be employed, there is not room for all the scenes to be set from one side, and it therefore becomes necessary to employ two gangs of men. Wire ropes cannot be employed for hand labour for obvious reasons. Now, it is a serious fact which has to be faced by the manager of a theatre that, so far as stage-hands are concerned, the load factor is an extremely poor one. Actually, in an ordinary three-act play, the stage-hand does not have a good half-hour's work to do, and, as a rule, he is paid half-a-crown for doing it. It is the aim of the new machine to remedy this state of affairs, and appearances are greatly in favour of its success. In the first place, the old hempen ropes will disappear and give place to wire. This, in itself, is an enormous advantage from the fire-risk point of view. Secondly, it will be possible to dispense with the services of at least ten stage-hands in the case of a small theatre like Wyndham's, while this number would be more than trebled at, say, Drury Lane. Further, it expedites the work.

One of the greatest difficulties in the employment of machinery on the stage is that of noise. In the present instance, this difficulty is overcome to such an extent as to make it negligible. Apart from the fact that the machine is practically noiseless, it is seldom employed except when the curtain is down, and, therefore, when the orchestra is playing and the audience talking. Even in the empty theatre the noise is almost inaudible from the front.

The machine itself is situated in the flies on the prompt side, and occupies nearly the entire length. Only a few inches from the floor of the gallery, and supported by iron brackets, is a shaft, 25 feet in length and $1\frac{1}{4}$ inches in diameter, with a key-way cut from end to end. This shaft is rope-driven by a Siemens 4 h.p. electric motor, and carries a number of split bevel gear wheels placed at suitable intervals. Above it and parallel with it is a counter-shaft of the same length and diameter, which can be driven from the main shaft when required through what is termed a "unit." Driving a friction clutch is a raw-hide bevel gear wheel, which engages with a split bevel on the main shaft. The other member of the clutch is fixed to a worm, and is also provided with a spring brake attachment, normally on when the clutch is not engaged. A further raw-hide gearing transmits the power to a sprocket, from which the counter-shaft is driven by a chain. Any number of winding drums can be keyed to this counter-shaft where required.

It is only when it is necessary to raise or lower two or more pieces of scenery at the same time that the counter-shaft is employed. When this is so, the drums are set, and the wire ropes are measured off to the correct length once and for all. It is then simply a matter of raising or lowering, and it will be observed that the relative positions of the pieces are invariable, which is far from being the case with manual labour. For single pieces of scenery a variety of the "unit" is adopted, the only difference being that instead of a chain wheel there is a winding drum, the driving being done, as before, directly from the main shaft. Each unit is provided with a lever which enables the operator to throw it into connection with the main shaft, and therefore wind up; or to disengage it and allow the piece of scenery to drop by its own weight; or, finally, to disengage it and hold it in position by the spring brake. This last-named is the normal condition of affairs. Thus it will be seen that while the machine is running scenery can be raised, lowered, or kept stationary, each winding drum being independent of all the others and of the counter-shaft. There is, of course, no reason why several counter-shafts should not be employed for use in different scenes, although only one has been installed at Wyndham's. Each unit is also provided with an automatic trip device to prevent over-winding. The motor is controlled by a Siemens iron-clad automatic starter, while an emergency switch is provided in close proximity to each unit, by which the motor may be stopped at any time. These emergency switches act upon the no-voltage release of the starter.

With these arrangements it is quite possible for a person standing in the prompt corner to set a scene in a few seconds without the slightest assistance from anyone in the flies. As a matter of fact, however, it has been decided to have the controller and levers in charge of a man in the flies.

In conclusion, we have to thank the management of Wyndham's Theatre for enabling our representative to inspect the machine, and Mr. H. Hipwell, chief engineer to Mr. Frank Curzon, for explaining many of the details. Mr. E. Lytton is the inventor of the apparatus.

Death from Accidental Shock.—An inquest was held at Manchester last Thursday on the death of an apprentice named F. T. Sherring, which occurred at the Westinghouse Works, Trafford Park, on Tuesday of last week. It appears that the deceased was at work in the insulation testing-room at a table a few yards away from the testing apparatus. He was seen to get up from his chair and stand watching the apparatus, when a sudden flash was noticed, and he fell over the barrier with which the high-tension apparatus is surrounded. It is thought that he must have brought his hand in close proximity with a wire forming part of the 25,000-volt circuit. A verdict of accidental death was returned, the jury adding that there ought to be some safeguard, either in the way of barriers or insulating materials, to prevent a recurrence of the accident.

Cadiz-Canaries Cable.—A British consular report states that the question of duplicating the existing Cadiz-Canaries cable has been receiving the attention of the Spanish Government. The existing cable, besides being a single line, is in an unsatisfactory condition, and is liable to constant breakdowns, when recourse has to be had to the somewhat circuitous Brest-Dakar route. Repairs were carried out in 1905 at a cost of £7,000, and it is thought that the cable cannot last more than a few years longer. A cable is now being laid between Palma, Majorca, and Barcelona. The question was recently raised in Congress of laying a cable between Cartagena and Oran, but it was pointed out that there already exists a cable from Almeria to Melilla and Chafarinas, now out of repair, which it would be more practical to extend to Nemours, thus putting Spain in communication with Algeria.

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WIRING BUSINESS IN CONJUNCTION WITH THE CENTRAL STATION

AT the present time, in spite of a good deal of controversy on the question, a large number of smaller central stations in this country are undertaking wiring work in conjunction with their electricity supply business. It is not proposed to discuss here whether this policy is wise or otherwise, but to point out that, if it is done, it is a branch of business which requires careful organisation and watching, and that the development of a system of dealing with consumers is essential and must be adhered to rigidly.

The work divides up into four main classes, consisting of new wiring work, repairs to existing wiring, wiring extensions to old work, and attention to consumers' complaints. Such a business, as will be here described when worked in conjunction with a central station, requires a wiring stores with a small but well-equipped show-room attached. This should be under the charge of a competent stores clerk, whose duties should consist of issuing stores to wiremen, keeping careful costs of the material issued to each job, attending to sales for cash over the counter, invoicing cash sales, taking in all consumers' reports and giving general information regarding wiring work to inquirers. The keeping of all other books, such as purchase ledgers, the invoicing of wiring installations, pricing, checking, stock books, &c., should be in the hands of the chief clerk of the station, in conjunction with the manager.

It is now necessary to discuss under the above-mentioned headings the organisation and running of this type of wiring business.

New Wiring Work.—As soon as a request comes in for an estimate, the leading wireman visits the house, takes particulars, including a rough sketch plan of the house, and makes out a list showing the rooms, the number of points, whether they are for pendants, brackets, or plugs, the number of switches required, &c. This leading wireman, by the bye, is not a walking wiring foreman, as such a man is a useless expense. From the particulars so obtained, a tender is made out in the usual way, and three typewritten copies of the list of fittings are prepared. One of these is sent with the tender, another is kept in the office for reference, and the third is given to the wireman who does the job. When the installation is complete, the wireman returns his copy of the list to the office, and marks on it any extra work or deviation of any kind from his original instructions, so that there can be no mistake when invoicing the job, as the invoice clerk can compare his copy with that of the wireman. This system of lists should be carried out even for adding or altering one single point. It entails very little work, and is an absolute check on the job being correctly invoiced. Moreover, it prevents any dispute arising with the consumer, because he also has his list of the work, the tender for which he has accepted.

Wiring Repairs.—Even in a small electricity supply system with only about 1,000 consumers connected, it is surprising what a quantity of detail is entailed by the branch of wiring business coming under the repairs heading. Where, however, free wiring work is done, an additional complication is the allocation of charges. The most simple system for this branch of the work is to have a counterfoil book with the counterfoil in exact duplicate. The storekeeper writes down the name and number of the job and the work to be done, then tears this out with the remaining two-thirds of the sheet left blank for particulars, which the wireman will fill in. The duplicated slip is, of course, retained in his book. The wireman, on completion of the job, fills in fully what he has done, and exactly what was the nature of the job. These sheets are then sent to the manager every day and he marks upon them an indication as to whether the job is a contract one or free wiring, and whether it is to be charged to the consumer or not. The slips are then handed into the office, and from them the invoices are made up, and the proper allocation of the job in the books is ensured. The chief use of these books is that an exact and correct report of the job is kept, so that the invoice clerk can make up the invoices, giving a correct and full detail of the job. He has not to refer to the storekeeper or any wireman to find out what has been done, and every job is properly allocated by the manager.

Extensions to Existing Installations.—The routine for this section is exactly the same as for new work, with the exception that, in the case of an extension to a free wiring job, the manager should inspect the premises himself, and decide whether it is advisable to go to any further capital expenditure in that particular case.

Consumers' Reports.—It will, perhaps, be astonishing to those central station men who have never had to run a wiring business in conjunction with their legitimate central station work to find how serious a matter these consumers' reports are, and how much attention they require. Out of 900 odd consumers, the average daily number that call with trivial complaints, or else in order to buy a few lamps, or otherwise to ask why the lighting in the cellar jumped at two minutes past eleven last Sunday, or for other equally foolish remarks, is, in the experience of the writer, 14. Taking 310 days in the year, this totals up to 3,400 petty matters occurring in one year, which require some small attention. The writer has found that the simplest way of dealing with the matter, and one that works admirably, is to keep a book, on the left-hand page of which is entered the consumers' name and address, to which is added his wish, or report, or grievance, or whatever it may be. As soon as this has been attended to, the storekeeper, who keeps this book, enters on the opposite page exactly what has been done. If a fuse has been blown, he enters it as having been repaired by so-and-so. If a meter is wrong, he enters it as reported to the meter department. If there is a bad light, he enters it as reported to the manager, and so on. It is found that this book entirely obviates any chance of small orders being overlooked, or of small repairs which cannot be effected at once being left undone or forgotten. In order to make this book completely effective, it must be left with the engineer-in-charge on the evening watch after the stores are closed for the night, and he should enter all reports or telephone messages relating to wiring that he receives during the evening, so that they are sure of proper attention next day by the wiring department.

A wiring business, although perhaps one of the most complicated and troublesome departments of electricity supply work, can, if run on something like the system outlined above, be worked quite easily and efficiently, and—most important point of all—satisfaction to the consumer with regard to his electricity supply can, to a large extent, be obtained by this means.

Overhead Telegraph Wires in London.—On Wednesday, the 12th inst., in the King's Bench Division of the High Court, Mr. Justice A. T. Lawrence, the Hon. A. C. Gathorne-Hardy, and Sir James Woodhouse, sitting as the Railway and Canal Commission, delivered judgment in the case of the Postmaster-General *v.* The Metropolitan Borough of Woolwich. (See ELECTRICAL ENGINEERING, February 6th, 1908, page 187.) The Commission unanimously decided both points raised in favour of the Postmaster-General, namely, that the wires should be attached to wooden poles and overhead in such parts of the borough as he desired.

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COMBINED ELECTRICITY WORKS AND DESTRUCTOR STATION AT GREENOCK

THE new combined electricity works and dust destructor at Greenock, the formal opening of which was notified in our last issue, shows a marked improvement over previous works of this class. A new method of charging the furnaces, introduced by the

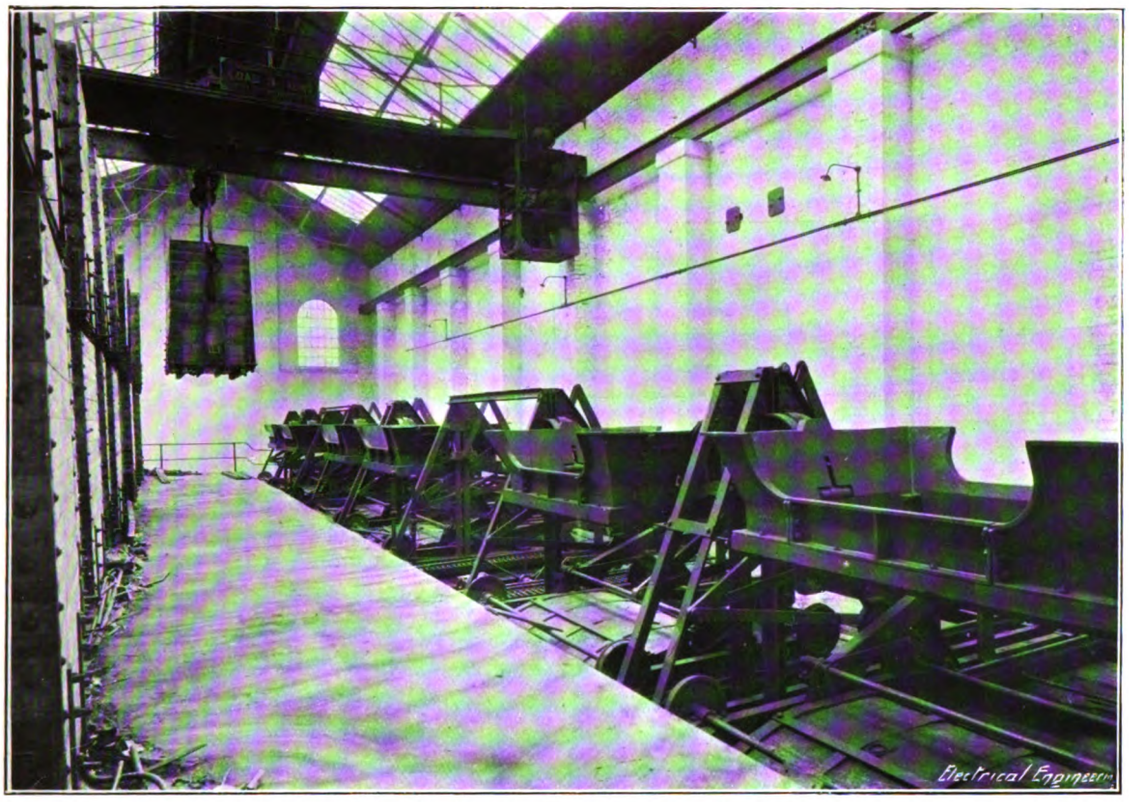


Fig. 1.—Top of the Destructor Furnaces.

Horsfall Destructor Co., Ltd., of Leeds, is made use of, by which all handling of the refuse at the works is rendered unnecessary, and the only extra manual work above that which is required in an ordinary electric power station is the "clinkering"—that is to say, the raking out from the furnaces of the solid products of combustion. An automatic method of performing this latter process has still to be devised.

On arrival at the works, the cart conveying the refuse passes on to a weighbridge, and thence is taken a few yards further to the tipping pit, which is at the same level as the boiler-house floor, and not above the furnaces, so that there is no long incline for the carts to be drawn up, as in some other destructor stations. At the tipping pit, the cart is emptied through a hopper, specially designed to prevent spilling, into a wooden tub, which is just sufficiently large to contain a cartful of refuse. One of these tubs is seen suspended from the travelling crane in Fig. 1, which is a view of the top of the destructor furnaces. A stock of these tubs is provided, and although in ordinary working it is probable that each will be emptied into the destructor furnace as soon as it is filled, they can be used to store the refuse so that their contents can be charged into the furnace as fuel is required. For storage purposes, the platform along the top of the furnaces, seen in Fig. 1, affords sufficient space for storing eighty tubs of refuse. The tub is a strongly-built square wooden box, open at the top, and with hinged lids at the bottom. Normally, these lids are held closed by the rods and hooks, from which the tub is suspended.

The tipping pit has accommodation for four tubs, and there are two filling hoppers arranged to move on rails across the pit, so that the hopper is slid away from the tub as soon as the latter has been filled. The tub is then lifted by the crane to the platform above the furnaces. The top of each furnace is normally closed by a charging door with a water-sealed

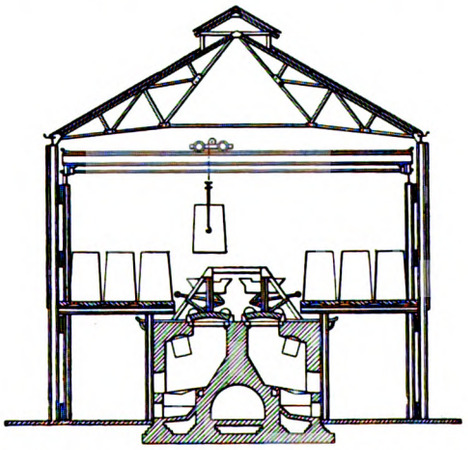


Fig. 2.—Sketch showing Destructor in Cross-section.

seat. As soon as the crane deposits the tub on the movable cradle-hopper above this, the weight of the tub causes this hopper to descend, and, in doing so, it actuates a system of levers and balance-weights, which cause the charging door to be lifted from its water-

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sealed seat, and pushed to one side, allowing the lower edge of the hopper to descend a very short distance through the charging hole of the furnace. As soon as this has taken place, the hinged lids at the bottom of the tub are automatically opened, and the refuse falls into the furnace. We were able to inspect a charge when we visited Greenock last week to see the new works, and were astonished at the ease, rapidity, and, above all, the cleanliness of the operation. The charging door of the furnace is only open for a few seconds, and the haze of dust usually associated with the conveyance of refuse into a destructor furnace was absent. The speed of charging has also a decided advantage from an economic point of view, as the inrush of cold air and consequent reduction of furnace temperature is reduced to a minimum. Fig. 2 is a sketch showing the destructor furnace in cross section, an idea of the shape of the charging hopper or cradle, and the small dimensions of the actual hole through which the refuse is charged into the furnace is given in Fig. 1, and these two illustrations will help to make the above description clear. The crane used for charging was supplied by Messrs. Broadbent & Sons, of Huddersfield.

Figs. 3 and 4 show the general arrangement of the works in plan and section. It is seen that the building is constructed in four bays. The first of these contains the destructor furnaces and clinkering floor, the second and third the destructor boilers and coal-fired boilers respectively, arranged with their fronts facing one another, and the fourth the engine-room. In this way the clinkering floor, where, of necessity, the atmosphere is laden with a certain amount of fine dust when clinkering is in progress, is at some considerable distance from the engine-room, so that no trouble should be experienced from this. There are six destructor cells, and the gases from them escape by the upper portion of the furnace arch into the combustion chamber at the back of the furnace, which communicates with the boilers. On their way to the boilers, the gases pass through a dust-catcher. Three boilers are fired by the destructor gases, one to each pair of destructor cells. In addition to these three boilers, independent coal-fired boilers are provided, for, as the load on the station increases, and the works are extended, the power furnished by the destructor will be only a small proportion of the total output.

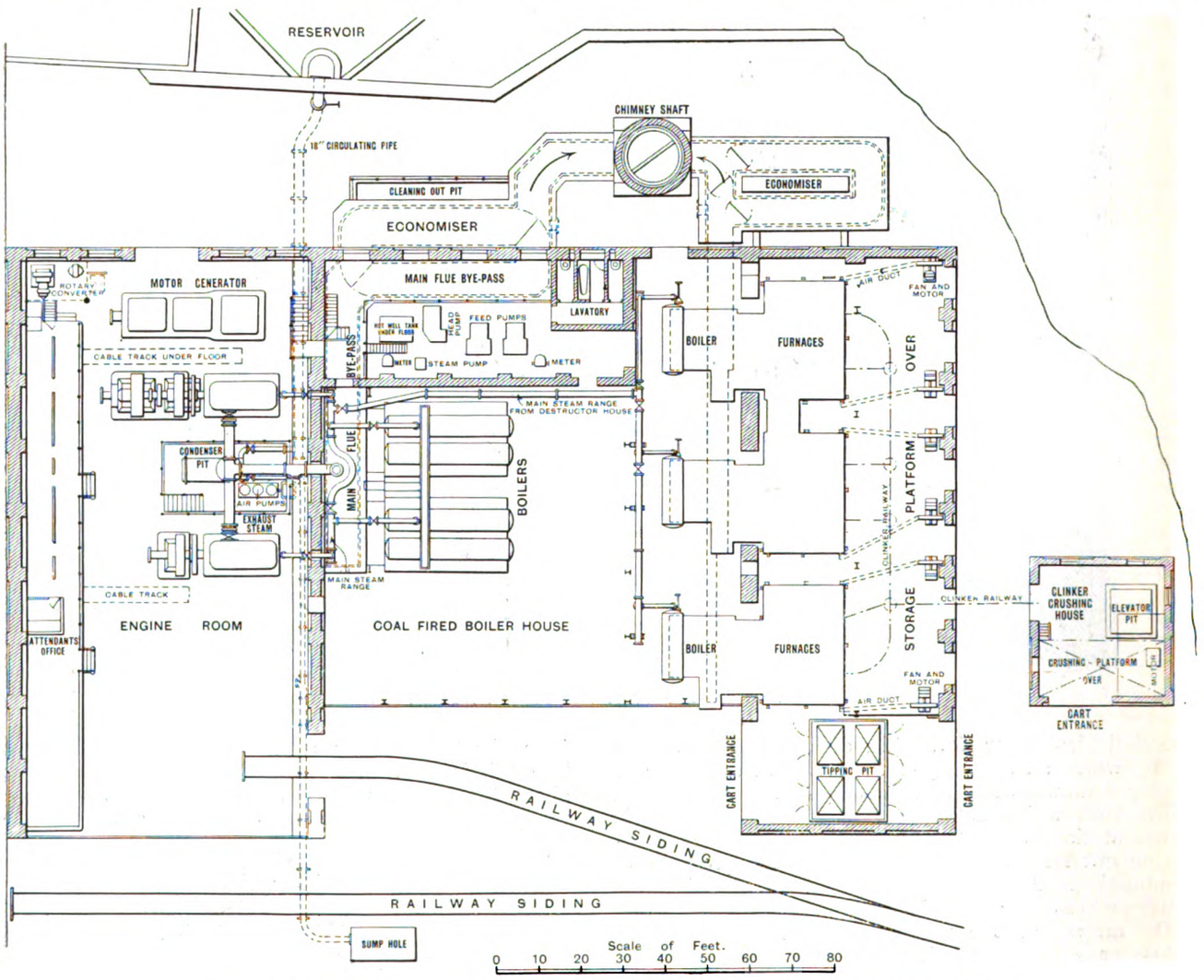


FIG. 3.—PLAN OF THE NEW GREENOCK COMBINED DESTRUCTOR AND ELECTRICITY WORKS.

A good view of the clinkering floor is shown in Fig. 5. As is seen, there is a large door in front of each cell, but two small inspection doors are also provided, through which the firemen can trim the furnace. The furnace grates slope from back to front to facilitate the breaking up and raking out of the clinker, which is often fairly hard. The grate bars are perforated with a number of small holes, and a blast of air at high pressure is forced through them by means of electrically-driven fans. These fans are driven by variable-speed totally-enclosed motors, made by the Phœnix Dynamo Manufacturing Co., Ltd., of Bradford, and the position of the starting and regulating switches, as well as one of the motors and fans, is clearly seen in Fig. 5. The use of a high-pressure

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blast instead of one at comparatively low pressure is an improvement on some of the older dust-destructors. Steam jets are also fitted to the furnaces, but are only intended as a standby in the event of the fan breaking down. A device is fitted by which the starting switch of the fan is released as soon as the furnace door is

All the flues are lined with firebrick, and in the furnaces specially made fireclay blocks are employed, set in fire-clay cement. The boilers are all of the Babcock & Wilcox marine type, rated at 200 lb. per sq. in. pressure, and they are fitted with superheaters to raise the temperature of the steam to 510° F. In the event

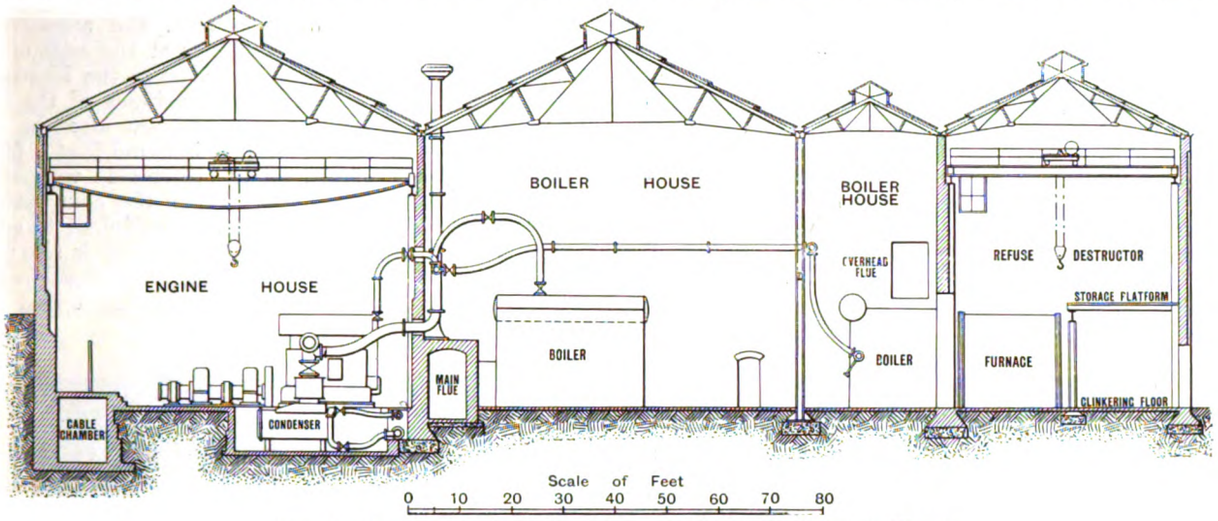


Fig. 4.—Cross Section of the New Greenock Electricity Works.

opened. The fans also serve to ventilate the clinkering floor, and clear the dust and fumes which are emitted when a furnace is being clinkered. This is done by carrying the fan inlets to the under side of the storage platform, and turning them inwards, so that the dust and fumes are drawn in by the fans, and delivered back

of a sudden demand for steam, the destructor boilers can be coal fired on auxiliary grates from the same stoking floor as the regular coal-fired boilers, but this would only be done in emergency, as the coal-fired boilers will be in regular use. The coal-fired boilers (each capable of evaporating 18,000 lb. of water per

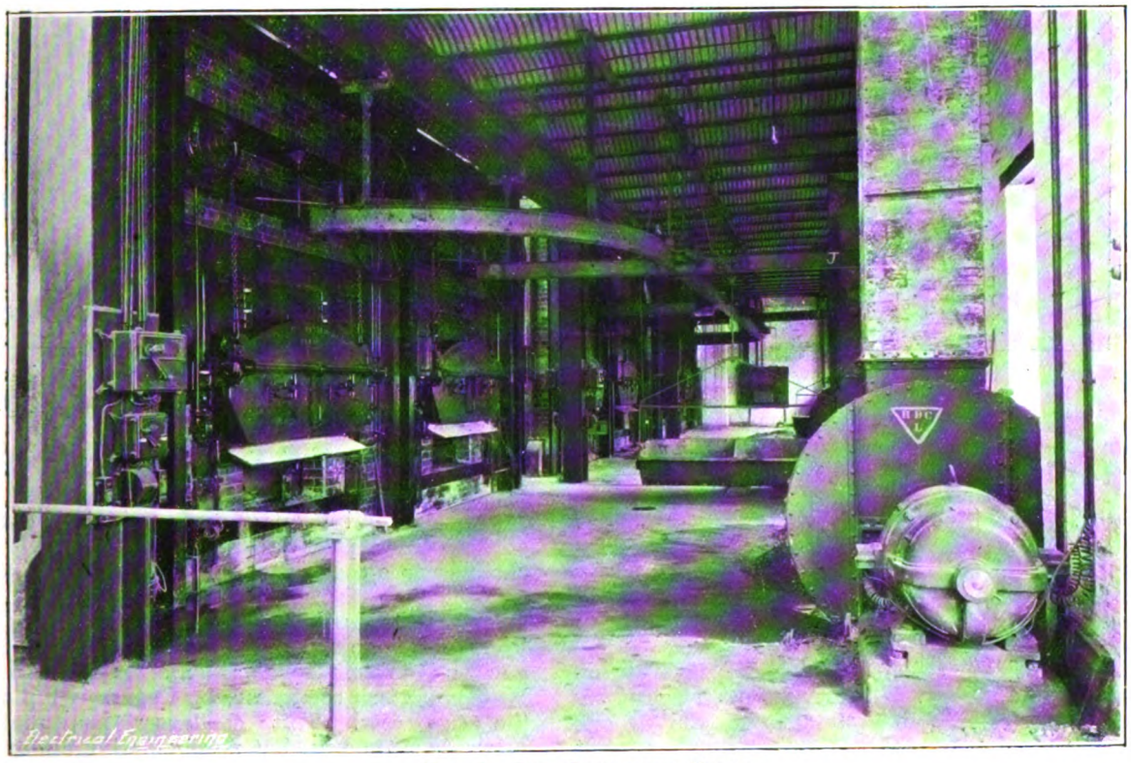


Fig. 5.—The Clinkering Floor.

to the furnaces. It is estimated that the time taken to cremate each cart-load of refuse will vary from one to one and a half hours. When the process is complete, the clinker is raked out into large buckets, suspended from the overhead railway seen in Fig. 5, and is either deposited in heaps, or may be delivered directly to a clinker crushing and screening mill.

hour) are fitted with Messrs. Babcock & Wilcox's most recent pattern of chain grate, which was described in our columns on December 19th last in connection with the new Derby electricity works. A bye-pass is provided from the destructor combustion chamber to the main overhead flue, so that, if a destructor boiler has to be put out of commission, the gases can be led

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directly to the flue. A Green's economiser with 120 tubes in two sections, and with the usual bye-pass, is also provided. The chimney is 15 ft. in height, and 10 ft. internal diameter.

Messrs. R. Aitkenhead & Sons, of Greenock, were contractors for the buildings and excavator work, Messrs. John M'Ewan & Co., of Greenock, supplied the steel work, and the carpenter work was done by Messrs. J. Miller & Co., also of Greenock.

The general arrangement of the steam pipes is seen in the plan and section (Figs. 3 and 4). Messrs. John Spencer & Co., of Wednesbury, supplied this part of the contract, as well as the feed piping. Each pair of destructor cells can be worked independently, and is connected to one boiler, and the steam from all the destructor boilers is led into a single 10-in. main, which is carried to the main steam range against the engine room, as is clearly seen in the plan, Fig. 3. The feed-piping for the destructor boilers is connected by a branch pipe to the system supplying the coal-fired boilers, in such a way that the former can either be fed through their own economiser or from the hot feed mains of the coal-fired boilers. Two electrically-driven Worthington feed-pumps and one Weir double-acting steam pump have been put in; with the exception of the latter, the auxiliaries in the station are all electrically driven. A storage tank of 12,000 gals. capacity is placed over the pump-room, and a Wright combined water-softening and de-oiling plant is employed to treat the feed water.

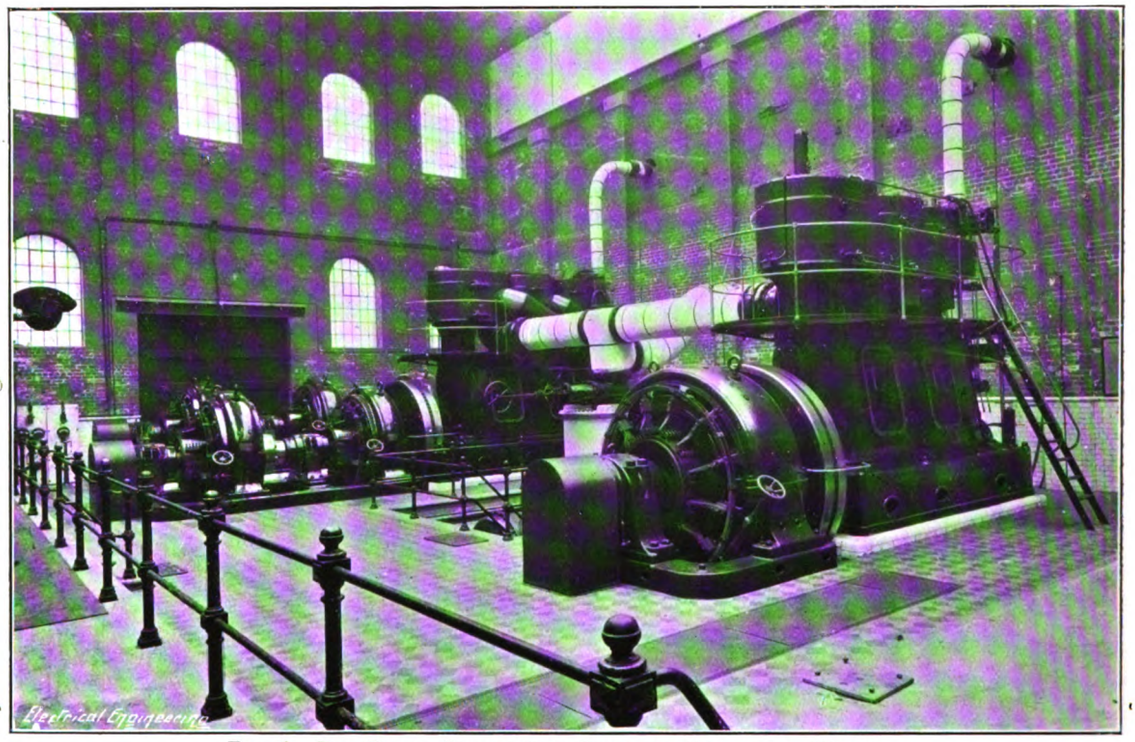


FIG. 6.—THE ENGINE ROOM: NEW GREENOCK ELECTRICITY WORKS.

In the engine-room (Fig. 6) are two Belliss-Westinghouse sets, one a 750-kw. machine, the other consisting of two 375-kw. generators in tandem, driven by one engine. The generators of this latter set supply current at 250 volts, while the 750-kw. machine generates at 500 volts. The use of so large a steam balancer is due to the fact that one of the large shipyards which is supplied from the station has 250-volt motors throughout, and when it was changed over to the Burgh mains, it was stipulated that supply should be given at this pressure through an independent feeder, and, if required, from a separate machine. At present, however, the feeder, which is three-wire, is connected to the general bus-bars. For the same reason, the spare plant takes the form of a large motor generator, consisting of a 750-kw., 500-volt, d.c. machine, coupled to two 375-kw., 250-volt, d.c. machines. The armature of the 750-kw. dynamo is interchangeable with that of the 750-kw. steam set, and the 375-kw. armatures of the second steam set and the motor generator are also interchangeable; in fact, the armatures of the steam set have half-couplings at the ends of their shafts, which are boxed in, as seen in the illustration. The fields of the two 375-kw. machines of the motor generator are cross-connected, as are also the fields of the double steam set, and it is found that a 60-h.p. motor can be switched on to either side without any serious variation in voltage. When the next extension is necessary, it will, of course, be sufficient to add an engine to the motor-generator set. There is also plenty of room on the site for several additional machines and boilers, and the building is at present closed by a temporary end.

The generators are 12-pole machines of the usual Westinghouse design. The Belliss engines are triple expansion; they govern on the throttle up to their full loads, and have automatic variable expansion for overloads. A small Worthington pump is fitted on the engine, which pumps oil from the top of the crank chamber to a cooling tank, where it is cooled by pipes connected to the circulating water system, and returned to the crank chamber at a temperature reduced from 130° F. to 95° F. The exhaust steam from both engines is taken through an oil separator to a Mirrlees-Watson surface condenser, in a condenser pit between the two sets. This condenser has motor-driven Edwards air-pumps, but no circulating pump is necessary. Water for condensing is obtained from the town's aqueducts, which bring water down from a lake on a hill above the town for use in several works.

In addition to the sets already mentioned, two small rotary converters with static transformers have been put in to raise the pressure to 3,300 volts three-phase for supply to a hospital about two and a quarter miles distant. These machines take current from the d.c. bus-bars, and, of course, act as "inverted" rotaries.

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The larger of the two sets is rated at 75 kw., and has a booster on the same shaft for voltage regulation. The smaller set is a 25-kw. machine. At the far end the current is converted to two-phase by transformers with the Scott connection, and the hospital is supplied by the two circuits so far as lighting is concerned, and two-phase for a hoist motor, &c.

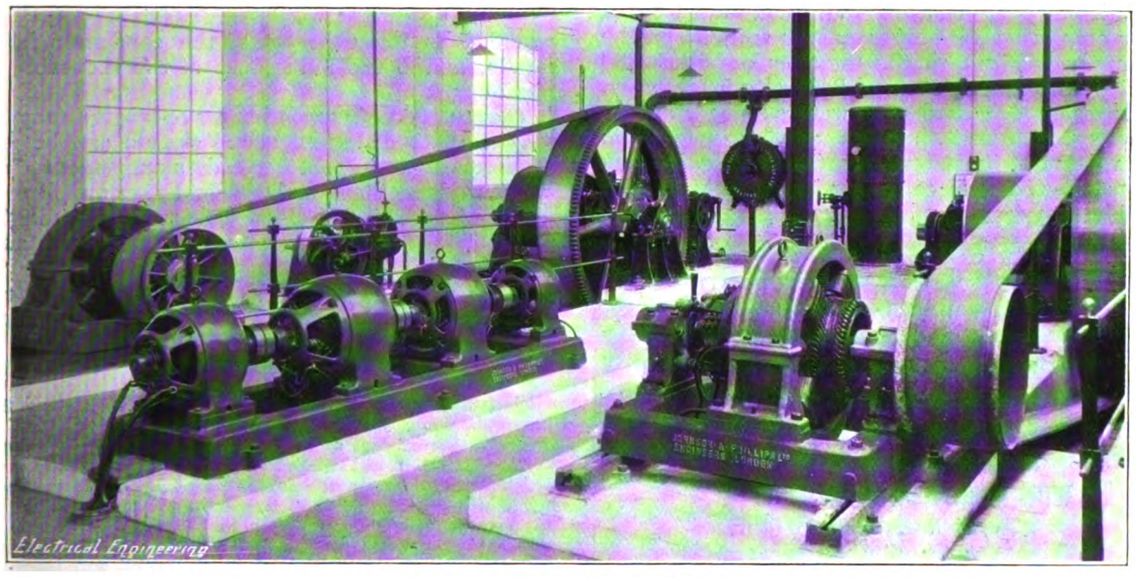
The main switchboard is of Westinghouse make. It is on a platform two feet above the engine-room floor. One of the noticeable features is the large number of Aron energy meters on its twelve panels, for metering the current supplied to large power consumers through separate feeders, and another is that the bus-bars (which are in duplicate) are raised on brackets at the back of the board on a level with the top. This makes the back connections easily accessible. The feeders are vulcanised bitumen cables, and come direct to the back of the board, but the machine cables are fireproof.

The conditions at Greenock that rendered necessary the building of a new electricity works were the not unusual ones that the load had increased to such an extent that the capacity of the old works was fully taken up, and there was no space available for the addition of new plant. In addition to a lighting and tramway load, there is a large power load in Greenock; motors aggregating between 4,000 and 5,000 h.p. are connected to the mains. The old station has a plant capacity of about 2,000 kw., divided over eight sets. The new works will eventually be by far the larger of the two. At present it takes a great part of the power load, much of which is supplied to shipyard and other works in close proximity, and assists during the lighting peak. The largest consumer is Caird's shipbuilding yard, in which about 1,300 h.p. is installed, and to which current is supplied at a flat rate of 1d. per unit. The compressers and hydraulic pumps are driven by motors fitted with automatic starters, and lighting also represents a fair proportion of the total consumption in this yard. On a P. & O. liner that is now being built there, about 700 lamps are being used.

The total energy output of the Greenock electricity works has risen from 158,000 units in 1899-1900 to just under 3,000,000 in 1907, about one-third of which is for traction. Treasurer N. M. Brown is Convener of the Electricity Committee, and Councillor J. W. Bennett, Convener of the Destructor Committee. Mr. J. G. Hare, of the Electricity Department, was Architect for the new buildings, and Messrs. Woodrow & Thomson, of Greenock, Measurers and Surveyors. The whole of the work in connection with the combined scheme was carried out to the specification of Mr. J. A. Robertson, Consulting and Resident Engineer to the Greenock Corporation, and we owe him our thanks for showing us the plant and providing us with drawings and other data. To Mr. Parker, his chief assistant, we are indebted for some excellent photographs, a selection of which have been used to illustrate this article.

ELECTRIC POWER AT THE FIRST GARDEN CITY

DESPITE the fact that the First Garden City Company had a gas supply in existence at Letchworth, it was decided some eighteen months ago, in consequence of the demand for electric power, to build an electric generating station and lay distributing cables. The plant consists of two gas-driven dynamos, balancers, boosters, battery, &c., and has recently been completed. The dynamos at the generating station are belt driven by two horizontal gas engines, each rated at 100 b.h.p., and are supplied with gas from two suction-gas plants, designed for working with anthracite fuel. There is also an arrangement of town gas connections, so that the engines may be worked either with town or producer gas, and the pipework has been arranged so that the engines can be supplied with producer gas from either of the two suction plants. A view of the engine-room is given below. One of the leading features in the design of the engines is the construction of the bedplate, which is extended underneath the cylinder to the extreme end of the working stroke of the piston, which is claimed to give more perfect support to the piston than is possible when the cylinder overhangs. The engines are provided with balanced cranks, and an automatic lubricating arrangement is fitted to the crank pin so that the engine may be able to run continuously. The engines, which are each provided with a geared barring arrangement so that one man is easily capable of turning the engine into a starting position, are started by means of compressed air contained in a mild steel receiver. A small town gas engine and single-acting compressor are provided to obtain the necessary store of



Interior of the Power Station.

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air under a pressure of about 150 to 180 lbs. per square inch. The air receiver is of large capacity, and has a sufficient store of air to start the engine several times in succession. The gas plants are of special design, so as to enable continuous runs to be made. They are provided with a water-motor fan for assistance in starting up, thus doing away with the necessity for having one attendant to operate the fan while the plant is being set to work. Each gas plant is provided with two coke scrubbers of large capacity. The dynamos, of Messrs. Johnson & Phillips's standard design, are each of 65 kw. capacity at 500-550 volts, 60 r.p.m. The booster balancer set consists of four machines coupled together on one bedplate. The two balancers mounted in the middle are capable—when not driving the boosters—of dealing with an out-of-balance load of 80 amps. The machines are cross compound wound, so that the E.M.F. on the overloaded side is automatically increased by one volt for every 10 amps. out-of-balance. The battery charging boosters give 50 amps. at any voltage from 2–90. The three-wire switchboard consists of panels to control the two dynamos, balancers, boosters, battery, two feeders, with the usual B.O.T. earth panel. The battery is of the D.P. type, and consists of 260 cells of the L type capable of giving a discharge of 30 amperes for 10 hours, with a final voltage of 1·85 per cell. The cells are in glass boxes mounted on insulators and trays in the ordinary way. The plates are of the D.P. standard pattern, the positives being the heavy cast plant type with D.P. special formation, and are separated by three rows of glass tubes held in position both at the top and bottom of the cells. The battery is erected on strong double-tier wood stands, coated with anti-sulphuric enamel, the stands being fitted together without any metal fastenings. The cables used in the generating station are V.I.R. insulated, the battery regulating cells cable connections having an additional lead covering to protect them. One feeder has up to the present been installed with distributors to the various factories. The cables are triple concentric paper-insulated and lead-covered, laid in wooden troughing on earthenware bridge pieces and covered by tiles. Supply is given to the factories at either 480 volts or 240 volts for power, and 240 volts for lighting. Service boxes of the usual type were supplied, and in each factory a cut-out, switch, supply meter and maximum demand indicator were fixed. The tenders for this installation were called for in December, 1906, to a specification drawn up by the consulting engineers, Messrs. O'Gorman and Cozens-Hardy, and, with the exception of the buildings, the whole contract was placed with Messrs. Johnson & Phillips (Limited), Charlton, Kent, who sublet the gas engines and suction plants to the Campbell Gas Engine Company, and the battery of accumulators to the D.P. Battery Company (Limited).

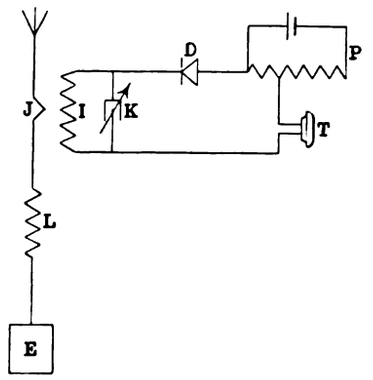
THE MEASUREMENT OF WAVE-LENGTHS IN WIRELESS TELEGRAPHY

By C. C. Monckton

WITH the near approach of the international control of radio-telegraphy, the standardisation of wave-meters has become a matter of considerable importance. Standard international inductances and capacities are required, for, with these fixed, the true principal wave-length of a station can easily be ascertained.

That considerable accuracy is necessary may be judged from the fact that, with a fleet of ships, it may be found convenient to employ different sending-waves from each ship, and receive diplex from any two with waves differing only two per cent. in frequency. It would appear probable that the existing standards are not widely different, as the writer recently measured the wave-lengths of several ships about 50 miles distant, and he was afterwards informed that his measurements were within half per cent. of those taken on the ships with standard inductances and capacities of another nation.

The writer used an arrangement for measuring the wave-lengths of the receiving circuits, which he does not think has previously been published. In the diagram, J is a single turn of inductance in the aerial circuit, and I is a coil of standard inductance, its distance from J being capable of variation. K is a standard variable air condenser, D a detector, P a potentiometer arrangement, and T a telephone receiver. The two re-



ceiving circuits are brought into tune by varying the inductance L and the capacity K. The coil I is then moved away from J till the sound in the telephone receiver is just audible; it will then be found that, when the circuits are in good tune with the sending station, if the capacity is altered in the slightest degree either way, the sound in the telephone receiver is lost.

The wave-length λ can then be calculated from the formula:

$$\lambda = 60{,}000\sqrt{CL},$$

where C is the capacity of the condenser in microfarads, and L the inductance of the moveable coil in millihenrys.

This method of measuring wave-lengths may be employed up to distances where signals can be received satisfactorily. In the actual arrangement used, a standard inductance and air condenser supplied by the Lodge-Muirhead Wireless Telegraph Syndicate was used. Two forms of detector were employed, and both were found equally satisfactory, the lead peroxide detector of Brown made by the Cambridge Scientific Instrument Co., and a microphonic carbon-steel detector made by Mr. H. W. Sullivan.

Electrification of Suburban Lines in Paris.—In alluding to the proposals made by the Western Railway of France for the electrification of part of its suburban lines, the *Railway Gazette* states that the object chiefly aimed at is to relieve the six tracks, which form the approach to the Saint Lazare terminus, of the heavy suburban traffic they now have to carry. It is proposed to have a new station under the existing terminus, with a separate approach from the Cour du Rome. The electric lines will start on the left of the existing tracks, will burrow under the Versailles lines and cross them again on viaduct, so as to allow them free communication with the Batignolles goods yard. At Asnières the electric lines will divide into two independent branches, one for Saint Germain and the other for Argenteuil. The Saint Germain and Argenteuil lines together carry about 12,000 passengers per hour during the rush hours under existing conditions, and the company hopes to double this carrying capacity with electric traction, by running 20 to 24 trains an hour during those periods. It is expected that the journey-time Paris-Saint Germain will be reduced from 44 to 23 minutes, and Paris-Argenteuil from 25 to 11 minutes, and there is some idea of refusing to carry luggage and parcels during the morning and evening rush hours. The total cost of the improvements contemplated by the company is estimated at £2,480,000, including £320,000 for a generating station.

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STEEL-TOWER TRANSMISSION LINE CONSTRUCTION IN SWEDEN

A POWER transmission installation having some features of especial interest is described in *Elektrische Kraftbetriebe u Bahnen*. The installation supplies power to the town of Westervik, in the south-east of Sweden. Power is generated three-phase, at a pressure of 10,000 volts, and is transmitted at that pressure by an overhead line to the transformer and converter stations at Westervik. The power station is situated

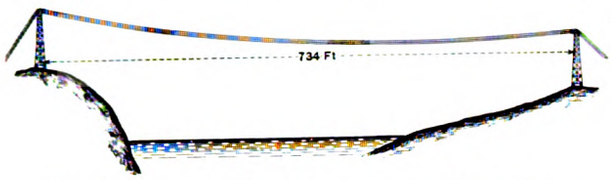


Fig. 1.—General Proportions of the Long Span.

at Tofvehult, some 14·5 km. (nine miles) distant from Westervik. The plant is to consist of three units, two of 325 h.p. each, and one of 650 h.p. The first two only are at present installed. On account of the natural canal formation at the falls where the power station is situated, the total cost of the constructional work and buildings (exclusive of machinery) works out at only £5·6 per kw. installed.

The two water-turbines, which run at 250 revolutions per minute, showed on full load test an efficiency of 81 per cent., and, on suddenly taking off the load, the observed change in speed was only 6 per cent. The direct-coupled generators are rated at 285 K.V.A. each, and generate direct at 10,000 volts. The former-wound coils of the stators are insulated with oiled linen and painted with black insulating varnish. In order to conduct away any static charge on the high-pressure line, each phase is connected to earth, at the power station, through a column of running water; on account of the high specific resistance of water, the current leaking to earth through this column is only 0·036 amps. per phase.

Half-way between Tofvehult and Westervik there is a deep inlet of the sea. To carry the transmission line round this would have increased the length from 14·5 to 20·5 km., and consequently it was decided to carry the line straight across the inlet.

Steel towers of special construction have been erected on either side of the inlet, the span between them being 735 ft. The towers are 70 ft. high, and the minimum height of the cable over the water is 130 ft. These proportions are shown in Fig. 1. The conductors for this portion of the line are of stranded steel wire of 60 sq. mm. (0·093 sq. in.) in section, corresponding to copper wires of 7 sq. mm. section. There are four conductors, three in use, and one as reserve. The mechanical construction of the towers is shown in Fig. 2. Each tower has four brackets, two on either side, which carry the insulating supports for the cables. One of these supports is shown in detail in Fig. 3. It consists of an oak block resting on six high-tension porcelain insulators. The insulators, the iron pins of which are fixed to the bracket, are cemented into the oak block. The upper surface of the block is protected from the rain by a thin zinc covering. In order that any mechanical tension in the cables shall not be transferred to the tower structure, the former are not rigidly fixed to the structure, but are supported on rollers, as is seen in Fig. 3. The flanged rollers rest on a cast-iron plate fixed to the oak block, and on these rollers rests the saddle to which the cable is fixed by means of five clamps. The cable is anchored beyond the points of support, at both ends of the span, and consequently the supporting saddle cannot roll off the bracket. Any movement sideways is prevented by the flanges on the rollers.

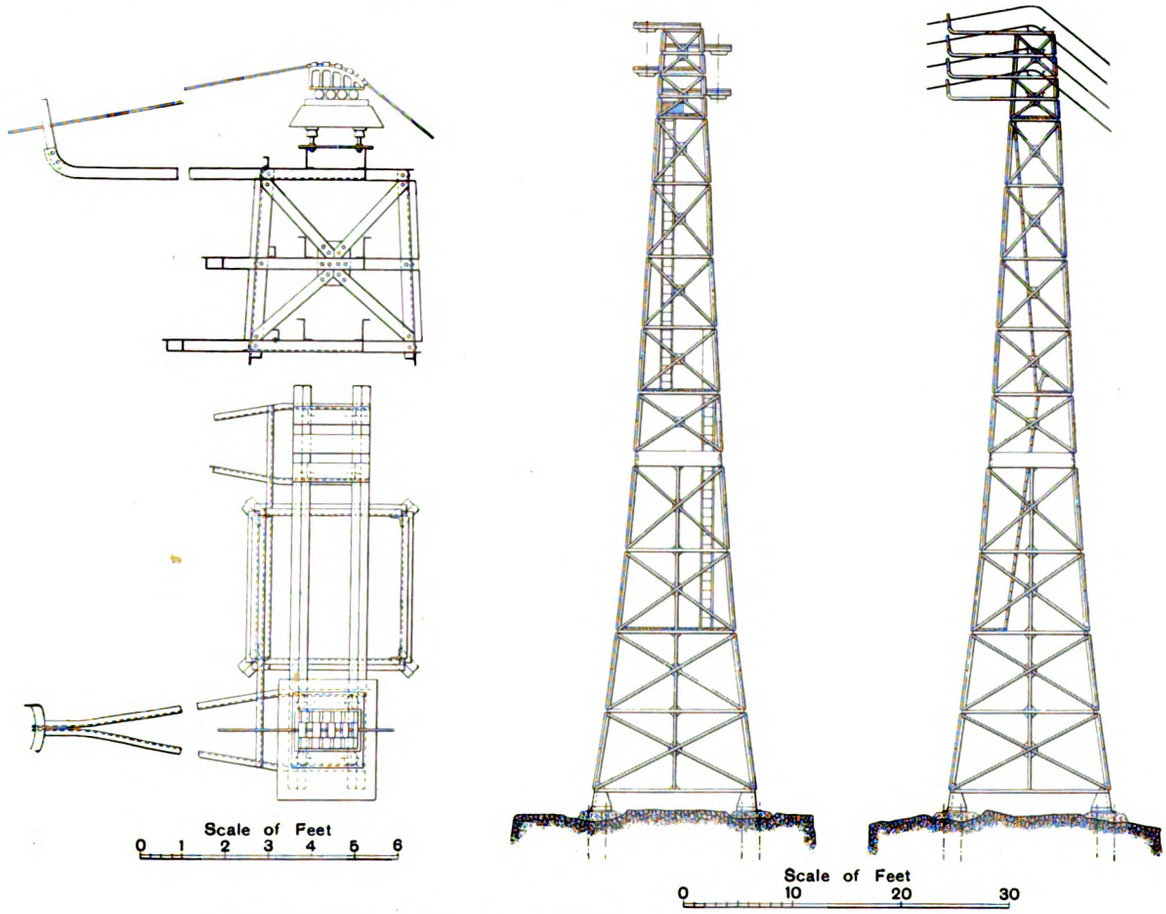


Fig. 2.—Details of Construction of Special Towers for the Long Span.

The tension in the cable at a temperature of −30° C., amounts to 600 kg. (1,320 lb.) between the towers, and 750 kg. (1,650 lb.) between towers and anchors. The maximum tensile stress in the cable is thus 12·5 kg. per sq. mm. (17,800 lb. per sq. in.), which provides a safety factor of 5. At +30° C., the maximum sag is about 30 ft. There is, however, no danger of the cables touching one another, as they are supported at different heights, and 6·5 ft. apart.

It has been noticed that the cables do not swing in the wind,

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but take up a constant position out of the vertical, remaining relatively at the same distance apart.

A difficult part of the construction was the anchoring of the cables on either side of the span. The cables had not only to be mechanically anchored, but also electrically insulated from earth. The insulators must therefore be able to withstand the mechanical tension of 750 kg., and the electrical pressure of 6,000 volts to earth. Two insulators, each consisting of a porcelain core under compression between iron straps, are connected in series. A thin layer of lead is placed between the iron and porcelain surfaces. The whole is surrounded with a zinc mantle to protect from the rain and mist. The remaining portion of the overhead line on either side of the long span is of the usual construction. The high-tension cables are strung spirally, making a complete revolution every 1·8 miles. A telephone line, also strung spirally, is supported on ordinary insulators below the high-tension line; across the inlet, however, an insulated cable is used.

In the transformer house at Westervik, the three-phase current is transformed from 10,000 volts to 500 volts, for the use of the factories, and some of the power is transmitted by underground cable at 3,000 volts to the converter house, where it is trans-

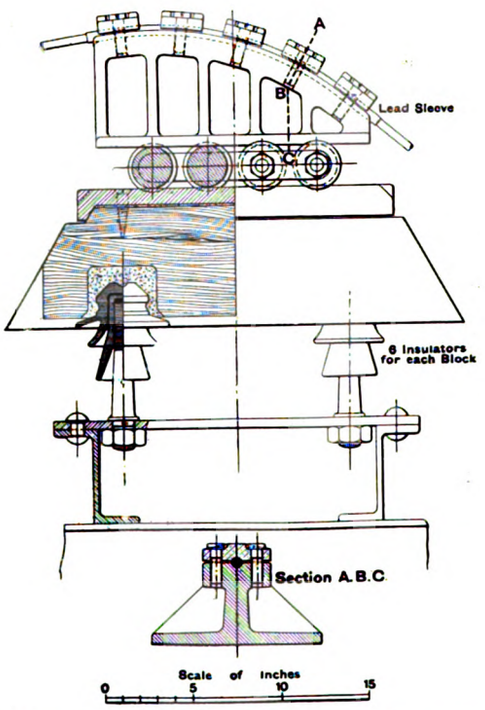


FIG. 3.—SADDLE AND INSULATED SUPPORTING BLOCK FOR STEEL CABLE.

formed to continuous-current at 2×110 volts, by means of motor generators. This station contains at present two motor-generator sets, an accumulator battery, and, as a reserve, the steam-driven generating sets, which were formerly used to supply the town. The following figures for the capital cost of the power station and high-tension line are of interest:—

Hydraulic works and buildings (for maximum 1,300 h.p.)	£5,450
Two water turbines for 325 h.p., 250 r.p.m. each, and two for 45 h.p., 600 r.p.m. each	1,000
Two generators for 285 K.V.A., 250 r.p.m. each, and two 30 kw., 600 r.p.m. each	1,075
Apparatus and Instruments	400
Total	£7,925
Total cost of the high-tension line, including cables, towers, and foundations	£2,300
Total cost	£10,225

The above costs include only the machines at present installed, viz., two for 325 h.p. each. The total cost of the complete power station would be about £9,600, or, taking the value of the maximum output at 880 kw., some £11 per kw. installed. The plans of the installation were prepared by the firm of David Bergman, Stockholm, and the electrical constructional work was carried out by the "Elektriska Aktiebolaget Holmia," Stockholm.

APPLICATIONS OF ELECTRICITY IN SPAIN

THE Commercial Attaché to H.M. Embassy at Madrid, Mr. S. P. Cockerell, in a long report upon the trade and commerce of Spain for the year 1906, has a good deal to say upon electrical and allied matters. The report also contains an appendix, which has been prepared by Mr. Vice-Consul Jackson, who has had a long experience of electrical engineering work in Spain. Mr. Jackson states that the development of the electrical industry is a striking feature of Spanish industrial history in the last decade, but it is regrettable to find that German, Swiss, French, American, and Belgian firms have been almost entirely responsible for this advance; indeed, it may be said that British electrical machinery is almost unknown there. The suggestion is made that it would be advantageous for the British electrical trade if the Institution of Electrical Engineers, or some representative combination of British manufacturers, took steps to have an investigation made into the openings which this country affords.

The number of power stations at the present time is put at 1,165, of which 692 are continuous current, and have an output of 47,533 kw.; 232 are single-phase, and have an output of 15,673 kw.; 70 work upon the two-phase system, and have an output of 7,213 kw.; 137 are three-phase stations with an output of 25,089 kw.; and the remaining 21 are classed as "mixed" stations, and have an output of 6,440 kw. The following list gives the most important towns having electric tramway services, together with the length of line in kilometres: Madrid, 50; Barcelona, 25; Bilbao, 25; Valencia, 20; San Sebastian, 20; Seville, 16; Zaragosa, 11. In the above-mentioned towns there is only one essentially British company, viz., the Seville Tramway Co., Ltd., whose capital, as well as its technical and commercial staffs, are British. In addition to the granting of a large number of tramway concessions during the year, the tram services in the following towns have been changed from animal to electric traction during 1906: Granada, Santander, Zaragosa, Bilbao, and Murcia. The majority of these systems have been constructed by German, Swiss, or United States firms. The report states that most of the tramway undertakings in Spain are worked upon the basis of hydraulic power, generating alternating currents, conversion to continuous current being by means of motor generators. The use of rotary converters is practically unknown in Spain.

With regard to electric lighting, most Spanish towns of any importance have a fair service of public and private electric lighting, but business in this line is not by a long way yet exhausted, as many of the existing installations are deficient, and could easily be reformed, or competition could be effected under favourable conditions. Leaving on one side the question of competition, however, there is still much to be done by way of electric lighting for smaller towns and villages. There are in Spain some 400 towns and villages of over 4,000 inhabitants, where there are no electric power stations.

The electrical material and machinery market is almost exclusively in the hands of Germany, Switzerland, France, the United States, and Belgium. One reason for this is the careful study which these countries have made of the requirements of Spain, and the influx of their capital in the electrical business. Recently there has been an increase in the construction of electrical fittings and machinery in Spain, and, with the protective tariff which came into force in July, 1906, this new industry may yet develop into an important one, though it will always be dependent on the foreign manufacturers, especially German, Belgian, and French firms, as these concerns are principally formed with foreign capital. The United Kingdom, as has already been mentioned, has turned some attention to mining undertakings in Spain. It seems a great mistake, says the report, that British financiers have not taken up Spanish electrical enterprises. There is still a vast field to be exploited, and it should not be allowed to remain in the hands of foreign financiers.

On examining the list of towns and villages which are not yet lit by electricity, it is seen that the north-west region of Spain (Galicia) is almost devoid of electricity. This district is rich in minerals, the country is very fertile, and has the advantage of being near the seaboard, with many good ports.

Street Box Construction.—In July last the County of London Electric Supply Co. was summoned by the Holborn Borough Council for having constructed a street box in Leather Lane, Holborn, without giving notice to the District Surveyor under the London Building Act, 1894. The contention of the company was that the box in question, which was only 32 cubic ft. in dimension, was not a "structure" within the meaning of the Act, and that, therefore, they were not bound to give notice. The stipendary magistrate, however, decided against the company, and fined them forty shillings and ten guineas costs, at the same time expressing his willingness to state a case (ELECTRICAL ENGINEERING, Vol. II., p. 142). The case came before the Lord Chief Justice, Mr. Justice A. T. Lawrence, and Mr. Justice Sutton sitting as a divisional court of the King's bench division on Wednesday last week when the decision of the magistrate was upheld.

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PROTECTIVE DEVICES FOR HIGH-TENSION CIRCUITS

DISCUSSION IN DUBLIN.

MR. J. S. PECK'S Paper on protective devices for high-tension circuits, the discussions upon which at Manchester and in London were reported in our last issue, was further discussed last Thursday before the Dublin Local Section of the Institution of Electrical Engineers. In the Paper, which has already been given at some length in ELECTRICAL ENGINEERING (February 6th, page 201), the author considered the nature of the "static" strains produced by lightning, switching, grounding or by any occurrence which causes an abrupt change in static potential, which may appear as high pressure to earth or between wires, or as a concentration of potential upon a portion of the circuit. To relieve the high pressure between line and ground or between wires, lightning arresters are used. To protect apparatus from concentration of potential, choke coils may be placed in series with the apparatus to be protected. Lightning arresters usually consist of an air-gap in series with a current limiting and an arc suppressing device. Four types of lightning arresters are in general use—the horn, the multi-gap, the water-jet, and the electrolytic. The electrolytic is the last type to enter the commercial field, and while the time it has been in active service is short, the author considered that there were indications that it would afford greater protection than any other arrester yet produced.

The Chairman (Mr. T. TOMLINSON), in declaring the Paper open for discussion, mentioned that Mr. Peck had come to Dublin specially to read his Paper. Mr. Tomlinson said that the lightning arresters described in the Paper were really a kind of safety valve, and cited as an analagous case a certain form of mechanical stoker, which had at times been known to jamb, with the result that owing to the large amount of power behind, something had to go, and the makers therefore inserted an intentionally weak pin in one of the pawls, which, whenever the machine jambed, broke, preventing greater damage.

Mr. W. TATLOW mentioned he had received a letter from Prof. Thrift, regretting his inability to be present. Mr. Tatlow thought the author had given an exceedingly lucid explanation regarding the rise of potential between adjacent turns of transformer coils at the instant of switching on. He asked whether the overhead earthed line which was usually erected was being superseded in favour of arresters. He would also be glad to know whether the choke coil inserted between the line and transformer was kept permanently in circuit, or only used for switching operations; if the former, he imagined there would be a good deal of loss entailed. He would further like to know whether the horn type of arrester was not liable to set up oscillations when it operated. It appeared that the Wurts type arrester was only applicable to alternating circuits, therefore, he presumed that it was necessary in the case of direct-current circuits to use either the horn or electrolytic type. He would be glad to know what was the solution used in electrolytic arresters, because he found that with the Nodon valve, in which phosphate of ammonia was used, the aluminium plates were attacked, and he had found that with tungstate of soda the film took a good deal of breaking down.

Mr. A. T. KINSEY thought that telegraph and telephone engineers in adopting the devices described by the author often created the troubles they were trying to avoid. It was now standard practice to earth every pole and arm, so that if a rise of pressure should occur on any section of the line, the current could get to earth immediately, without traversing any length of line, which helped them very considerably, and he had known cases where cattle had been killed at the foot of the poles while the wire remained intact. Mr. Kinsey was rather surprised that the author had not said one word about the fuses used in connection with spark-gap arresters; sometimes these fuses scattered over miles, and miles of line would be blown, causing serious inconvenience: also, he frequently found that in the case of the little spark gaps, consisting of glass tubes with platinum points, that when a spark passed the platinum got deposited the glass, establishing a permanent connection. Regarding transformer breakdowns, they used small transformers in connection with superimposed telephone circuits, and he had had many breakdowns occur between windings. Further, he could fully endorse the author's statement as to the troubles likely to follow the use of circuits, partly overhead, and partly underground, and he had in many cases found the lead covering burned at the points where the underground joined the overhead system.

Mr. G. MARSHALL HARRISS suggested that there was no actual necessity for the use of such devices in this country. He had, however, had some little trouble due to lightning, and was pleased to say how well the Wurts arrester worked; he had stood and watched it act during a thunderstorm, when it responded to almost every flash. He was of opinion that there was no apparatus able to deal with a direct stroke of lightning; if a pole was struck it was immediately splintered into matchwood, and no device could prevent that. Prof. Forbes had once suggested to him that if the line was taken one complete turn round the building, it would probably (owing to the choking effect of even one turn at so high a frequency), prevent the charge entering the buildings and reaching the transformers or machines.

Mr. R. N. TWEEDY mentioned that in tramway work it was generally the custom to insert a choking coil between the busbars and the incoming line, and he considered that the freedom from damage due to lightning was largely due to chokers and the arresters also installed. Mr. Tweedy mentioned that from his experience any arresters having moving parts were entirely useless under severe conditions. He would like the author to inform them as to the steps taken in America to safeguard people who walked under the high-tension transmission lines, as judging from the illustrations shown by the author, there was a distinct element of danger. In England the Board of Trade insist upon elaborate earthed cradles.

Mr. KETTLE (Dublin Corporation Electricity Department), said that many engineers had had painful experience of the destructive effects of pressure surges which occurred on switching in high-tension induction motors and transformers. The resultant breakdowns invariably took place between the individual wires of some of the terminal coils. These individual wires were, of course, only very lightly insulated from each other, although the coils were heavily insulated from the core. With regard to Mr. Tatlow's remarks about the inability of the Wurts multi-gap arrester to deal with direct-current lines, Wurts had also invented a direct-current arrester, consisting of two metal electrodes embedded in a marble slab, the gap between them being bridged by the charred surface of a piece of lignum vitæ, which was in turn covered by another marble slab. The gap between the electrodes held back the line pressure without appreciable leakage, but broke down under pressure surges. He would like to know from Mr. Peck whether the electrolytic arrester was effective for direct current. In his Paper Mr. Peck had dismissed in a few words the water-jet arrester which is used largely on the Continent, in conjunction with a combination of horn arrester and series water resistance. This arrangement had been found very effective, but Mr. Peck condemned it on account of the leakage and the need of water pressure. He had also in his remarks cited the fact that the water-jet arrester always had a horn arrester in parallel with it as evidence that its users had no confidence in it. This was not exactly fair criticism. The electrolytic arrester which Mr. Peck advocated needed, according to him, another arrester in series with it. In fact, it seemed as if the electrolytic arrester performed the functions of a series resistance rather than that of an arrester proper, so that in that respect at any rate, it did not score very much over the water-jet arrester. Besides the water-jet arrester and the combined horn arrester and series resistance performed different functions, the water-jet smoothing down the pressure surges, which might not be of sufficient magnitude to jump the horn gap. The two were thus something like the ordinary and the emergency governors of an engine. The power needed to supply water for the water-jet arrester was a small matter at generating or substations, as where transformers were in use water would probably be used for cooling the transformers. Whilst on the subject of leakage he would like to know whether Mr. Peck had any figures showing the value of the leakage on the water-jet, and also the comparative leakage on the electrolytic arrester, if it were at all practicable to use it alone. Mr. Peck had mentioned as the special feature of the electrolytic arrester that when it came into action it lost nearly all its resistance, and became practically a short circuit, thus affording a free passage for the discharge. This certainly made it a very efficient substitute for the ordinary series resistance, but what would be the effect of two of these arresters discharging simultaneously? Would it not constitute a short circuit on the line, and produce similar effects to two horn arresters without series resistances?

Mr. J. S. PECK (in reply), agreed with Mr. Tomlinson's simile regarding the function of the lightning arrester, which was, as Mr. Tomlinson had said, really a safety-valve to the system to which it was connected. Replying to Mr. Tatlow, he said that the ground wires alluded to gave trouble owing to rusting at the joints, but now much greater care was taken in their erection than formerly. The choke coil was always in circuit with the transformer or other apparatus which it was designed to protect, because disturbances often occur on a line unintentionally, such as earths, short circuits, &c., when an abrupt change may occur; therefore, by constantly keeping the choker in circuit, the apparatus is always protected. He agreed

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that the horn type arrester might in some cases cause oscillations in the circuit. The Wurts' arrester was only suitable for alternating circuits, but he understood that one was being developed for direct-current circuits, and which was likely to give excellent results. Regarding the permanency of the electrolytic arrester, he knew cases where they had been in service over one year, and no change whatever in the film was found. The horn type of arrester was not, in his opinion, very satisfactory on circuits of 15,000 volts, or less, as the arc does not rise quickly enough. Many engineers had expressed an opinion similar to that of Mr. Kinsey but at the same time trouble due to lightning, &c., were so serious, and the cost of the apparatus so small, that they had tried them; a great number of sceptical users had tested the efficacy of the instruments by inserting a piece of paper between the spark gaps, and found it punctured after a storm, which proved their efficacy. Regarding the transformer breakdowns mentioned by Mr. Kinsey, he rather thought that many telegraph engineers did not appreciate the necessity of thorough insulation for high voltages. He remembered one case in particular, in which transformers and other apparatus were repeatedly being damaged. The complaint was that the arresters were useless for their purpose. Subsequent investigation showed that the insulation of the apparatus was at fault, and on its being increased the arresters acted perfectly, it being, of course, essential that arresters should be set to act at a considerable pressure above that of the line. Regarding overhead transmission lines in America, these are always run through the supply undertakers' own property, a sole right of way being acquired, and overhead transmission lines are not carried through city streets: no precautions are taken on the undertakers' own right of way, as only employés should be there, and they are aware of the existing danger. Mr. Peck explained that water arresters were usually turned off, the water supply only being turned on when storms were anticipated.

COST OF ELECTRICAL POWER FOR INDUSTRIAL PURPOSES

THE discussion on Mr. J. F. C. Snell's Paper on this subject was continued at the Glasgow Local Section of the Institution of Electrical Engineers on Tuesday last week. Previous reports of the Paper itself and the discussions in London, Dublin, and Glasgow, appeared in our issues of January 16th, 23rd, and 30th.

Mr. F. A. NEWINGTON (City Electrical Engineer, Edinburgh) said that the existence of a good diversity factor was of great advantage in levelling the peak loads, but unfortunately very few people even knew what was meant by the term. Mr. Snell and those proposing similar schemes, seemed to think that London was suddenly and urgently in need of 400,000 h.p. of electrical energy; was this really the case?

Mr. F. C. RAPHAEL said that the real difficulty with regard to the electric power question in London would arise from the fact that the powers of the existing companies expired in 1931, so that there would be a natural disinclination to scrap old plant and spend money on new plant, and larger units as that time approached, since the ultimate purchase price of the plant by the local authority would be uncertain. On the other hand, he thought that Mr. Snell's criticism of the present price charged for power by electricity undertakings in London overlooked the fact that they might take into account the ultimate increase in load and consequent cheaper cost of generation. As an analogy, Mr. Raphael took the case of a factory set down with special machines to make a particular article in large quantities at a cheaper price than it could be obtained by the ordinary methods. Until they had reached a certain output at that factory, the low costs of production would not be attained, and there would be no advantage by the manufacture in large quantities. But they would be acting on quite sound business lines to charge the low price for their product at first, so as to reach as rapidly as possible the output which would enable them to sell at this price with a profit.

Mr. STOTHERT (Babcock & Wilcox) said that the cost of generation with the private plant at their works at Renfrew came to from 0·25d. to 0·33d. per unit, or, adding an allowance for depreciation, 0·45d. per unit. They had three 400-kw. sets, and one 600-kw. set, and the load factor was 50 per cent. He had been informed that at Messrs. Watson & Co.'s paper mills the costs were only 0·19d. per unit, including 7 per cent. for interest and depreciation.

Mr. NEWINGTON said that two suction gas plants of 90 h.p. each, one working ten hours and the other five hours a day, had been installed at a general engineering works which previously took power from the Corporation mains at 1·2d. per unit for combined light and power. The cost of running for two months was as follows:—Wages, £100; coal, £133; water, £31; oil, £31; repairs, £8; insurance, £24; total running costs, £327. Adding 10 per cent. for depreciation, interest, &c., on a total capital cost of £3,680, the total cost came to £695, or 1·13d. per unit, in which nothing was included for the rent of land.

Mr. T. C. PARSONS (Burgh Electrical Engineer, Govan) said that, in his figures for graving docks, Mr. Snell should not have taken as a basis for comparison the costs per ton of vessel docked, but per ft.-lb. of water pumped. On this basis the gas engine pump came out 33 per cent. better than the electrical one. Mr. Parsons also took exception to Mr. Snell's dictum that the smaller towns should not have been allowed to build their own electricity works, but should have bought their energy in bulk, and he read out a list of stations taking energy in bulk which had either not shown any profit at all or had made but small profits.

Mr. J. A. ROBERTSON (Burgh Electrical Engineer, Greenock) was able to give some figures (obtained since the last meeting) of the cost of running private plants. In a shipyard which consumed 360,000 units last year, as recorded by a watt-hour meter, the costs per unit had been as follows:—Coal, 0·47d.; oil, 0·08d.; wages, 0·22d.; repairs, 0·21d.; total, 0·98d., with no allowance for depreciation. The plant was belt-driven, and its cost had been £4,000. He also pointed out the small proportion of the cost of power to the total expenditure in a shipyard. Taking as an example the engine and boiler works employing 1,020 hands, referred to in Mr. Snell's Table III., and assuming that the cost paid for current was 1d. per unit, and the average wages 30s. per week, the total annual cost of electric power was only between 5 and 6 per cent. of the wages bill for the year. In a certain shipyard at Greenock the ratio was even less: the wages bill was £135,000, and the total cost of power supplied from the Corporation mains £4,000. Taking account of the extra reliability and the saving in capital costs, there could be very little object in being troubled with a private plant.

Prof. F. G. BAILY (Chairman of the Section) said that if a company or the L.C.C. were to buy out the old stations in London at a valuation taking account of future profits, it would increase the total capital expenditure and electrical energy would cost more than at present. On the other hand, if the stations were not bought out and a new works were started to supply at a cheaper price, it would be robbery. He also expressed his surprise that in Mr. Snell's tables oil engines should show lower costs than suction gas plant.

Mr. J. F. C. SNELL, in reply to the whole discussion, said that Tables I. and II. in his Paper did not include supervision, establishment charges, or rating, nor was any capital charge for spare plant taken in. Since he had written his Paper, more than a year ago, oil had risen in price to 82s. 6d., and as his figures were based on a price of 42s. 6d., a considerable correction must be made. Referring to Mr. Robert Robertson's curves, he said that no user would be found with a 50 per cent. load factor to take power at the prices shown by the curve XY. He defended the £12 per kw. station, and gave the one at the Powell Duffryn colliery, cited by Mr. Sparks, as an example. Referring next to gas plants, he said that he had never been able to get any gas engine plant running in actual practice that consumed only 20 cubic ft. per B.H.P. He knew a case in which a plant was looked after admirably, and consumed 30 cubic ft. per kw.-hour. Much lower consumption, down to perhaps 15 to 16 cubic ft. per B.H.P.-hour had been obtained in tests, but the gas consumption went up considerably when the plant was out of the maker's hands. After apologising for not referring to all the points raised in the discussion owing to its great length, Mr. Snell concluded by replying to Prof. Baily's observation about robbing the existing supply undertakers in London. He would not propose to rob them, but, on the contrary, to supply them at such a price that after adding their present capital charges they could still retail to the consumer at a cheaper rate than their present prices.

Permanent Wireless Telegraph Station at the Eiffel Tower.—The *Engineer* states that the French Government has decided to establish a permanent underground wireless telegraph station at the base of the Eiffel Tower (on which is the aërial) with commodious offices, in place of the temporary buildings now in use. Wireless communication is still being kept up daily with the warship *Kleber* at Casa Blanca.

Overhead v. Underground Telephone Wires.—On Wednesday last week judgment was delivered by the Railway and Canal Commission in the appeal of the Postmaster-General v. Watford Urban District Council. The case involved the point as to whether certain telephone lines should be placed overhead or underground, the Watford Council contending that they should be placed underground. Full particulars of the previous hearing were given in ELECTRICAL ENGINEERING, Vol. II., p. 1014. Sir James Woodhouse, in giving judgment, said that although the amount involved was small, the Postmaster-General had brought the matter into court, as he thought the case raised a question of great importance. If the contention of the Council were upheld, it would cause a serious obstacle to the economical carrying on of the telephone service. The only objection raised by the respondents to carrying the wires overhead was that it would cause an obstruction to the traffic. He had visited the locality, and was satisfied that there would be no obstruction to the traffic by the erection of the six or seven poles proposed, and that the objection of the Council to their erection was not well founded. Mr. Justice A. T. Lawrence and the Hon. A. E. Gathorne-Hardy agreed, and the appeal was accordingly allowed.

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A NEW PETROL-ELECTRIC RAILWAY CAR

A NEW railway car for independent use on the Delaware and Hudson Railway in America, propelled by a petrol engine, and employing electrical transmission gear, which has made some recent trial runs, is described in the *Street Railway Journal*. The car was built by the General Electric Co., and differs somewhat from the earlier petrol-electric car, supplied to the same railway. The complete car is 50 ft. long overall, and seats 44 passengers. Its total weight is 31 tons.

The engine drives a 90 kw. continuous-current generator, working at a variable voltage, which supplies current through suitable control gear to two 60 h.p. traction motors. The generating set is placed in a compartment at one end of the vehicle. The engine, which has developed as much as 150 h.p., was specially designed for the work by the General Electric Company, and is of the V type, with eight inclined cylinders, each of 8-inch bore, by 7 in. stroke. A four-throw crank shaft is, therefore, possible. The construction is very light and compact, and all the sixteen valves are actuated by a single cam-shaft between the cylinders. Two carburettors are employed, and high-tension ignition is used, with separate coils for each cylinder and accumulator. For starting the engine, the somewhat unusual plan is followed of providing a special breech block mechanism, which fires a charge of black powder in one of the cylinders. Cooling is on the thermo-syphon system, without pumps or fans, and a large radiator is provided on the roof of the car. Petrol is stored in a 90-gallon steel pressure tank, from which it passes to an auxiliary tank, from which a gravity feed is given to the carburettors.

The generator is a 90-kw. 8-pole, separately excited machine, which has been specially designed with a view to procuring the lightest possible machine for the necessary output. It is provided with commutating poles. At starting, the field excitation is weak, so that large currents are required to give the necessary starting torque. The normal pressure when running at 550 r.p.m. is 250 volts, at which time the current will amount to 360 amps., but at starting, a current of 800 amps. can be secured at a corresponding decrease in voltage. It would be impossible to commutate so large a current in a machine with so great a kilowatt capacity per pound without the use of commutating poles.

The total weight of the generator, including exciter, is only 2,740 lb., while a standard machine of this output weighs 8,600 lb. As is only natural in a machine where the weight has been so materially reduced, the temperature rise is higher and the efficiency lower than in standard apparatus of the same output. The higher temperatures are fully provided for by the type of insulation employed; there is no paper or muslin used anywhere in the machine. The armature coils are insulated with mica, the interpole coils with asbestos, and the field coils are wound with enamelled wire. The armature leads to the commutator are riveted as well as soldered, although the precaution has been taken to use pure tin for soldering, which has a melting point of over 200 degs. C. Air ducts of ample dimensions are provided to insure a large volume of air being circulated through the core. The efficiency is 88 per cent., being only about 3 per cent. lower than a standard machine having a temperature rise of 35 degs. C.

The exciter is a 3-kw. 70-volt, shunt-wound machine, with its armature mounted directly on the armature shaft of the main generator and its field yoke supported by the bearing brackets, enabling it to fit under the back ends of the generator armature windings.

The speed of the motors is governed by a potential control, the generator being separately excited and the terminal voltage of the motors being varied by means of a rheostat in series with the exciting circuit. The armature circuit of the main generator comprises the armature—fuse—two contactors in series, reverser, and the two motors. The motors are connected in series or in parallel, according to the position of the controller handle, and they are grounded to the truck framework, while the solenoid coils for operating the contactors are energised by a storage battery floating across the field circuit. The reverser is operated, as usual, by a separate reverser handle on the controller.

The current from the exciter passes around the field of the main generator and through the rheostat; the function of the controller is to cut in and out this rheostat as occasion demands.

A storage battery which floats on the exciter circuit is used for supplying the lighting circuits and its charging and discharging is controlled by means of a reverse current relay which permits the lights being supplied directly from the exciting circuit or from the storage battery according to the voltage of the exciter circuit. A Tirrill regulator is employed for regulating the voltage on the lighting circuit. These arrangements enable the car lights being used when the engine is at rest.

The master controller, which has some unique features, gives seven steps with the two motors connected in series, and eight steps with the two motors connected in parallel. It is provided with four handles, three of which are mounted one above the other on concentric shafts. The function of the top handle is to advance and retard the ignition of the engine, the second controls the throttle of the engine, while the third handle controls the generator field resistances and the contractors, which establish the circuit for the motors, besides transposing the motor connections from series to parallel. The fourth handle operates the reversing switch and controls the direction of rotation of the motors.

The car is heated by passing part of the exhaust gases through pipes suitably located in the car body. The air compressor for the brakes is coupled directly to the engine. The arrangement of the motor on the trucks, one mounted on each, does not call for particular remark.

On a recent trial trip of about 78 miles, including 23 stops and a number of slowdowns due to signals, the speed of the car varied from 23 m.p.h. on a 1·3 per cent. up grade to 56 m.p.h. on a ¼ per cent. down grade, except where traffic conditions and road regulations required lower speeds. Where traffic conditions permitted, a speed of 50 m.p.h. was recorded on level track, and from Albany to Mechanicsville a speed of 47 m.p.h. was sustained on a steadily rising grade.

LONDON ELECTRIC LIGHTING ACCOUNTS

CENTRAL ELECTRIC SUPPLY CO.—The Report for 1907 states that energy has been supplied to the St. James's and Pall Mall Electric Light Company, Ltd., and the Westminster Electric Supply Corporation, Ltd., throughout the year, to an amount of 17,431,370 units. After making a full allowance for sinking fund and depreciation, the net balance for the year 1907 is £5,036, and adding balance brought forward from 1906, the amount now to be dealt with is £5,042. A dividend of 5 per cent. on the ordinary shares for the year is recommended, carrying forward £42 14s. 0d. Reference is made in the report to the Bill to confer further powers upon the company in conjunction with certain other of the West End electric lighting companies.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING CO.—The report for the year ending December 31st, 1907, states that the number of houses and shops connected with the system has increased from 3,977 on December 31st, 1906, to 4,172 on December 31st, 1907, while the number of lamps calculated on the usual basis of 8-candle power has increased from 353,532 (10,600 kw.) to 383,200 (11,500 kw.). The renewal account now stands at £69,602, an increase of £3,223. After providing for the amount placed to renewal account, and after paying the dividends on the 6 per cent. first preference shares to June 30th, 1907, on the 5 per cent. second preference shares to September 30th, 1907, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the nett revenue account for the year 1907 is £9,854. The directors draw attention to the fact that the rate of dividend has been maintained, despite the high price of coal and the large amount paid in respect of local taxation, which latter item alone now amounts to a sum equivalent to about 6 per cent. on the ordinary shares. Of the above sum £1,500 has been appropriated to the payment of the first preference dividend to the end of the year, and £625 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date. It is proposed to pay out of the balance of £7,729 a further dividend on the ordinary shares at the rate of 10 per cent. per annum, for the past half-year, making with the interim dividend paid on August 1st, 10 per cent. for the year. This will leave a balance of £2,479 to be carried forward. After the general meeting on the 27th inst., there will be an extraordinary general meeting for the purpose of confirming the resolution passed on the 6th inst., relative to the Bill now being promoted by this company in conjunction with four of the other electric supply companies in London.

LONDON ELECTRIC SUPPLY CORPORATION.—The report for the year ended December 31st, 1907, shows a profit of £46,319, to which has to be added the amount brought

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forward, £4,170, less interest on temporary loan and expenses incurred in Parliament last Session, viz., £900, making a total of £49,589. Out of this the interest on debenture stock to December 31st, viz., £14,975, has been paid, leaving a balance of £34,613. The Board propose a dividend of 6 per cent. on the preference shares for the year (of which an interim dividend of 3 per cent. was paid on September 1st, 1907), viz., £20,952; a dividend of 2½ per cent. on the ordinary shares for the year, viz., £8,325; to reserve account (making a total of £57,500), £2,500; to carry forward, £2,836. The number of units sold amounted to 10,011,987, as against 10,544,484 last year. The diminution in the revenue account is caused by the large decrease in the receipts from the London County Council for their tramways, as compared with last year, together with a considerable increase in the price of coal. On the other hand, the power supplied for industrial purposes shows an increase from 840,634 units to 2,111,921, and the general business (excluding that of the London County Council) shows an increase of over 30 per cent., viz., from 5,420,258 to 7,118,513 units. It is expected that a commencement will be made in May next to supply power to the London, Brighton and South Coast Railway Company for working the trains on their South London line between Victoria and London Bridge. The directors have joined with other electric supply companies in London in depositing a Bill in the coming Session of Parliament for conferring further powers upon all the companies, in order to obviate the necessity for, and to take the place of, the various Power Bills which have been promoted during the last three Sessions. Such Bill would utilise the existing plant for the best and meet the public demand for cheaper, *i.e.*, for centralised power supply. An extraordinary general meeting will be held at the conclusion of the general meeting on the 27th inst., for the purpose of considering and approving this Bill.

NOTTING HILL ELECTRIC LIGHTING CO.—The report for the year 1907 shows expenditure on capital account of £2,168. The capital account now stands at £233,526. The expenditure on capital account exceeds the receipts by £25,526. The cost of the joint station to date has amounted to £184,049, and joint debenture stock amounting to £180,790 has been issued. This stock is subject to a cumulative sinking fund, which now amounts to £24,390, invested in trustee securities. There are now connected to the mains the equivalent of 160,349 8-c.p. lamps. The number of consumers is now 2,673, and 98 per cent. of these are supplied at 200 volts. The gross revenue for the year was £38,055, showing an increase of £1,131, and the total net profit was £19,007. From this there have to be deducted depreciation, renewal and reserve fund, £2,000; debenture and other interest, £2,586; Kensington and Notting Hill joint debenture stock—interest £2,216, sinking fund, £1,154; reserve for bad or doubtful debts, £50; leaving a balance available for dividend of £11,000. The directors recommend the usual dividend of 6 per cent. (less income-tax) on both the preference and ordinary shares, and that the balance be divided in accordance with the articles of association, one half being credited to the founders' shares, and the other half to the ordinary and preference shares. This will enable a further 1 per cent. to be paid on both ordinary and preference, with a distribution of £2 15s. per share on the founders' shares. An interim dividend of 3 per cent. was paid to the holders of the ordinary shares on July 1st, and the balance of 4 per cent. will be paid forthwith, together with the distribution on the founders' shares. The preference shares having received their full 6 per cent., the 1 per cent. bonus will be added to the interim dividend on these shares, to be paid on July 1st next. The reduction in the net profit is more than accounted for by the increased costs at the Wood Lane works during the latter half of the year. This was occasioned partly by the increased price of coal, but mainly by the cost of exceptionally extensive repairs which had to be carried on under unfavourable conditions, owing to the impossibility under the existing Electric Lighting Acts of obtaining current by joining up with neighbouring companies. The rates paid to the local authorities (including this company's proportion of those charged in the Wood Lane supply) amounted to £3,475, approximately equivalent to a dividend of 2½ per cent. on the share capital. The law and Parliamentary costs for the year amounted to £202 17s. 2d., and were incurred in promoting one Bill and opposing others in conjunction with the other electrical supply companies in London. None of these, however, were passed during the Session. In conjunction with its neighbours (the Kensington and Knightsbridge Electric Lighting Co., Ltd., the Westminster Electric Supply Corporation, Ltd., the St. James's and Pall Mall Electric Light Co., Ltd., and the Central Electric Supply Co., Ltd.), this company is promoting a Bill in the present Parliament for the purpose of enabling a close working arrangement and means for interchange of current to be made between those undertakings, the experience of the past year having shown this to be very necessary. The Bill was fully explained and approved by the shareholders at a Wharncliffe meeting held on the 3rd inst., and a further meeting to confirm this resolution will be held after the ordinary general meeting on February 25th.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO.—The report for 1907 states that the supply has been distributed from the Carnaby Street and Mason's Yard works of the company to the equivalent of 341,428 lamps (10,926 kilowatts), being an increase of 32,444 lamps (1,038 kilowatts). For this purpose 5,429,190 units were generated at the company's works, and 5,286,440 units were purchased from the Central Electric Supply Co., Ltd. The Central Electric Supply Co. has declared a dividend of 5 per cent. on the ordinary shares, in respect of which a sum of £2,500 will be payable to the company. In conjunction with the Westminster Electric Supply Corporation, Ltd., the Central Electric Supply Co., Ltd., the Kensington and Knightsbridge Electric Lighting Co., Ltd., and the Notting Hill Electric Lighting Co., Ltd., a Bill is being promoted in the present Session of Parliament, with the principal objects of securing additional economy of production and regularity of service by linking up their several sources of supply in the West End of London. The net profits for the year 1907 amount to £27,889, to which is added £486 balance from last account, making £28,375. Deducting interim dividend for the June half-year, there is an amount now to be dealt with of £14,875.

WESTMINSTER ELECTRIC SUPPLY CO.—The report for the year 1907 states that the output of electrical energy, which on December 31st, 1906, amounted to the equivalent of 859,004 8 c.p. lamps, had increased by December 31st, 1907, to the equivalent of 929,579 lamps, the largest addition in any one year. A considerable part of this addition is for power and heat, for which there has been an increasing demand during the last few years. The length of roadway in which continuous current mains have been laid now exceeds 84 miles, making about 329 miles of ways, into which upwards of 258 miles of copper (strip and cable) have been drawn. In addition, five miles of trunk mains (24 miles of ways) are laid in the company's area, to connect the stations with the Central Electric Supply Company's station at St. John's Wood. A copy of the accounts of that company is enclosed herewith for the information of shareholders. The London County Council have now handed over to the company the new site for a station in Horseferry Road, in accordance with the provisions of the London County Council (Improvements) Act of 1900, which, as mentioned in last year's report, is to replace the company's present station in Millbank Street. The directors have placed the contract for the new buildings of the station, and the work has commenced. The sum to be paid by the London County Council in connection with the reinstatement is to be settled shortly by arbitration. An interim dividend, at the rate of 10 per cent. per annum on the ordinary shares, and the dividend on the 4½ per cent. preference shares, for the half-year ending June 30th, 1907, has been distributed. After allowing for depreciation, sinking fund, and other charges, the net balance is £36,997, from which must be deducted the second half-year's dividend on the preference shares, which absorbed £8,636, leaving a balance of £28,313. Out of this the Board recommend the payment of a dividend at the rate of 10 per cent. per annum, less income tax, for the past half-year, carrying forward a balance of £2,185. Although the output has increased during the current year, the amount available for net revenue has diminished principally owing to the heavy amount paid in the City of Westminster for rates, which now amounts to £16,000 (equal to nearly 3 per cent. dividend on the ordinary share capital). Other contributory causes are the large increase in the price of coal and the investment of a sum of £245,000 in first-class securities on account of depreciation and reserve. The sum thus invested, though bringing in a smaller rate of interest than if employed in the business, places the company in a very strong financial position, which the directors feel sure the shareholders will appreciate.

Noisy Operation of Dynamos.—An article by N. R. Craighill in the *Electrical World* (New York) discusses the question of the noisy running of electric motors and generators, a matter to which attention has been called several times lately in discussions at the Local Sections of the Institution of Electrical Engineers. The author states that in order to obtain noiseless operation, the pole-face density should be not more than 50,000 lines per square inch for medium and large-sized machines, and for small ones considerably less. When this density is exceeded, it is practically impossible to prevent noise. A large number of slots per pole and large air-gaps are conducive to quiet operation, but both lead to uneconomical designs. The pitch of the note given out by a machine depends, of course, upon the number of teeth in the armature and the speed of the same, but the possibility of having noisy running depends upon certain relations between the slot pitch and the length of the pole arc. As the result of experiments it was found that the noise could generally be eliminated by a slight trimming of the pole tips, but still further trimming resulted in alternate noise and quiet. The more nearly the ratio between pole-arc and slot-pitch lies midway between two whole numbers, the less tendency there will be for a machine to hum. Thus for quiet operation, the ratio pole-arc to slot-pitch should be equal to a whole number, plus one half. When the pole tips are rounded, the effective length of the pole arc must be used to obtain this ratio.

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THE PETROL-ELECTRIC SYSTEM FOR OMNIBUSES

MR. BERNARD HOPPS (of the British Thomson-Houston Co.) read a Paper on Thursday last before the Rugby Engineering Society entitled, "The London Motor Omnibus Problem, with Special Reference to the Petrol-Electric System." The introductory portion of the Paper briefly sketched the course of events which have led up to the present state of affairs as regards motor omnibuses in London, of which there are now over 900 on the streets. The trouble experienced with older types of vehicle and the effect of the Scotland Yard Regulations were mentioned, and a few words were said as to the relative advantages of different forms of motive power.

In turning to petrol-electric systems, the author said that the first aim in designing a 'bus for London service should be to reduce everything to the simplest possible form. The temptation is often great to introduce some device, more or less complicated, which produces a refinement in the control, as, for example, electrically controlled throttles, &c., whose action depends more or less on a fine adjustment, but which, in the hands of the average London 'bus-driver, is very soon rendered inoperative. The electrical equipment must be self-contained, and sturdily-built, and should be so simple that it can be taken to pieces and re-erected satisfactorily by an ordinary fitter.

Petrol-electric systems may be roughly grouped under the following headings :—

(*a*) Those which start and accelerate electrically, after which the electric drive is cut out and is taken up by a clutch driving direct through from the engine. (An example of this class is the Hart-Durtnall system, described in ELECTRICAL ENGINEERING, Vol. I., p. 147.)

(*b*) Those which employ accumulators to assist the engine in climbing grades, &c. (Such as the "Autcmixte" or Pieper system.)

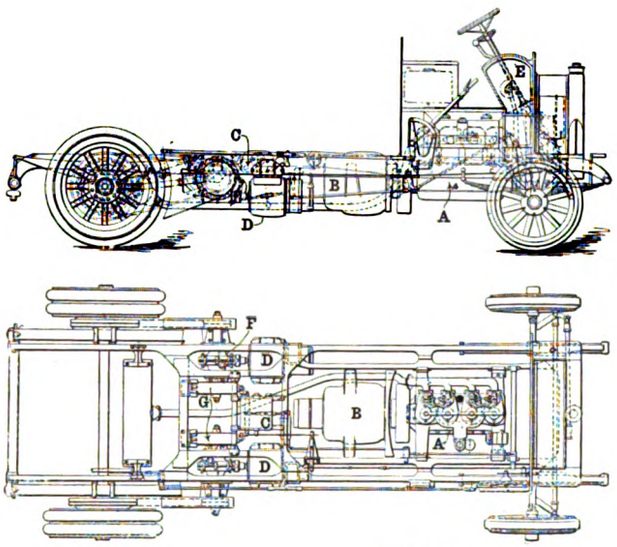
(*c*) Those which drive entirely electrically (including the Stevens, Greenwood & Batley, Kriéger, Mercedes—Mixte, and other systems, as well as that of the author's own firm. See ELECTRICAL ENGINEERING, Vol. I., pp. 461, 690, and January 16th, p. 83.)

It is claimed for the first method (*a*) that since the electrical equipment is only used for starting and accelerating, it can be made comparatively smaller, lighter, and cheaper. This was characterised by the author as an erroneous idea, as it was not practicable to limit the output of the electrical equipment to starting and acceleration duties only, since occasions may arise where hills of considerable length must be negotiated, the gradient of which will be too severe for the direct drive, and which, therefore, must be climbed entirely through the electrical transmission. Since such grades represent the most severe duty for the electrical equipment, it followed that in order to avoid overheating, it must be made almost as large and heavy as would be necessary were it called upon to propel the vehicle during the whole of the working period. It may be said that for service in our large cities, as, for example, London, the grades encountered are insignificant, and can be surmounted with the direct drive; but for this class of service where traffic is always congested, and where constant stops and starts are necessary, he thought there was no real advantage in employing a direct drive to decrease the duty of the electrical equipment, since it cannot be used for sufficient length of time.

It is further claimed for this system, he continued, that the so-called direct drive at full speed is more efficient than a purely electrical transmission. Assuming that this is so, and that a few per cent. saving in efficiency may be obtained owing to the elimination of the electrical losses, which at full speed, however, are at their minimum, this arrangement introduces a clutch, which complicates the control and adds another item to upkeep. It also necessitates the alignment of the motor, generator, and engine. It limits the speed of the motor to that of the engine, whereas with a purely electrical drive the motor can safely be run at double the speed of the engine with a corresponding saving in weight and cost. This system may possibly have advantages for driving light pleasure cars, but in the author's opinion it has none when applied to motor omnibuses for London or similar service. With regard to the second system (*b*) in which accumulators are used to assist the engine, it is somewhat difficult to see what advantage is obtained by their introduction; they add a complication, and require a special organisation to attend to them. The accumulator usually employed is a Plante type, which it is true will withstand a considerable amount of abuse both as regards heavy discharges and vibration, but the battery required is as heavy, and as costly as an electric motor would be, and far more expensive in upkeep. The simplicity of the control is sacrificed, and a skilled driver is essential to operate such a system efficiently. For heavy country service, in which long steep hills have to be negotiated, the discharge rate on the accumulators is high, and there is the possibility that they may become totally discharged before the top of the hill is reached. The only advantage that can be claimed for such a system is that of recuperation during the braking and coasting periods.

There remains the third system (*c*), which was that adopted by his own firm. This consists of a direct-current dynamo driven by a petrol engine, the whole of the engine power being converted by the dynamo into electrical energy, which is transmitted through a controller to the motor, or motors, driving the road wheels. In this system either one or two series-wound motors may be used, depending on the nature of the service. The chief feature of this system is the constant watt output self-regulating dynamo, which reduces the control to its simplest form, and thus renders the employment of skilled drivers unnecessary.

In order to fully appreciate the advantages of this machine, it is necessary to study the characteristic of the petrol engine that drives it. The maximum h.p. that can be developed by a petrol engine is limited to practically its normal working out-



A. Engine.
B. Auto-Regulating Generator.
C. Controller.
D. Series Wound Motors.
E. Operating Box.
F. Worm Reduction.
G. Countershaft Brakes.

ELEVATION AND PLAN OF OMNIBUS CHASSIS, FITTED WITH B.T.-H. PEIROL-ELECTRIC SYSTEM OF TRANSMISSION.

put. The torque developed remains approximately constant; it follows, therefore, that as the speed diminishes, due to overload, the h.p. developed diminishes, and this at the time when the maximum b.h.p. output is most required. In this respect it is unlike a steam engine, which can be made to develop considerably more than its normal torque for short periods, by increasing the cut-off and the steam pressure.

In the case of a gear-driven 'bus of the usual type, in order to provide sufficient torque at starting, it is necessary to introduce a comparatively large gear ratio between the engine and the road wheels. The vehicle is accelerated to a certain speed on this gear, which is then changed for one of a lower ratio, and so on, until three or even four ratio changes have been made to bring the vehicle up to full running speed. Before each gear-change is made, the driving strain must first be taken off the teeth of the gear wheels. This is accomplished by withdrawing a clutch operated by a foot pedal, thus disconnecting the engine from the drive. It can be readily understood that a considerable amount of judgment and skill is required to effect each gear-change without noise or shock.

At starting, the motors demand a large current in order to develop the necessary starting torque; the dynamo supplies this current, but at a very low voltage. As the motors speed up they automatically demand less current, which is supplied by the generator, but at an increased voltage. In other words, the voltage of the generator varies in inverse ratio to the ampere output, therefore the power required to drive it can never exceed a certain predetermined maximum, which is arranged to

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correspond to the maximum power of the engine. Whatever the current demand may be from the generator, it cannot cause an overload on the engine sufficient to reduce its speed and h.p. output.

Almost as important a feature in this system as the generator is the system of control, which has been reduced to the simplest possible form. By use of the auto-regulating generator series parallel control is rendered unnecessary, excepting for services including unusually steep grades. The auto-generator will supply all the current requisite for starting, accelerating and for climbing ordinary grades, with the motors permanently connected in parallel. The controller proper is therefore reduced to a reversing switch of the simplest form. In order to stop the vehicle, the current is not interrupted at the main controller, but the voltage of the generator is reduced to zero by inserting a high resistance in the generator field, and at the same time reducing the engine speed. This is accomplished in practice by a single foot pedal, which is inter-connected with the engine governor, and a field rheostat, in such a manner that when the pedal is fully depressed the engine is governed to run at about 400 r.p.m., and at the same time all the resistance is inserted in the generator field, which is thus weakened to such an extent that the current ceases to flow to the motors, and the vehicle is stopped without breaking the main circuit. On releasing the pedal, the first movement cuts out the resistance, and the generator volts build up on the load, causing sufficient current to flow to the motors to start the vehicle, which will continue to run slowly, the engine remaining governed at 400 r.p.m. On entirely releasing the pedal, the governor is "held up," allowing the engine speed to at once increase to its normal value, and the vehicle to smoothly and rapidly accelerate to its full speed. To slow in traffic it is merely necessary to more or less depress the pedal, thereby reducing the engine speed, and consequently the generator voltage and the vehicle speed. The 'bus fitted with this system is therefore stopped and started, and the speed controlled by one foot pedal, which can be worked with any degree of suddenness without causing shock at starting, or damage to the engine, or transmission. The same pedal is inter-connected in a simple manner with the lever operating the controller in such a way that it is necessary to first depress the pedal to its full extent before the controller can be operated; this ensures the current being reduced to zero before the main circuit is broken. No sparking can therefore take place at the controller, which can be made without carbon breaks or magnetic blow-outs.

A drawing of an omnibus chassis fitted with this equipment is given in the accompanying figure, from which it will be seen that the motors are placed at the sides of the frame and drive the rear wheels through a double reduction consisting of a worm-gear and a chain.

A LARGE ELECTRIC LIFT

AN interesting elevator installation which has recently been completed at the Hoboken terminal of the Hudson and Manhattan Railway Co.'s tunnels under the Hudson river is described in the *Electric Railway Review*. This elevator is for the purpose of placing in and removing from the tunnels and subway the electrically-equipped passenger-cars which will run in these tunnels. These cars are 48 ft. long over all by 9 ft. wide, and weigh empty 64,000 lb., loaded with passengers 85,000 lb. To raise and lower these cars into and out of the tunnel there has been installed an elevator of 100,000 lb. lifting capacity, with a platform 50 ft. long and 12 ft. wide, weighing 32,000 lb.

To provide for this elevator there was first constructed a wellway, with reinforced concrete walls from the tunnel level to the surface. Upon the side walls of this structure are placed six steel columns supporting a steel girder framing directly over the hoistway, and upon these girders is placed the machine operating the elevator platform. This machine consists of two drum shafts, each 50 ft. long, one placed near each side of the wellway. These drum shafts are at the centre of their length driven by a system of four balanced worm gears, arranged so that the load on all four worm gears is equal under all conditions of platform load. All thrust loads are balanced by the worm shafts, which have right and left hand worms operating the worm gears. These worms and gears run in oil baths in tight casings. The entire system of drum shafts, worm gears, and worm shafts is driven by one 100-h.p. motor placed at the centre of one side of the elevator machine.

The elevator platform is constructed with two longitudinal steel girders, one under each rail, with suitable steel framing to support the suspension sheaves, whereby the platform is suspended from and operated by the elevator machine. The floor of the platform, which is 600 square ft. in area, is covered with diamond pattern steel floor plates. At the sides of the elevator platform, connecting with the machine above, are 32 ¾-in. diameter steel cables, which pass under suspension sheaves below the steel plate floor of the elevator and return to anchorages in the steel overhead structure. By this arrangement one-half the load is suspended directly by the overhead structure, and one-half is suspended from the drums of the elevator machine. In addition to the thirty-two machine cables, the platform is suspended by eight counterweight cables, making a total suspension of the elevator platform and load by 40 ¾-in. diameter steel cables, having a total combined strength of 1,552,000 lb. The counterweights weigh 63,800 lb. total. The machine and cables are so arranged that the elevator platform cannot incline from a horizontal position, wherever the load may be placed upon the elevator platform. Iron frame gates are provided, which close when the elevator platform is not at the landings.

The elevator is controlled electrically by a pilot switch, operated by a hand shipping cable, and the elevator may, at the will of the operator, be run at speeds of 10 to 20 ft. travel per minute, the platform stopping automatically at the track levels. The rise of the elevator from the tunnel track to the surface track is about 30 ft. The elevator platform will be equipped with the third rail conductor, which will be alive only when the platform is at the track levels, and the tunnel cars may be run by their own motors on, off, or across the elevator platform. Provision has been made to hold the elevator platform securely in position while the cars are run upon it.

In addition to the usual service of this elevator in handling cars into and out of the tunnels, it is arranged to be utilised for quickly changing one or both of the motor trucks under a car body. For this purpose the elevator platform travels 3 ft. above the surface tracks, and when in this position blocks are thrown in place under the car body, the truck connections are released, and as the elevator platform descends the car body remains supported upon the blocks while the trucks descend on the elevator platform. New trucks may in a similar manner be placed under the car body. This operation permits the quick interchange of car bodies and trucks when either may require repairs.

This elevator is now in uninterrupted operation, handling rails, ballast, and other tunnel equipment material. It provides the only means of access of the cars into and out of the tunnel. The construction of the elevator is fireproof throughout. While the elevator was installed for a lifting capacity of 50 tons, it has handled loads of 65 tons.

Electrical Engineers Volunteers.—The undermentioned second lieutenants have been promoted lieutenants in the London division: G. W. C. Kaye, S. W. Humphery. In the Severn division, Lieutenant-Colonel J. A. Hughes is granted the honorary rank of Colonel.

Traction Subways in New York.—The Public Service Commission finally approved, on February 4th, the plans for the Broadway-Lexington Avenue subway. The line will begin at the Battery, continue under Church and Vesey Streets to Broadway, and then under Broadway and Lexington Avenue to the Bronx side of the Harlem, where it will branch into two spurs, one to Woodlawn Cemetery, and the other to Pelham Bay Park. According to the *Street Railway Journal* (New York) the estimated cost of the road and a connecting-link across town under Canal Street is $67,000,000.

Accumulator Manufacturers' Dispute.—In the Court of Appeal on Tuesday, before Lord Justice Vaughan Williams, Lord Justice Farwell, and Lord Justice Kennedy, the case of the United Motor Industries, Ltd. *v.* C. A. Vandervell & Co. (see ELECTRICAL ENGINEERING, Vol. II., page 108) was heard. It will be remembered that the plaintiffs at one time had exclusive rights of sale of an ignition accumulator, known as the "Castle" accumulator, manufactured by the defendants, and the question to be settled referred to the right of the defendants to continue to use the name "Castle" after the agreement had terminated for cells of their manufacture not sold by the plaintiffs. The appeal was from the judgment of Mr. Justice Walton, who had granted the plaintiffs' judgment for one farthing damages, with costs, except as to two-thirds of the costs of the trial. Mr. Justice Vaughan, in giving judgment, said that the mere smallness of damages was not a good cause for depriving a successful litigant of the costs of the issues on which he had succeeded. He held that the appeal must be allowed. Mr. Justice Farwell agreed, and said that there was no good cause for departing from the general rule. Lord Justice Kennedy dissented, and thought that the Court of Appeal had no right to alter the former decision. The appeal was allowed with costs by the majority of the court.

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SINGLE-PHASE AND THREE-PHASE LOCOMOTIVES: A COMPARISON

REFERENCE was made in ELECTRICAL ENGINEERING, Vol. II., p. 366, to the new 15-cycle single-phase electric locomotive built for the Pennsylvania Railroad for test purposes. The periodicity adopted—15 cycles—has been repeatedly put forward in recent discussions, as the most favourable as regards the weight and properties of the electrical equipment of the rolling stock generally, and, according to many experts, is especially desirable for single-phase motors, rather than the hitherto universally accepted periodicity of 25 cycles. Fifteen cycles is also the periodicity in use on the large three-phase railway lines of Europe, the Valtellina and the Simplon lines, and is that to be used for the Giovi & Savona-San Giuseppe lines, just under construction. The following comparison of the records attained by this single-phase locomotive and those on the New Haven road, with the results obtained with three-phase locomotives, in an article by Bela Valatin, in the *Street Railway Journal*, is of interest.

The latter, which were described in full in ELECTRICAL ENGINEERING, Vol. I., p. 1005, are now built with three ranges of speed. The 8-pole motor of a locomotive of this type, built by the Ganz Electric Co., for the Italian State Railways, has a capacity, on one hour rating, of 1,500 h.p., at a weight of 13·4 tons (metric), and at 220 r.p.m. While building new locomotives of the same type, the manufacturers have recently found it possible, through some changes in the design, to increase the rating of the motors by 20 per cent. to 1,800 h.p., while the external dimensions and the speed of the motor remain unaltered. Another 8-pole motor of similar construction, designed by the Ganz Electric Co., developing 1,100 h.p. on the one hour rating at 3,000 volts, 15 cycles, and 220 r.p.m., weighs 10 metric tons. Neither of these motors has forced draft.

This last motor seems suitable for a comparison with the single-phase motor of the Pennsylvania locomotive, since neither the weights, nor the speeds of the two motors differ materially. The capacity on the one hour rating of each motor of the Pennsylvania locomotive is stated to be 500 h.p., the rated drawbar-pull is given at 14,700 lb., and the diameter of the drivers is 72 inches. From these data the speed of the motor must be 236 r.p.m. The chief data of the two motors are then, as shown in Table I., where the weight factor is :—

$$\left(\frac{G \times n}{2200 \times 100 \times \text{HP}}\right)$$

Table I.

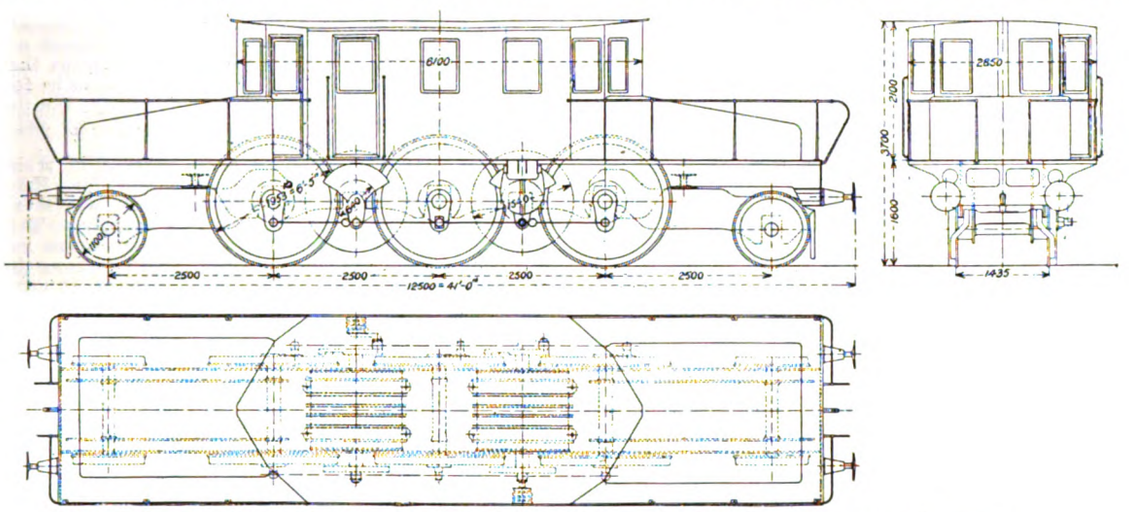
	Single-phase motor.	Three-phase motor.
Rated capacity in horse-power	500	1,100
Weights, pounds, G	19,500	22,000
Revolutions per minute, n	236	220
Weight factor	42	20

From this table it appears that the weight factor of the single-phase motor is more than double that of the corresponding three-phase motor; that is to say, the three-phase motor will develop more than double the power of the single-phase motor at the same weight and number of revolutions.

Very interesting results are also reached if we consider the whole locomotive. The accompanying diagram below was made for this purpose. To confine the comparison to construction actually carried out, the type of locomtive represented by the Italian model previously mentioned has been adopted. The mechanical part of the locomotive would be changed only in so far as the wheel diameter would have to be increased to 77 in., so that the speed of the locomotive might be the same as that of the Pennsylvania locomotive at the rated capacity. The two motors are the 8-pole 1,100 h.p. three-phase motors above described, and may be run at half their standard speed in concatenation, in which case one of the motors has to be commutated to low-tension in the same manner as the 12-pole motor of the three-speed locomotive.

The weight of the locomotive, as actually carried out, was 62 metric tons. In consequence of the larger drivers the mechanical part of the locomotive proposed for comparison would be increased by about 3 tons, from 30 to 33 tons, metric. The weight of the motors themselves would be only 20 tons, as against 25 tons for the motors of the three-speed locomotive, so that the total weight of the locomotive would be 60 metric tons, equivalent to 66 American tons.

If we allow a departure from the condition that the motors of the two locomotives compared should have the same number of revolutions, and, for three-phase, adopt a 6-pole motor or a 4-pole motor, that is to say, motors of one and one-half times or double the number of revolutions, the weight of the motors decreases quite considerably. At the same time the wheel diameter also increases, and with it the weight of the mechanical part of the locomotive. The locomotive proposed for comparison, therefore, is far from being the most favourable design which might be put forward from the point of view of constructional weight for three-phase currents. On the other hand, with single-phase motors, a reduction of the total weight could hardly be attained through an increase of motor speed and decrease of wheel diameter—provided the gearless arrangement with the motors mounted on the shaft is retained—on account of the large dimensions of the motors, which put a limit to th minimum diameter of the wheels. On the other hand, if an arrangement of driving by cranks and connecting rods should be adopted, as in the three-phase locomotive, great constructional difficulties arise in consequence of the increased distance between axles, the greater difference in the height of axles and shafts, &c.



PLAN AND ELEVATION OF THE THREE-PHASE LOCOMOTIVE FOR ITALIAN STATE RAILWAYS.

Table II. gives the chief data of the two locomotives under comparison :—

Table II.

	Single-phase locomotive.	Three-phase locomotive.
Total weight of locomotive in American tons	140	66
Adhesive weight in tons	100	46
Weight of motors in tons	37	22
Rated capacity of motors in horse-power	2,000	2,200
Tractive effort on the one-hour rating in pounds	14,700	16,170
Length over all in feet	62	41
Speed in miles per hour at rated capacity	50	50

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From these data it appears that the locomotive of the Pennsylvania Railroad, at an approximately equal capacity, has a weight more than double that of a corresponding three-phase locomotive. Concurrently the hauling power of the locomotive is less than that of the three-phase locomotive, because, to arrive at the paying train-weight, double the amount has to be deducted from the total train-weight for the idle weight of the single-phase locomotive, as for the three-phase one. This is of importance, especially if there are heavy grades on the road. If, for instance, the railroad has a constant grade of 1 per cent., that is to say, one where the motors may not be loaded beyond their rated capacity, the Pennsylvania locomotive will be able to haul 267 American tons, beside its own weight, while the three-phase locomotive will haul 382 tons, beside its own weight, or 43 per cent. more. The speed in both cases is fifty miles per hour. (The train resistance in this calculation has been taken at 16 lb. per ton on the level.) When the long grades of the line are higher than 1 per cent. this ratio becomes yet more unfavourable for single-phase current. For instance, the single-phase locomotive compared, may, on a constant grade of 2 per cent., haul 123 American tons, whereas the three-phase locomotive will haul 212 tons, or 72 per cent. more, or, if the three-phase locomotive exercises only the same tractive effort as the single-phase locomotive considered, 197 tons, or still 60 per cent. more.

Table II. also shows for the single-phase locomotive, a considerably greater weight on drivers, which, on the basis of a coefficient of one-fifth, yields a maximum tractive effort of 40,000 lb. However, if we consider that so high a maximum with a tractive effort, on the one hour rating, of only 14,700 lb., is scarcely needed, and, with other electric locomotives (for instance, large d.c. locomotives), is never called for; if we further consider that three-phase locomotives will give a higher tractive effort for the same adhesive weight than single-phase locomotives, owing to the even character of the torque of the three-phase motor as contrasted with the pulsating torque of the single-phase motor, we shall conclude that this circumstance does not represent a disadvantage of three-phase operation. At the same time it should be noted that it would be easy to design a three-phase locomotive, which, at the same total weight (66 tons), would utilise its entire weight for adhesion, and should the requirements regarding maximum pull be still higher, the weight could be further increased by the addition of ballast weights. Even then the locomotive would weigh only about half as much as the single-phase locomotive considered, while it could, without trouble, develop for a short time the maximum tractive effort required.

The maximum tractive effort of the Pennsylvania locomotive is not so much a consequence of its motor capacity, as of its great construction weight, which is a disadvantage, and cannot be done away with because of the great weight of motors and transformers. It may be said, therefore, that, roughly speaking, half the weight will suffice to turn out a three-phase locomotive of the same, or rather more, power than that of a corresponding single-phase locomotive.

Wireless Telegraphy in Spain.—The wireless telegraph stations of Corunna and Ferrol, which were the property of the newspaper "El Diario Ferrolano," have recently been ceded to the State in exchange for a temporary and gratuitous service to the newspaper in question. The stations will remain open to the use of the public, and will be employed for the instruction of the employees of the wireless telegraph service, who are destined for the stations to be established at strategic points.

The Imperial College of Science.—The acting-secretary of the college has written to the Education Committee of the London County Council, asking for a maintenance grant of £5,000 for the year 1908-9. According to the scheme of 1903, the Council proposed to contribute the sum of £20,000 per annum, provided that land, buildings, and equipment for the proposed additional technological teaching and research, to the value of not less than £500,000, were in use. The acting-secretary states that the governors do not think it necessary that the Council should contribute the full amount of £20,000. The General Purposes Sub-committee of the Education Committee, report that although the governors have a capital of £510,500 at their disposal, only £86,000 is in use—this amount being roughly the value of the new portion of the Royal College of Science building. Until the value of the new buildings and equipment had risen to the stated value of £500,000, the Council were not bound to contribute any sum whatever, but they were prepared to include the sum of £5,000 in the annual estimates, and to actually pay this amount if the Council was satisfied that the additional expenditure on the part of the governors for the development of post-graduate teaching and research for the session 1908-9 amounted to not less than this sum.

THE GENERAL ELECTRIC DINNER

AT the eighteenth annual dinner of the General Electric Co., Ltd., held last Saturday at the Trocadero Restaurant, Mr. GUSTAV BYNG presided over a gathering numbering upwards of 450. After the loyal toasts, the chairman proposed "The Prosperity of Electrical Science and Industry." The success of any company, he said, depended on three main factors: the management, the general state of the industry, and political considerations. Mr. Byng then made appreciative references to the work of Mr. Hirst, the managing director, and of many individual members of the staff. With regard to the state of electrical science and industry, we had a serious rival in gas, but the metallic filament lamp had given a tremendous impetus to the electric lighting industry. The Robertson factories were working hard, and the foundations of a large new factory for metallic filament lamps had been laid at Hammersmith. England would soon be on a level with other countries in this matter. The influence of the third factor was not so favourable to success; the members of the present Government were, he said, opposed to the idea that industrial enterprise should be national. It was the duty of the Government to stand by and assist the manufacturer. He emphasised his own opinion that Free Trade had a bad influence on the industry, and attributed to the present fiscal policy of the Government the disproportionate amount of unskilled as compared with skilled labour.

Colonel R. E. B. CROMPTON (president of the Institution of Electrical Engineers) was the first to respond. He said that he was not one of those who thought that the electrical industry was in its decadence. England was obliged to confine herself to smaller and less showy work than that carried out abroad owing to the lack of water-power, but he thought that in this direction England had done well—nowhere could be found more excellent or better controlled systems of supply; and the average prices for electrical energy, both for lighting and heating, were less than in any other country.

Mr. W. M. MORDEY made some remarks in praise of the energy and enterprise of Mr. Byng and Mr. Hirst. With regard to the work in other countries, he was sure that we had little to learn as to electricity supply. Three years ago he had compared twenty representative towns in England and in Germany, and he had found that three times the number of units were supplied in the English towns at one half the price. He thought that the electricity supply companies would do well to enter into the field offered by small houses taking energy on the prepayment system. Both light and heat must be supplied, however.

Mr. H. HIRST welcomed the guests, and read letters from Sir W. H. Preece and Prof. W. E. Ayrton, who were unable to attend. Sir W. H. Preece was celebrating his 75th birthday in his own family circle, and a telegram of congratulation was despatched from the assembly.

Mr. E. GRANT BURLS and Prof. J. PERRY responded for the guests The latter welcomed the advent of the osmium and tantalum filament lamps, and remarked that the competition with gas had been a good thing for the industry; the invention of the incandescent gas mantle, particularly, had put us on our metal! Electrical engineers, however, should not be too confident about heating; heating by gas was equivalent to paying £6 per ton for coal, but heating by electricity might be said to be equivalent to paying £130 per ton.

The health of the chairman was proposed by Mr. Rashleigh Phipps (president of the Electrical Contractors' Association). In addition to those already mentioned, the guests included the Hon. C. H. Rason (Agent-General for Western Australia) and a large number of well-known consulting engineers, central station engineers, and others connected with electrical engineering. During and after dinner an excellent programme of music was performed, and the evening concluded with an entertainment in which several well-known variety artistes took part.

Temporary Supply at Gillingham.—On Wednesday last week in the King's bench division of the High Court the Lord Chief Justice, Mr. Justice A. T. Lawrence, and Mr. Justice Sutton, sitting as a divisional court, had before them the case of the Mayor, Aldermen, and Burgesses of Gillingham, Kent, *v.* The Kent Electric Power Co., which came before their lordships on a case stated by the arbitrator. In 1905, owing to the destruction by fire of the generating station of the Gillingham Urban District Council, an agreement was entered into with the Kent Electric Power Co. for a temporary supply of electrical energy. This agreement was dated June 6th, 1905, and provided for the current to be metered at the defendants' power station, any difference between the parties concerning the agreement or its construction was to be referred to an arbitrator. A supplemental agreement was later entered into for a continuation of the supply under the original agreement. At the date of this extension agreement, a question arose as to the accuracy of the meter. The point went to arbitration, and the arbitrator, being in doubt as to whether he would be in order in admitting evidence of certain tests of the meter in question, applied to the court for direction. Their Lordships decided that the case should be sent back to the arbitrator for the admission of the evidence referred to.

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A NEW SINGLE-PHASE RAILWAY MOTOR

MR. E. F. ALEXANDERSON read a Paper recently before the American Institute of Electrical Engineers describing a new single-phase motor designed for traction purposes. The motor in question, is neither a series nor a repulsion motor in the generally accepted sense, but embodies the best features of both. The windings resemble those of a series motor, and the armature and stator are permanently connected in series. A general diagram of the motor is shown in Fig. 1. The terminal voltage can be selected with greater liberty than in a series motor, but not so arbitrarily as in the case of a repulsion motor. The author designates the motor as a "series repulsion motor" for lack of a better name.

In its performance it resembles the series motors with commutating poles, but several distinct advantages are claimed over the same. Instead of producing a commutating flux locally by coils on the stator, the conductors in the armature are located in such places where the desired flux will naturally exist. This arrangement simplifies the stator winding considerably. The compensating winding of the series motor is replaced by an inducing winding with twice as many turns, and the energy is introduced either in the stator alone or in the stator and rotor together. By this arrangement, as will be explained later, the starting torque is doubled for the same commutation and the same supply of current.

In the compensated repulsion motor the commutating field becomes too strong as soon as the speed appreciably exceeds synchronism, unless special arrangements are made to suppress this field locally. The motor under consideration is not limited by the synchronous speed, as the repulsion motor feature is reduced at the high speeds, and its action follows more closely the performance of a series motor; the number of poles can therefore be selected with the same liberty as in a series motor. This is of great importance for the motor characteristics, particularly in regard to weight and starting torque. Furthermore, no extra set of brushes, nor any series transformer, is required, which makes the motor equally well adapted for direct and alternating current. These being the most important general characteristics of the motor, there are a number of features which are of interest, particularly to the designer.

A theoretical discussion of some length is given in the Paper to demonstrate how the two fundamental conditions for good commutation can be fulfilled in a series repulsion motor at any speed without the aid of commutating poles. Instead of creating a commutating flux artificially in a place where the commutated conductors happen to be, the conductors are located in a place where the correct flux will naturally exist. By controlling the value as well as the phase of the different fluxes as described, perfect commutation can be obtained at any speed. The improvement introduced by the fractional-pitch armature winding is a separate matter and is of the same character as the change from an ordinary direct-current machine to a commutating-pole machine.

The starting of a single-phase motor is materially handicapped by the fact that the alternating nature of the main

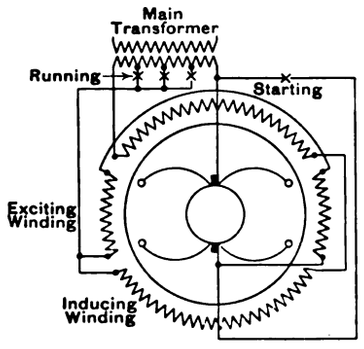


FIG. 1.

field sets up currents in the armature coils which are short-circuited by the brushes. This same difficulty is experienced in all known types of single-phase commutator motors. Although the principle involved is the same in the motor under consideration, the practical result gained by the arrangement employed is a starting torque twice as high as would be possible in a corresponding series motor for the same commutation and the same supply of current.

This double starting torque is obtained by winding the stator with twice as many turns as the armature. The motor starts as a repulsion motor with the armature short-circuited as shown in Fig. 2. The current as it enters the stator has only half the strength of that in the rotor, owing to the ratio of stator to rotor turns. The short-circuiting switch of the rotor carries only half as much current as the rotor itself, because the current in the short-circuited connection is only the difference between the stator and the rotor current. The inducing winding, the field, and the armature are connected permanently in series, but with the connections shown, the field is in series with the stator circuit at starting and with

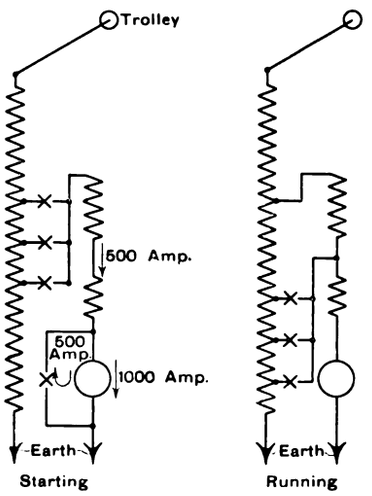


FIG. 2.

the rotor circuit when running. In starting, the rotor carries twice as much current as when running, in order to give the same field strength—in this manner doubling the starting torque. The sparking at starting is quite insignificant up to a certain value of the voltage short-circuited by a brush, but beyond this point the commutation rapidly becomes bad. This critical value is about the same as that which gives a reasonably good commutation in running. In regard to the practical application of the system, it may be mentioned that several four-motor equipments for alternating and direct current have been in operation for some time. The alternating-current control equipment has a total of seven contactors and a reversing switch. This gives four points on the controller which seems quite satisfactory for motor-car operation, though any number of steps can be added to take care of locomotive operating conditions.

The preferred method of control is the one shown in Figs. 2 and 3. In starting, the armature is short-circuited, and the full secondary voltage of the transformer is impressed upon the inducing and exciting windings. The current flowing through the stator continues through the armature, but due to the ratio of turns of inducing winding and armature winding, an additional current of equal strength to the stator current flows through the local circuit of the armature and the short-circuited connection. In the running connection, part of the power is introduced in the stator and part in the rotor, and the field winding carries the same current as the armature; that is, twice the stator current, thus giving a relatively greater field strength than in the starting condition, just as it would be produced by a series-multiple connection of the field winding.

Although the total potential impressed upon the stator and rotor is the same for starting and running, the result of changing the connection so as to transfer the energy input from the stator to the rotor has the effect of increasing the resulting voltage of the motor. This is due to the ratio of transformation between stator and rotor. In this manner a higher speed is obtained by impressing a higher resulting voltage, and the same change of connections makes the motor adapted for a higher speed by changing the ratio of series and repulsion motor action.

The considerations governing the power factor of single-phase motors are then briefly considered, and it is shown that the power-factor of the "series repulsion motor" is practically the same as in a series motor.

The use of resistance leads, which has been so much discussed, has been found to be unnecessary in motors of the

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type described. Certain motors which have been operated for a considerable time as series motors, and then rewound so as to embody the features described in this paper, have shown an increased life of brushes and commutator up to the standard of good direct-current practice. The improvement in commutation was so great that it was possible at the same time to increase the thickness of the brush and the output of the motor.

In regard to choice of frequency, the series repulsion motor again gives greater liberty. Whereas the starting torque can be doubled on either 15 or 25 cycles, it may be mentioned that a series motor which was almost inoperative at a certain load at 25 cycles, after rewinding, as described, was tested as a series repulsion motor, and found to give excellent commutation at 40 cycles, at the same load. It can therefore be said in general that 25 cycles is entirely satisfactory for all geared motor work; it is preferable in that the combination of motor and transformer weighs less at 25 than at 15 cycles.

Economy of Material.—The motor described can be built in larger capacities than the series motor. The principal reason for this is the inherently good commutation and increased starting torque which make resistance leads unnecessary, thereby eliminating the heat generated by the resistance leads, and also gaining space in the slots, which can be used for copper. Furthermore, it is possible to increase the flux per pole without impairing the commutation.

The author sums up the advantages claimed for the new type of motor as follows:—

(1) Good commutation at all speeds without the use of resistance leads. (2) Larger capacities possible than with the series motor. (3) High tractive effort possible, due to the liberty of selecting the number of poles. (4) Increased starting torque, possible because of the inherent ratio of winding turns, without supplying an increased current from the main transformer. (5) Simplicity of construction. The stator is the same as in the series motor, in fact easier to construct due to the greater liberty of placing the field-winding in slots. The armature is constructed according to standard direct-current practice with the conductors soldered into the commutator bars. (6) Equally well applicable to direct and alternating current.

CATALOGUES AND PAMPHLETS RECEIVED

ALTERNATORS, TRANSFORMERS, METERS.—New leaflets from the Electrical Co. deal with the following subjects:—Specification of revolving field type three-phase alternators with internal or external field; price lists of single-phase oil-insulated transformers, from 1 to 70 kw.; three-phase oil transformers up to 100 kw.; and continuous-current meters for switchboard and traction use.

ARC LAMPS.—A leaflet from the Warner Engineering Co. gives particulars of the "Warner Solio" arc lamp, three forms of which, with decorative metal cases, are illustrated. A polar curve is given showing the excellent distribution of light obtainable with this form of lamp, for which an efficiency of 0·223 watts per mean hemispherical candle-power is claimed. Three sizes, for 8, 10, and 12 amperes respectively, are made, both for continuous and alternating currents.

ARC LAMPS.—A revised price list has been issued by The Foster Arc Lamp & Engineering Co., of Wimbledon, which covers a very considerable range of types of arc lamps and accessories, and also some small transformers for use with metallic filament lamps. The general features of the Foster enclosed arc lamp were described and illustrated in ELECTRICAL ENGINEERING, Vol. II., page 768. Lamps of this description are made in various forms and sizes, and special attention may be called to the inverted reflectors listed. A simple form of hot wire alternating enclosed lamp is also included, in addition to special lamps for photographic purposes, and the Foster flame arc lamp for direct or alternating currents, with the usual inclined carbons and a feed mechanism of the brake type.

CRYSTOPAL TILING.—A pamphlet from Messrs. George Kent, Ltd., points out the advantages of this special form of tiling for the interior of such buildings as generating stations, &c. The white opal glass surface is easily cleaned, and reflects a great amount of light, and the elastic nature of the backing gives the material great strength.

INSTRUMENTS.—A list is to hand from Messrs. Isenthal & Co. composed of several separate sections, conveniently arranged in a cover, and provided with a thumb index for facilitating reference, which covers a considerable range of measuring instruments supplied by this firm. The types included comprise electromagnetic ammeters and voltmeters of switchboard and portable patterns, dead-beat moving coil instruments, and hot-wire instruments. A separate section deals with dynamometer type wattmeters. Flush type and edgewise type and illuminated dial instruments are included, in addition to ordinary patterns, as well as one or two forms of insulation testing apparatus.

METALLIC FILAMENT LAMPS.—A card from the Electrical Co. gives particulars of the "Aegma" metallic filament lamp, which is made in the 25 to 50 c.p. sizes for 100 to 130 volts.

PORTABLE ELECTRIC TOOLS.—A new catalogue of portable electric tools, &c., has been issued by the Consolidated Pneumatic Tool Co., Ltd. A large variety of electric drills are included with self-contained motors. A feature of these machines is the use of a small fan on the motor spindle by which a current of air is drawn through the motor for cooling purposes, so that motors of extremely light weight for their outfit can be employed. The planetary form of reduction gear used also permits of great compactness, and the ball thrust bearings tend to high efficiency. The smaller drills are of the ordinary single armature type, but an ingenious arrangement of two or even three armatures revolving in one field system is adopted in the larger machines. Some of these drills were illustrated in ELECTRICAL ENGINEERING (Vol. II., p. 612) in connection with the recent Engineering and Machinery Exhibition at Olympia. Alternating and continuous current drills are included, and a number of useful accessories are listed, including a special form of feed gear for adapting these drill to rail bonding work. Other tools are portable grinders, buffers, &c., for hand or lathe use, as well as pedestal forms, and a special design of long-necked grinder for internal work. A particularly compact self-contained blower for dusting electrical machinery is listed, and another line of machinery which should be mentioned is simply designed series of electric worm-geared lifting blocks. Other apparatus includes a magnetic separator, which can be employed for separating iron and steel borings and turnings from dirt, and several other purposes, and a submarine arc lamp for the use of divers.

STORAGE BATTERIES.—The D.P. Battery Co. have issued a pamphlet on their well-known storage batteries, printed with three parallel columns in English, Japanese, and French respectively. The Japanese lettering is printed in lines across the page, to read from left to right, in order to correspond with the other two languages, and the prices are given in £ s. d., although Japanese numerals are employed. We notice what appears to be a typographical error in the table of capacities on p. 10, where, in the Japanese column, the second size is given as 140 instead of 240 ampere hours.

TELEGRAPH, TELEPHONE, AND RAILWAY SIGNAL APPARATUS.—A handsome bound catalogue from the Walters Electrical Manufacturing Company at Kensal Road, W., contains particulars of a very complete line of telegraph instruments, including Morse ink writers, full sets of apparatus for single and double current, simplex and duplex, diplex and quadruplex working, sounders, relays, keys, and other apparatus, galvanometers, and testing appliances. A number of patterns of bells, indicators, and pushes are included, and a complete range of lock and block instruments for railway signalling. The telephone section embodies most of the familiar types of wall and table sets for battery and magneto working, small switchboards for private exchanges, and automatic replacement intercommunication telephones. Battery materials of all kinds are included, as well as insulators, line material, and tools.

TRANSFORMERS.—Messrs. Johnson & Phillips, Ltd., have issued a carefully arranged and well illustrated pamphlet describing their series of standard designs for single-phase and three-phase transformers. The air-cooled type are built up to 100 k.v.a. capacity, the oil-self-cooled type up to 400 k.v.a., and oil-insulated water-cooled type up to any size. The cores are of the "butt joint" type, and a damaged coil can be easily replaced. The frame is simple, and is so designed that there are no clamping bolts through the part which carries the magnetic flux. Particulars of performance of this type of transformer, and finally the dimensions and weights for both single-phase and three-phase air and oil cooled transformers are given.

WEIGHING MACHINERY.—The new catalogue of weighing machinery issued by Messrs. Hodgson & Stead, of Manchester, contains illustrated particulars of practically every kind of weighing appliance, ranging from the largest railway weighbridges, down to the smallest scales and balances, including a particularly large selection of platform weighing machines for general purposes.

Sale of Magneto-Igniters.—In the Court of Appeal on Friday before Lord Justice Vaughan Williams, Lord Justice Farnwell, and Lord Justice Kennedy, the case of De la Valette *v.* Riches & Co. was decided. The first claim had been admitted, but defendants (Riches & Co.) had brought a counterclaim for breach of contract, and judgment had been given by Mr. Justice Walton, who had granted defendants £750 damages, but had raised the point as to whether the agreement was enforcible. (*See* ELECTRICAL ENGINEERING, Vol. II., page 193.) Their lordships held that the contract did not come within the Statute of Frauds, and was not enforcable, and accordingly the appeal was allowed.

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THE OFFICIAL AUDIT OF ELECTRIC SUPPLY COMPANIES' ACCOUNTS

In November last the Board of Trade issued to electric supply companies a letter, which we reprinted at the time, stating that "they are considering how far it would be possible or expedient to utilise for the purposes of the official audit, the audit conducted on behalf of the shareholders, and so to reduce the amount of work and inconvenience involved by the double audit." This letter has led to protests from a large number of local authorities, who are evidently under the impression that their interests as the potential purchasers of the companies' undertakings are in some way protected by the existing official audit, and would consequently be imperilled if it were dispensed with. The principal ground for this view appears to be that the purchase prices to be paid when the undertakings are eventually acquired by the local authority, will be based upon the companies' capital expenditure, as shown by their books, and that it is therefore necessary that an official audit shall be maintained to prevent improper allocation of expenditure to capital account, or inflated and unnecessary capital expenditure.

There are two principal conditions under which the company undertakings may be purchased by the local authorities, and it is necessary to consider these separately in order to see whether, and to what extent, the official audit could be a protection against over-payment by the purchasers.

The first or general statutory conditions are those provided by Section 2 of the Electric Lighting Act of 1882, which permits the local authority to purchase the undertaking at the appointed time at the fair market value of the lands, works, materials, and plant *at the time of the purchase*, due regard being had to the nature and *then condition* of such buildings, &c., &c., and to *the state of repair* thereof, and to the circumstance that they are in such a position as to be ready for immediate working, and, to their suitability of the same to the purposes of the undertaking, but without any addition in respect of compulsory purchase or of goodwill, or of any profits which may or might have been made, or of any similar considerations. Failing agreement between the parties, the price is to be determined by arbitration, and the section above summarised is a statutory instruction to the arbitrator as to the basis he must take for his award.

There has been no purchase under the section, but it is sufficiently close to the purchase clause (Section 43) of the Tramways Act of 1870, to make it certain that the legal meaning is substantially the same, so far as it has any bearing upon the question of audit of the companies' accounts.

In the first place, the value is the structural value of the works, plant, &c.; at *the time of the purchase*, in their *then* condition, their *then* state of repair, and their suitability to the purposes of the undertaking; this can be determinable only by contemporary evidence, and the capital account of the company during the years of its exploitation could not be admitted as evidence by any arbitrator. This view is supported by the actual working of the Tramways Act purchase clause. In the arbitrations held thereunder, the valuations made by both sides are their estimates of the structural value at the time of purchase. The usual method is to set out the cost of the undertaking as a new structure at the "appointed day," and to depreciate it, according to its age, the ascertained rates of wear and the actual state of repair? Some of the company's plans and books may be accepted, as the bases of "quantities," and it is usual for the experts on both sides to endeavour to "agree quantities," in which process the company's records may be used. Any such use is, however, strictly by consent of the purchaser, who may dispute every detail of the company's "quantities," as well as their valuation, if so disposed.

The very specific instructions laid down by Parliament for the guidance of the arbitrator, do not include his scrutiny of the company's books, and it is submitted that those books and the published accounts derived therefrom, will be entirely immaterial to the awards made; and consequently, that their official audit or non-audit must be equally immaterial.

The other conditions under which the local authorities may purchase electric supply undertakings are, generally, in virtue of agreements to purchase before the expiry of the period at which the compulsory purchase clause becomes applicable. Such an agreement may be made in virtue of Section 3, of the Act of 1883, either when the company is obtaining its Parliamentary powers, when the terms form virtually part of the "price of consent," or it may be made at any time after the granting of the powers. In either case the agreement must have the approval of the Board of Trade.

The terms of such agreements, of which there are many in existence, vary widely, but they are in general so drafted as to provide that the company shall receive, in some form or other, compensation for the prospective profits of the time elapsing between the date of purchase by agreement, and that at which compulsory purchase may occur; and in many cases the compensation is defined as a premium added to the capital properly expended upon the undertaking. There are other cases in which the compensation is defined as a sum sufficient to make up some average dividend upon the capital expended, during the whole period of the company's concession; and in all these cases the company's books will no doubt be relevant, but not conclusive. It is therefore contended that the official audit of the accounts is necessary to prevent improper swelling of the purchase price, but if this view is correct it would put upon the official auditor a much more onerous task than that of audit, no less indeed than an annual valuation of the undertaking in the terms of the purchase agreement. On this basis, clearly, the potential seller and purchaser would necessarily seek to protect their interests before the auditor, exactly as they do before an arbitrator. It hardly seems to need argument to show that such an annual valuation is impracticable, and would be a foolish waste of time and money.

To take a concrete illustration, the case of the Borough of Camberwell may suffice. Here, the Borough may buy the undertaking of the County of London Electric Supply Company, at any time, by paying an amount equal to a sum of £133 for every £100 "properly expended on the undertaking and chargeable to the capital account." "The undertaking" means the company's undertaking within the Borough of Camberwell. The company works this in conjunction with other undertakings, as one business. It has no generating station in Camberwell, but it has, on the other hand, mains passing through Camberwell which supply other districts. Evidently the question of how much capital has been "properly expended and charged to the capital account," in respect to that undertaking is one upon which the seller and the buyer, both in good faith, may differ widely, and one on which neither would be willing to take an official's opinion, unless he were acting judicially *ad hoc*, and heard the parties in a regular way. The Camberwell Borough Council has asked the Board of Trade to set up machinery by which its own representations and the explanations of the company may be duly considered, but does not seem to recognise that it is really asking for an annual valuation, and will probably not wish to pay for such work at the usual rates.

The proposal of the Board of Trade to accept the audit of the shareholders' auditor seems to have been made to relieve the companies of the work and expense of two audits of the same accounts. It is difficult to see how any public interest can suffer from the change. It must be assumed that auditors accepted by the Board of Trade will be professional accountants of undoubted capacity and integrity. The official auditors have no legal power to amend accounts of which they do not approve; they may comment on them, and the spectacle is on record of an official auditor in his comments speaking of items which he has "disallowed" for years in succession, with no effect upon the accounts.

A New Form of Accumulator.—A form of battery, containing some points of novelty, made by the Standard Electric Accumulator Co., of New York, is described in the *Street Railway Journal*. The main feature is the complete enclosure of the active material and its lead electrode in a very thin, strong, and porous box of unglazed pottery. The result is a cell having the same chemical properties as other lead-lead-oxide couples, but very light for its output, since the supporting grids have been replaced by the much lighter earthenware. Moreover, the active material stays permanently in place. The cells are built up on the unit system. Each unit box is about 3½ in. square, and half an inch thick over all. Its sides are porous plates, of which the inner surfaces are reticulated, and the outer faces ribbed. The reticulations strengthen the plates and firmly grip the active material, while the ribs give added strength, and also serve as spacers to hold adjacent boxes far enough apart to permit free circulation of the electrolyte when the cell is in use. When assembled the opposed ribs provide vertical flues in which the acid flows freely. The body of the plate is about 1/32 of an inch thick, and so porous that liquid goes through it almost as through blotting paper, while the pores are so fine as completely to prevent any infiltration of the active materials. In building the battery the reticulated sides of the plates are compactly filled with a paste of lead oxide, and a sheet-lead electrode is placed between two plates. The edges are closed tight, either by flanges on the plates themselves or by edge pieces applied when the cell is assembled. In the larger cells as many unit plates as are necessary are assembled with a single large lead sheet as electrode between the active surfaces, and these composite boxes are assembled with non-conducting backing plates and hard lead bands. The element thus assembled is placed in its electrolyte, "formed" in the ordinary manner, and is then ready for use.

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A DYNAMOMETER FOR TESTING AUTOMOBILES

A VERY complete apparatus for carrying out tests of automobiles and making measurements under running conditions of speed draw for full horse power of road wheels, brake power, &c., has been installed by the Automobile Club of America, New York.

The dynamometer, which is described in *The Electrical World* (New York), consists of a moving track upon which cars can be fully tried while remaining stationary and under observation. In 1904, Dr. S. S. Wheeler was requested by the club to design and build a machine for determining accurately the performance of cars of all kinds, and the present machine is the result of several years' attention to this problem. It is an assemblage of power absorbing and measuring instruments, and a large power chart with automatically operated pointers. It absorbs and measures the power so that, at a glance, the speed, tractive effort and horse-power can be clearly seen and read at each instant. The measurements show the power delivered at the ground by the wheels of the automobile. Instead of travelling along, as on a road, the car is held stationary by cables upon the floor with its driving wheels resting upon two large drums which reach up through the floor, and which the engine of the automobile causes to revolve. The revolution of the drums is resisted by a large pendulum hanging below the floor, and attached to the drum shaft, not rigidly, but through a device furnishing a degree of friction which can be varied.

The pendulum, in consequence, swings out from the vertical a distance exactly proportional to the pull exerted by the car upon the drums. The amount of this pull, or tractive effort, is indicated by a pointer attached to the pendulum and reaching above the floor. The indications given by the pendulum are transferred to a ruler travelling across the face of a large chart by a wire cable moved by a small motor, in such manner that with each varying position of the pendulum pointer, the cable is moved to correspond to its new position.

The more difficult operation of measuring accurately the speed of the car, by moving another ruler vertically across the large chart, is accomplished by special apparatus of some novelty.

A cone is revolved by an electric motor at absolutely constant speed. To verify this speed, a bell, attached to the cone shaft, rings at each 100 revolutions, or at intervals of 30 seconds. A wheel or roller, driven by the automobile and, therefore, revolving slowly or fast to correspond, rolls upon the surface of the cone and is pulled, by an independent motor, back and forth between the small and large ends of the cone until it finds the point where it does not slip because that portion of the cone presents the same speed as the roller. This longitudinal adjustment of the roller is transmitted by a wire cable to the speed ruler on the chart, and the power required for moving the ruler is thus made independent of the automobile. In other words, none of the power of the automobile is used in operating the indicators on the chart. The method of speed measurement employed, based upon one element running at a constant speed like a clock, that can be verified, insures great accuracy. The roller, driven by the car if running at 60 miles per hour, must be drawn to a position near the large end of the cone in order to run with the cone. Whereas, if the car drives the roller at only five miles per hour, it must be drawn to a position near the small end of the cone. A system of electric contacts is arranged with a motor to shift the roller automatically until it finds the point where it will roll on the cone without slipping.

The speed and power rulers are thus moved across the chart automatically to correspond with the speed and the tractive effort or pull that the dynamometer shows the car is making.

On the board are painted the horse-power corresponding to each different speed and pull, so that the result at each moment can be read at a glance and without calculations.

The chart can be read easily by the driver of the car. The speed of the car may be read from the chart in miles per hour, minutes per mile, kilometres per hour, &c., by means of the several different scales provided.

All of the measuring apparatus is made reversible so that when running backward the performance of the car may be measured. As a secondary apparatus, a grade meter is provided, operated by the pendulum indicator of the dynamometer. To use the grade meter the clamp is set upon the sliding scale at the point representing the weight of the car. The moving lever then assumes at each moment the angle of inclination of the grade the car would climb (if there were no wind resistance, slipping, &c.), with the effort that the car is then making.

To observe an automobile coasting down hill, either forward or backward, it is necessary merely to start the electric motor on the shaft carrying the two large drums upon which the driving wheels of the automobile rest. The brakes may then be tested, and the wheels or gears or engine may be run free (not run by the power of the automobile), and the relative friction loss of the automobile may be ascertained. The exhaust from the automobile engine is directed into a pipe connected to an electrically driven exhaust fan, so that the test room is free from smoke and obnoxious fumes. The apparatus was built by the Crocker-Wheeler Company.

The Mersey Railway Contract.—On Friday, in the Chancery Division of the High Court, Mr. Justice Eve heard a motion in the action of the British Westinghouse Electric Manufacturing Co., Ltd., v. The Mersey Railway Co. Mr. Stewart Smith, K.C., and Mr. Martelli, appeared for the plaintiffs, and Mr. P. Ogden Laurence, K.C., and Mr. Clauson were for the defendants. Counsel explained that the defendant company had obtained powers to convert its line to electric traction. The plaintiffs, who carried out the work, were to take payment in debenture stock, and were also to find money to redeem certain existing debenture stock. This arrangement was embodied in an agreement dated July 15th, 1901. That agreement recited that there was then outstanding original first debenture stock amounting to £249,276, and that under its new Act of 1900, the defendant company was authorised to create and issue two further amounts of debenture stock of £275,000 and £428,000, making a total of £703,000 debenture stock. The contract price for the work was to be £620,000, payable in 4 per cent. perpetual debenture stock. Therefore on the redemption of the £249,276, the company was entitled to create and issue £703,000 perpetual 4 per cent. debenture stock. The agreement also provided that the Mersey Railway Co. should not issue the difference between the £249,276 and £275,000, or the difference betwen the £620,000 and the £703,000, at a higher rate of interest than 4 per cent., or at a lower price than par, without the previous consent of the plaintiff company in writing. The action was brought for alleged breach of this clause. The reason for the clause was that the company should not flood the market with stock which would spoil the plaintiff company's holding. His lordship inquired if Mr. Smith contended that the clause bound the defendant company for all time. Mr. Smith said he did not know, but he did say that it bound the defendant company so long as the plaintiff company had rights under the contract. The plaintiff had still got some of the debenture stock, and there was a considerable block of the £620,000, namely, £34,000, unissued. The plaintiff company said the work was all completed in June, 1906, but as so often happened in these contracts disputes had occurred. The railway company said that the work was not completed, and that the plaintiff company had been paid all it was entitled to. The parties had been at arbitration on the matter, and a supplementary agreement was entered into on July 19th, 1904, and the defendant company now said that there had been a breach by the plaintiff company of its obligations under the supplementary contract, which released the defendant company from its liability under the original works contract. That was the question that had to be determined. If the defendant company was right, the consequences to the plaintiff company would be very serious, because there was £34,000 stock unissued, and if the fetter under clause 4 of the works contract were removed the defendant company would issue stock at such discount as it pleased. In this way the defendant company could interfere with the large holding of stock held by the plaintiff company, and its friends, and could destroy any market for the plaintiff company's shares by putting blocks of debentures on the market at a lower price. The defendant company, in fact, was trying to force the plaintiff company to at once take up the unissued £34,000 stock. Mr. P. Ogden Laurence, K.C., for the defendant company, argued that no reading of clause 5 warranted the construction that the plaintiff company was to have two months' notice in each year. His lordship, in his judgment, held that the plaintiff company was bound to take over the stock on January 2nd, 1908, and that by the failure to do so the company stood released from the works contract. It was said that the conduct of the company, subsequent to the failure of the plaintiff company to take the shares amounted to a waiver of the consequences, because it did not present the stock. But the obligation was on the plaintiff company to present itself with the money to pay for the stock. The company was, by plaintiff's failure to take the stock on January 2nd, 1908, released from clause 4, and all he could do was to refuse the motion. The motion was accordingly refused ith costs.

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ELECTROCHEMISTRY AND ELECTROMETALLURGY

TWO highly interesting articles by Dr. A. E. Tutton, F.R.S., have appeared in the last two numbers of the *Times Engineering Supplement* upon "The Diamond and its Artificial Reproduction." The first article deals mainly with the diamond as it is found naturally occurring, and its properties. It is premised that the diamond is always produced by the crystallising of molten carbon under pressure, and it is presumed that the crystallisation usually took place within molten iron. The blue clay which forms the pipes in which the diamond is found is not the magma in which the crystallisation took place, but the diamonds have been forced up into the clay by volcanic agencies. Recently blocks of one of the original rocks in which crystallisation took place were found in blue clay. These blocks consisted of an eclogite containing large quantities of iron, and small diamonds were actually found within them, thus giving the final proof that such was the original mode of origin of the diamond. Although carborundum and metallic tantalum approach the diamond in hardness, they do not exceed it, and the diamond is still the hardest substance that we know. Although diamond is so hard, it is extremely brittle, and can readily be reduced to a powder by a blow from the hammer. But Sir William Crookes has shown that if it be placed between two hard steel jaws, and an even pressure applied, the jaws can be made to touch each other, the diamond having been embedded into the hard steel as if it were wax. Diamond is, as is well known, an allotropic modification of carbon, and by strongly heating it in an electric arc, can be converted to graphite. Quite recently Parsons and Swinton have shown that by rapid bombardment by means cathode rays, the diamond can be converted into a graphite coke. The current used was about 48 milliamperes at 11,200 volts, and at a temperature of 1,890 C. the diamond swelled up and became converted into this coke. It was left to electric furnace methods to prove on a laboratory scale that the necessary conditions for the production of crystalline carbon in the form of the diamond, are high temperature pressure and slow solidification. High temperature, because it is first of all necessary to liquefy the carbon. It has been found when amorphous carbon and graphite are heated to a temperature of 3,600° in the electric arc, in an atmosphere incapable of chemically acting upon the carbon, that they vaporise without first liquefying, and on cooling condense to form crystals of graphite. Diamond, on the other hand, is first converted into graphite, and then vaporises, and on condensation forms graphite. Now arsenic behaves in a similar manner, but if heated under pressure, it can be liquefied. The conclusion there is, that if carbon is heated to a sufficiently high temperature at a sufficient pressure, and is allowed to cool under pressure, crystalline carbon in the form of diamond will settle out.

In 1896 Moissan showed that by dissolving sugar carbon (the purest form of amorphous carbon) in molten iron, and plunging it into cold water or mercury, great pressure is produced. When pure iron is cooled it contracts regularly like any other metal. But when carboniferous iron is cooled it expands in the act of solidifying. By suddenly quenching iron, a solid layer or crust is produced outside the molten metal. When, therefore, the inside layer commences to solidify, it expands as it solidifies, and thus, as it is encompassed with the solid crust, enormous pressure is exerted. When quite cold the iron was dissolved away by means of acids, and there was left behind minute crystals of diamond. Moissan melted the iron in a carbon crucible with a current of 1,000 amps. at 60 volts, a temperature of between 3,000 and 4,000° C. thus being obtained. Crookes, in 1897, confirmed Moissan's work, and again in 1905 Moissan publihsed a further paper upon the subject. Shortly after Moissan published his work in 1896, Professor Majorana, in Italy, also showed that pressure and high temperature were necessary. He heated a piece of charcoal between two carbon electrodes, and then while incandescent drove it with great force into a hole in a steel block. In 1905 Sir Andrew Noble exploded cordite in closed steel cylinders, a temperature of 5,100° was obtained, and a pressure of 50 tons per square inch. Sir William Crookes examined some of the carbon deposited, and found it to contain minute diamonds. Although electricity has been successful in unravelling nature's secret of manufacturing the diamond, it is not probable that diamonds will ever be manufactured. We have no conception of the enormous forces exerted by nature in the earth's interior, where masses of molten metal and rocks are cooled slowly. And this is really the point, we cannot conduct our experiments upon a sufficiently large scale, and cool slowly enough, to ever expect to obtain large crystals of diamond. It has already been mentioned that carbon exists in three allotropic forms. There is no difficulty in obtaining amorphous carbon or charcoal, but until the introduction of the electric furnace it was not possible to manufacture graphite, but last year, as we mentioned in this article last week, 3,092 tons were manufactured in the electric furnace.

In contradistinction to the results obtained by J. Tafel, who stated that when nitrates were reduced in acid solution with copper cathodes the reduction does not go beyond the hydroxylamine stage, H. E. Patten found that hydroxylamine is reducible with copper cathodes, and he was able to obtain 58·8 per cent of the theoretical yield of ammonia. The electrolyte contained in this case 1·7 per cent. of sulphuric acid. (*Chemiker Zeitung*, 1907, 1,135.) Tafel now replies (*Chemiker Zeitung*, 1908, 135) that his reductions were carried out with a heavy current in 50 per cent. sulphuric acid, and that in such an electrolyte hydroxylamine is not reduced to ammonia. He has, however, repeated the work, using diluted acid, and finds that hydroxylamine is actually reduced when the concentration of the acid in the cell is below a certain minimum. The question is one of interest, the probable explanation is that in dilute solutions the hydrogen is given up with a higher super-tension than in strong solutions.

Electrochemical and Metallurgical Industry of February reports that the Canadian Zinc Co. is making good progress with the completion of its plant. The plant is designed for the electric reduction of zinc, and is being built after the designs of F. T. Snyder. An electric plant is working successfully in Sweden, but this is the first plant to be erected on the American Continent. A large quantity of the lead ore in the Slocan district contains zinc, and the smelters demand a penalty for the zinc content. Consequently, a considerable quantity of the ore cannot be worked owing to this penalty. The establishment of the Canadian Zinc works in Nelson will mean the opening up of many Slocan properties which at present cannot be worked remuneratively.

In the same number of *Electrochemical and Metallurgical Industry*, a Multiple-Voltage Dynamo for Electroplating purposes is described. There are two commutators and two sets of brushes, one on each side of the machine. The commutators are each connected with half of a double winding on the armature. For plating purposes each set of brushes may be connected to a plating tank, so that two separate tanks may be operated from the same machine. Both may be operated independently of the other, since by placing in each circuit an adjustable resistance it is possible to adjust the pressure at the terminals of each tank at will. It is also possible, by connecting the negative brush on the one side of the machine with the positive brush on the other side to connect the two armature windings in series, so that the double voltage is produced at the two free brushes. Suppose, for example, that the machine is built to give normally 5 volts on each side, it is possible to supply any voltage between zero and 5 to two tanks simultaneously and independently by means of the two adjustable resistances. But by connecting in series as just described, it is possible to obtain anything between 5 and 10 volts. By using a single machine in this way, the saving in first cost and floor space is self-evident. The whole of these changes can be made with three switches. One for connecting the two windings of the dynamo in series. When this switch is open there is no connection between the two windings, and the current can be taken off from both sides of the machine independently and fed to two local circuits. One switch in each of the two local circuits is necessary to open and close them independently. These dynamos are built for from 400 to 10,000 amps., and are supplied by the Zucher and Levett and Loeb Co., of New York.

The first award of the Perkin medal has been made to Mr. J. B. F. Herreshoff, the chief scientific adviser to the Nichols Copper Co. The Perkin medal was founded in 1906 in connection with the "coal tar colour" jubilee, and is to be given to an American chemist in recognition for good work done. It is particularly interesting that it should have been given to an "electro-chemist," it also shows the importance which the Americans attach to this comparatively new branch of chemistry.

The Electrochemische Werke, of Berlin, which is in a very flourishing condition, have just declared a dividend of 9 per cent. Their chief works are in Bitterfeld and Rheinfelden, and also at the Chemische Fabrik Griesheim-Electron in Frankfort. They manufacture chlorine, bleaching powder, potassium, hydroxide, sodium hydroxide, potassium carbonate, magnesium, calcium carbide, and metallic calcium; they also manufacture oxalic acid, but not by an electrochemical process.

It is found that small quantities of iron which may dissolve off from the iron electrode, or from impurities in the electrolyte on to the nickel oxide electrode, very considerably affect its capacity. Edison—*American Patent* 876,445 (1907)- states that the addition of 2 per cent. of lithium hydroxide to the electrode very considerably increases the life of the nickel electrode. The electrolyte, beside the lithium hydroxide, is made up of 15 per cent. sodium hydroxide or 21 per cent. of potassium hydroxide.

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ELECTRICAL SCIENCE

British and American

On the Positive Electrons in the Sodium Atom.—The greatest part of existing evidence regarding the structure of atoms indicates that the centres of vibration which emit the spectral lines are negatively charged corpuscles. For instance, the Zeeman effect shows that the D lines of sodium are due to the vibrations of negative charges, and the same conclusion is drawn from observations of the magnetic rotation of the plane of polarisation for waves of very nearly the same frequency as the D lines. Band spectra do not show the Zeeman effect, and thus this method is unavailable for investigating the centres of vibration responsible for the bands. R. W. Wood has been working at the problem in another way, and describes his most recent results in the *Philosophical Magazine* for February. White light, plane polarised by passage through a nicol, was passed through heated sodium vapour in a magnetic field, and through a second nicol into a spectroscope. When the nicols are crossed a magnetic rotation spectrum appears in the spectroscope if the vapour is hot and the field on; but because the slightest turn of the analysing nicol restores the full ordinary spectrum, no information as to whether the magnetic rotation is in the positive or negative direction could be directly obtained. When the light emerging from the second nicol in the above experiment was passed through another tube of hot sodium vapour in a magnetic field, and analysed by a third nicol, it was found that rotating this third nicol had no effect. This shows that the spectral lines observed are really narrow bands comprising wave-lengths undergoing gradually differing rotations. The observer, therefore, analysed the light with a pair of Fresnel prisms. The continuous spectrum thus obtained was traversed by a number of horizontal dark bands, which correspond to the points on the slit at which the plane of polarisation is parallel to the plane of extinction of the analysing nicol. Under these circumstances the magnetically rotated line should penetrate the dark band from above or below, according as the rotation is positive or negative. The sodium tube was heated until the fine black absorption lines in the red end of the spectrum appeared distinctly above and below a horizontal dark band due to the Fresnel prisms, then the current was thrown into the magnet. As the field gradually rose, numerous needles of light penetrated the dark band, both from above and below. This, the author concludes, establishes the existence in the sodium atom of both positive and negative electrons.

Self and Mutual Inductance Formulæ.—In the January *Bulletin* of the Washington Bureau of Standards, E. B. Rosa gathers a number of inductance formula, and gives proofs of them. Many of the formulæ are, of course, well-known, and are reproduced merely for convenience of reference; but others are less familiar, and a few are new. One that may be referred to is that of the self-inductance of a "non-inductive" winding of round wires. Suppose the wire arranged as a to-and-fro winding in a plane, the length of each section being l, the distance apart of the adjacent wires, centre to centre, being d, and the wire of radius P, and let $2n$ be the total number of to-and-fro lengths. The author shows that the self-inductance is

$$2l\left[\log\frac{d}{\rho}+\frac{1}{4}-2\log\left(\frac{2\,.\,4\,.\,6\,.\,8\,\ldots\,(n-1)}{1\,.\,3\,.\,5\,.\,7\,\ldots\,(n-2)\sqrt{n}}\right)\right]$$

The term involving n assumes the values 0, 0·1931, 0·2876 0·3522, 0·3804, 0·3961, as $2n$ becomes 2, 4, 6, 10, 14 and 18. The author shows also that the same formula holds for the case of a to-and-fro winding on a circular cylinder, provided that the length of the coil is small compared with its radius.

Continental

A New Electric Furnace.—In the *Comptes Rendus* for February 3rd, L. Clerc and A. Minet describe an electric furnace in which any temperatures from red heat up to the temperature of the arc may be conveniently obtained. When an arc is surrounded by oxide of calcium or magnesium, or other refractory substance, it may be several centimetres in length without consuming more than ordinary power. Keeping the E.M.F. constant at, say, 60 volts, the length may be varied at pleasure by giving the cavity suitable dimensions and the current a certain strength. The sectional area of the cavity containing the electrodes should vary according to a power of the length, which is a little higher than unity, and the current should vary with a power of the sectional area somewhat less than unity. A magnesia or carbon crucible is introduced into the cavity from below. It is mounted on a rod, which can be raised or lowered into any desired position from outside. The crucible contains from 2 to 40 grammes of the substance to be treated, according to its density. The power consumed is one or two kilowatts. The temperature is regulated by bringing the crucible nearer to the arc or further from it. An unusual advantage claimed is that after one electrode has been withdrawn and reinstated, the arc relights without contact.

Flames as Rectifiers.—A. Cathiard showed some time ago that a flame may act as a rectifier for an alternating current of high tension and low intensity. The unidirectional character of the discharge is confirmed by the oscillograph. In a recent communication published in the *Comptes Rendus* for February 3rd, he announces that in this case a true disintegration of the cathode is produced. It is accompanied by the appearance of a very brilliant point on the cathode, whereas the anode is only surrounded by a diffuse violet tuft. If two identical parallel electrodes, say two cylinders, are mounted in the same horizontal plane, and one of them is immersed in a flame containing no solid conductors in suspension, the electrode so immersed is always a cathode. On transferring the flame to the anode, it at once becomes the cathode. The experiment is easily shown with cylindrical rods of homogeneous close-grained carbon, which are specially suitable for anodes.

Magneto-optic Anomalies.—A. Dufour, who recently announced an anomaly in the arc spectrum of calcium fluoride which suggests the existence of positive electrons (see ELECTRICAL ENGINEERING, p. 216, February 6, 1908), carries the matter a stage further in the *Comptes Rendus* of February 3rd. He has found a similar effect (a reversal of the polarisation of the edges of bands in the magnetic field) in the arc spectra of other haloid salts, but in none of these salts do *all* the bands show the effect. The author gives the following tables, in which the figures represent the wave-length of the sharp edge of such band, that the abnormal and normal polarisations are indicated by the letters A and N respectively:—

CaF_2	603A	605A	606N	
SrF_2	651A	653A	660(?)N	
BaF_2	495A	499A	500N	
$CaCl_2$	618A	619A	621N	
$SrCl_2$	635A	636A	661A	674N
$BaCl_2$	514A			

It will be noticed that the abnormal effects all tend towards the shorter wave-lengths. It is significant that this effect is only observed in compounds, though whether these are maintained at the temperature of the arc seems more than doubtful.

Oxford Tramway Arbitration. The point of law raised before the arbitration at the commencement of the Oxford tramway arbitration proceedings came before the Lord Chief Justice, Mr. Justice A. T. Lawrence and Mr. Justice Sutton on Friday. We gave full particulars of the point in question in ELECTRICAL ENGINEERING, Vol. I., page 122. Briefly, the facts are as follows:—The National Electric Construction Co. having obtained Parliamentary powers in co-operation with the Oxford Corporation for the conversion of the existing horse tramways to electric traction, agreed to purchase the latter undertaking under the terms of an agreement between the Corporation and the existing Oxford Tramways Co., the purchase to take place as from December 31st, 1906, which was in advance of the statutory period. The exact price to be paid was to be determined by arbitration. These arbitration proceedings commenced in July last, but at the very outset the difficulty arose which has just been settled by the Court. The agreement between the Oxford Corporation and the existing company is dated December 14th, 1906, and it lays down that the purchase shall take place under Section 44 of the Tramways Act of 1870. It will be remembered that Section 43 of the Tramways Act is the clause under which a local authority may purchase, the price excluding any consideration for goodwill. Clause 44 lays it down that the owners of the tramway undertaking may sell to any body or persons as distinct from the local authority. Mr. Balfour Browne, K.C., for the Oxford Tramway Co., intimated at the arbitration his intention of proceeding on the basis that the purchase was to take place upon going-concern terms, inasmuch as the agreement contained the words, "the then value" of the undertaking. Mr. Hutchinson, for the National Electric Construction Co., argued that Clause 44 of the Tramways Act of 1870 is governed by Clause 43, and that therefore the purchase should take place on the basis of the then value, exclusive of any provision for goodwill or future profits. In giving judgment, the Lord Chief Justice said that, in his opinion, the case was too clear for argument. The agreement stated that the Corporation would "purchase the said undertaking of the said company in pursuance of and in the manner provided by Section 44 of the said Act. And whereas it has been agreed between the company and the Council that the company shall sell and the Council shall purchase the said undertaking upon terms of paying the then value thereof, as provided by Section 43 of the Tramways Act, 1870," and later, quite consistently, "in respect of the tramway as on December 31st, 1906, the standard value for the undertaking is to be the same as in Section 43." The decision, therefore, must be in favour of the Oxford Corporation, and as there was a question in the Special Case which asked the opinion of the Court on the matter of costs, he was quite clearly of opinion that the Corporation of Oxford ought to have the costs of this appeal. Mr. Justice A. T. Lawrence and Mr. Justice Sutton concurred.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published Feb. 13th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from abroad.

1907 Patents

1,197, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*) Boron is purified and rendered a conductor by heating it to a high temperature in a vacuum. It is then fused, powdered up, and finally compressed, with or without a binding material, into the required shape. Four claims, one figure.

1,356, GANZ & CO. EISENGIESSEREI UND MASCHINENFABRIKS AKT. GES. A device for regulating the pressure of alternating current generators. A resistance with a positive temperature coefficient is placed in the field circuit of the exciting machine. This resistance is also in the secondary circuit of a pressure transformer, and, further, another alternating current from the secondary of a current or series transformer is led in at equipotential points in the secondary winding of the said pressure transformer, which current is opposed to that of the pressure transformer. The resultant current, which heats the resistance, decreases in value with increasing load or diminishing power-factor. The resistance cools, decreases in value, and the excitation is increased. Further improvements for rendering the whole more sensitive are described. Seven claims, four figures.

1,759, RAYMOND-BARKER & AMALGAMATED RADIO-TELEGRAPH CO. Radio-telegraphy with undamped oscillations of two or more different wave-lengths and signals of equal time value. This system is particularly adapted for telephonic reception, as two-tone signals are more distinctive than long and short single-tone signals. Receiving apparatus for audible or visible signals for the same system is described. Three claims, eight figures.

2,459, MILES WALKER. As the voltage between adjacent commutator bars of armatures of high speed dynamos is sometimes very high, intermediate bars, which are connected to points on an auxiliary ring or drum winding intermediate in potential between the potentials of the two adjacent main bars, are inserted between the main bars. If the auxiliary winding is a drum winding, it can extend to half the length of the core only, and the end connections are then arranged in a duct in the middle of the core. The auxiliary winding is placed in the same slots as the main winding. Three claims, seven figures.

4,182, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*) A protective device for D.C. or A.C. circuits, which will operate to open the circuit upon either an overload or a reversal of current. The device is arranged with a time limit of the bellows type, which is inoperative on an excessive overload or a reversal of energy. A pivoted armature provided with a series winding is moved by a field-magnet provided with a differential shunt and series winding, the series overpowering the shunt on overload. The device will operate even if the voltage of the circuit falls to zero. Five claims, three figures.

5,575, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*) An improved method of manufacture of tungsten filaments for electric lamps. The filament, consisting of a compressed mass of cadmium amalgam and powdered tungsten, is first heated in a vacuum furnace, which drives off the mercury, leaving a strong filament. The cadmium is then volatilised by passing current through the filament in a vacuum. Three claims, four figures.

6,242, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*) To obtain a higher voltage than the normal, from a mercury-vapour rectifying device, two auxiliary anodes are provided which can be connected to terminals on the secondary of the transformer, which include extra turns, an increased voltage on either side of the neutral connection being applied by this means. Three claims, one figure.

10,007, SIEMENS BROS. DYNAMO WORKS & POYNDER. In order to run an asynchronous motor at a reduced speed economically, the rotor winding of the same feeds into the stator winding of an auxiliary motor, to which is coupled another asynchronous machine. The latter has a larger number of stator poles than the former. The rotors of both machines are of the ordinary short-circuited type. The stator winding of the second asynchronous machine is connected to the supply mains. The energy transmitted by induction to the rotor of the main motor, and ordinarily wasted in resistances, is thus converted to the frequency of the supply and partly recovered. The speed varies only slightly with the load, and by inserting a variable-speed gear between the two auxiliary machines, several working speeds can be obtained. Five claims, one figure.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Names in brackets indicate communicators of inventions from abroad.

Summaries of the more important of these patents will appear in our next issue.

1906 Patents

24,252, BRITISH THOMSON-HOUSTON CO. (*Allgemeine Elektricitäts-Ges.*). Manufacture of incandescing bodies for electric lamps.

24,253, BRITISH THOMSON-HOUSTON CO. (*Allgemeine Elektricitats Ges.*). Electric lamps having incandescing bodies of refractory metal.

1907 Patents

1,947, HANSEL. Electrically-operated installation for forwarding postal letters.

1,963, LOEBL & BRITISH EVER-READY ELECTRICAL CO. Electrical switches.

2,132, FLETTNER & FELTEN & GUILLEAUME-LAHMEYERWERKE AKT.-GES. Controlling motors from a distance.

2,165, ST. JERNBERG. Winding apparatus with variable loads.

2,283, MUIRHEAD. Coherers for wireless telegraphy.

2,381, PARSONS, WILSON, & FORD. Blading for turbines.

2,413, BROWN. Electrical block signalling system.

2,416, SUMPNER. Alternating current instruments.

2,417, CHAMBERS & BENNETT. Electrical switches for internal-combustion engines.

2,509, HUMPHREY. Ignition of internal-combustion engines.

3,116, CUNNINGTON. Electric heaters for bedding and clothing.

3,739, LANCASHIRE DYNAMO & MOTOR CO., WARBURTON, & KELSALL. Method of equalising the power supplied to electric motors.

4,564, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Incandescing bodies for electric lamps.

4,706, HOWORTH (*Akt.-Ges., Brown, Boveri & Cie.*). Single-phase alternating current motors.

4,742, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Alternating current motors.

5,037, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Methods of regulating lighting systems.

5,050, ROSS. Ignition system for explosion engines.

7,883, NAUJOKS, NAUJOKS, & GOEPPERT. Electrically-controlled elevators.

8,138, BERRY, SKINNER, & MARKHAM. Protected fuses.

8,874, HAHN. Alternating current vapour apparatus.

9,965, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electrically-operated signals for railways.

14,725, SIEMENS BROS. DYNAMO WORKS (*Siemens Schuckertwerke Ges.*). Electrical potential regulators or speed-controlling devices.

14,765, SIMMS MANUFACTURING CO. & ALTREE. Ignition devices for internal-combustion engines.

15,009, FELTEN & GUILLEAUME-LAHMEYERWERKE AKT.-GES. Alternating current electro-magnets.

15,442, CONRAD. Voltage regulation of generators.

16,745, LE MANQUAIS. Electric junction boxes.

16,854, TARDIEU. Telephonic apparatus.

17,455, DEUTSCHE TELEPHONWERKE GES. Signalling apparatus.

17,617, CARTER. Coin-controlled pay station for telephones.

18,152, STONE. Apparatus for determining the direction of space telegraph signals.

18,868, KWAPIL & BIHN. Electro-magnetic make and break ignition devices for explosion engines.

19,805, WACKERMANN. Device for transferring drawings and manuscripts to a distance by electricity.

21,966, CHISWELL. Adjustable holder for telephones.

22,638, SMITH. Winding of phonopore and like induction coils.

27,541, PAULI. Electric incandescent filament lamps.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patents

11,979, DEUTSCHE BECK-BOGENLAMPEN GES. Supported carbon for arc lamps.

12,633, GALLETTI. Methods of producing electric oscillations.

12,636, GALLETTI. Wireless telegraphy.

1908 Patents

412, STEYNIS & CHAUMUT. Ozoniser.

1,427, DE FOREST. Space telegraphy.

1,532, SIEMENS & HALSKE AKT.-GES. Electric signalling.

1,615, BELIN. Apparatus for reproducing graphic documents at a distance.

1,773, ALEXANDERSON. Motor control.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ld.	10	7	5/-*	10½—11½	
Do. 4½% Cum. Pref.	10	4½	4½	10—11 xd	
Do. 6% Cum. Second Pref.	10	6	6	10—10¾ xd	-½
Do. 4½% Debenture, Red.	Stock	4½	4½	100—103	
Bromley (Kent) E.L.& Power Co., Ld.	5	5½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	95—98	
Brompton & Kensington E. S. Co., Ld.	5	10	4½*	7—8	
Do. 7% Cum. Pref.	5	7	7*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4*	97—100	
Ch. Cross. W. E. & City E. S. Co.	5	5	5*	4⅜—4⅝	
Do. 4½% Cum. Pref.	5	4½	2½*	4⅜—4⅝ xd	-⅛
Do. 4% Deb. Red	Stock	4	4*	97—100	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½	4⅜—4⅝	
Chelsea Electric Supply Co., Ltd.	5	4½	2/-*	3⅜—4⅛	
Do. 4½% Deb. Red	Stock	4½	4½	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	5%	10—11	
Do. 6% Cum. Pref.	10	6	6*	11½—12½	
Do. 5% Deb. Red	Stock	5	5%	120—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	99—102	+1
Cty of Durham E. P. Dis. Co.	5	4	2/1½*	3¼—4	-¼
Do. 5% Pref.	5	5	5*	4⅜—4⅝	
County of London Elect. Sup. Co. Ld.	10	5	4*	7⅞—8	+¼
Do. 6% Cum. Pref.	10	6	6*	11⅛—11⅝	
Do. 4½% Deb. Red	Stock	4½	4½	105—108	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	96—99	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	¼—⅜	-⅛
Do. 6% Cum. Pref.	5	3½	—	⅜—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	70—80	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4⅝—5⅛	
Do. 5% Cum. Pref.	5	5	2/6*	5—5⅛	
Do. 4½% 1st Deb. Red	Stock	4½	4½	94—97	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6½—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%	95—98	
Kens. & N't'ng Hill E.L. Cos. Db.Rd.	Stock	4	4%	99—103	
London Electric Supply Corporation	3	4	2/11½d*	1⅛—1⅜	
Do. 6% Pref.	5	6	6%*	4⅝—5⅛	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	91—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	5⅜—6⅛	-⅛
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—5⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	106—110	+2
Do. 3½% Mort. Deb. Red	Stock	3½	3½	85—90	
Midland E. Corp. for P. Dist. 1st Mt. Db.	100 & 500	4½	4½	98—101	
Newcastle & Dist. E. L. Co., £9 paid	10	5	3/7½d.*	9½—10½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½	99—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6½—6⅝	
Do. £2 Pm.	5	8	1/4⅞d*	6¼—6⅜	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5⅛	
Do. 10/- Pm.	5	5	1/4⅞d	5—5⅛	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	6%*	11½—12½	
Oxford Electric Co., Ltd.	5	7	2/6*	5⅝—6⅛	-⅛
Do. 4% Deb. Red.	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ld.	5	10	5/-*	7⅜—8⅜	
Do. 7% Non-Cum. Pref.	5	7	3/6*	6⅜—7⅛	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	½—1½	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2½—3	
South Metropolitan E. L. & P. Co.	1	2½	6d*	⅜—⅝	
Do. 7% Cum. Pref.	1	7	8¾d.*	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	101—104	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1½—2⅛	
Do. 5% Cum. Pref.	5	5	2/6*	2—2⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	5%*	8—9	
Do. 4½% Cum. Pref.	5	4½	4½%	5—5½	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	87—90	
Central London	Stock	4	3%	65—68 xd	
Do. 4% Preferred	Stock	4	4%	82—84 xd	-2
Do. Deferred	Stock	4	2%	44—47 xd	+1
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	76—79	+2
City and South London Cons.	Stock	2⅞	4¼%	39—41 xd	-1
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	114—117 xd	-2
Do. 5% Perp. Pref. 1895	Stock	5	5%	112—115 xd	-2
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	-3
Great Northern & City Pref. "A"	10	4	11s.d.	1¼—1⅜	
Gt. Northern, Piccadilly & Brompton	10	4	4/-*	4½—5½	+½
Do. 4% Perp. Deb.	Stock	4	4%	85—88	+1
Mersey Cons.	Stock	nil	—	2—4	
Do. 8% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	½%	38—39	+½
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½%	72—75	
Metropolitan District	Stock	nil	—	10½—11½	+½
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Pref. Deb.	Stock	4	4%	71—76	+3
Do. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	-2
Underground Elec. Railways Co of London 5% Profit Shg. Sec. Notes	Various	5	5%	43—47	+7
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅜—¾	
Do. 5% Cum. Pref.	1	5	5%	⅞—1⅛	
Do. 4½% Deb. Red.	Stock	4½	4½%	90—95	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	-⅛
Do. 6% Cum. Pref.	10	6	6%*	4⅜—5¼	-⅛
Do. 5% Perp. Deb.	Stock	5	5%	96—100	
Do. 4½% 2nd Deb.	Stock	4½	4½%	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4⅜—4⅞	+⅛
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	98—101	+2

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%			
Dublin United Trams Co.	10	6	6%*	12½—13½	-¼
Do. 6% Pref.	10	6	6%	12½—13½ xd	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	-½
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	⅞—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7⅞—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	92—95	-3
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—⅛	
Do. 5% Cum. Pref.	1	5	6d*	⅛—⅜	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	97—100	+2
National Elec. Construction Co. Ltd.	1	10	2/-	½—¾	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅜—1½	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	½—¾	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9⅜d*	1—1⅛	
Do. 5% Cum. Pref.	1	5	5%	⅞—1 xd	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4½—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	1/1½	⅞—1⅛	
Do. 4% Deb. Red	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	60—70	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1⅛	
Do. 6% Cum. Pref.	5	nil	—	3⅛—3⅝	-⅛
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	3½%	56—59 xd	-1
Do. 6% Pref. Ord.	Stock	6	6%	99½—101½ xd	-2
Do. Def. Ord.	Stock	1¾	1%	14½—14¾ xd	-1
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	87—90	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3½	
Do. 10% Cum. Pref.	5	10	5/-*	8½—9½	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4¼	4⅜%	13⅜—14⅛	+⅛
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12⅜—13¼	+¼
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5⅜	5%	131—136	+1
Do. 3½% Pref.	Stock	3½	1¾%	84—87	
Do. 4% Mort. Deb.	Stock	4	4%	100—103	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	33—35	+1
Indo-European Telegraph Co. Ltd.	25	13	65/-	54—57	+1
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	-1/16
National Telephone Co., Ltd., Pref.	Stock	6	6%*	111—113	+½
Do. Deferred	Stock	5½	6%*	111½—113½	+½
Do. 6% Cum. 1st Pref.	10	6	6%*	11—13	
Do. 6% Cum. 2nd Pref.	10	6	6%*	10½—12½	
Do. 5% 3rd Pref.	5	5	5%*	5⅞—5⅛	+1/16
Do. 3½% Deb. Red	Stock	3½	3½%	97—99	
Do. 4% Deb. Red.	Stock	4	4%	100½—102½	+½
West African Telegraph Co. Ltd.	10	4	4/-	10—10½	
Western Telegraph Co., Ltd.	10	7	6%	13⅞—13⅞	
Do. 4% Deb.	Stock	4	4%	98½—101½	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	¼—⅜	+1/16
Do. 6% Cum. Pref.	1	6	7½d	3/16—5/16	+1/16
Babcock & Wilcox, Ord.	1	20	1/7½*	3½—3¾	
Do. 6% Pref.	1	6	7½d	1⅛—1⅜	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6⅝—7⅛	
Do. 6% Cum. Pref.	5	6	6%	5½—6	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	101—104	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%*	85—89	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅜—⅝	-⅛
Do. 4% Mort. Deb. Red.	Stock	4	4%	42—47	+1
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	1/16—⅛	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	79—82	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	11—12	+¾
Do. 5% Cum. Pref.	5	5	5%	5⅜—5⅝	+⅛
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106—108	
Consolidated Electrical Co., Ltd.	1	3	8¾d*	1/16—⅛	
Crompton & Co., Ltd.	3	5	5%	1⅞—2⅛	+⅛
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1—1⅛	
Do. 6% Cum. Pref.	1	6	7½d	1—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	99—102	
Edison & Swan United "A," £3 paid	5	4½	2/6	3—1	
Do. do. (fully paid)	5	4½	4/2	1⅜—2⅛	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	1/16—⅛	
Do. 7% Cum. Pref.	2	7	—	1⅛—1⅜	
Do. 4½% 1st Mort. Deb.	Stock	4	4%	65—69	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8¼	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	11⅜—12⅜	+½
Do. 4½% Cum. Pref.	5	4½	2/3*	5—5¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15—16	+½
Do. 4% Deb. Red.	100	4	4%*	99—101	+1
Tel. Const. & Maintenance Co.	12	15	5%*	33—35	+¼
Do. 4% Deb. Bds. Red	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3½—3¾	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

BALLYSHANNON: *Electric Lighting.*—The Council's permission has been given to Mr. J. S. Myles for the erection of an electric lighting works, subject to public rights being secured.

BELFAST: *Tramway Employees Wages.*—The Tramways Committee has had an application from the tramway men's union, asking for an advance in the present scale of wages for motor men and conductors, and fixing a maximum of 7d. per hour, to be reached after three years' service. In October last the Corporation voluntarily agreed that all conductors and motor men should receive a maximum pay of 6½d. per hour after three years' service, instead of after six years, as at present, such scale to come into operation in April, 1908. This concession on the part of the Corporation will entail an additional cost of £1,300 per annum, and in view of this fact, it has been decided not to re-open the question with the tramway men's union.

Cavehill and Whitewell Tramways Bill.—The London correspondent of the *Belfast News Letter* stated that on Thursday night Mr. Devlin, the Nationalist M.P. for Belfast (West), issued the following statement in the lobby of the House of Commons:—"Mr. Joseph Devlin, M.P., is willing, in the interests of the 70,000 ratepayers who are opposed to the Bill promoted by the Belfast Corporation for the purchase of the Cavehill and Whitewell Tramways, to agree to the passage of the measure provided the purchase price is reduced to £46,000, with the recreation grounds at Glengormley thrown in free. Mr. Devlin hopes by this arrangement to save the ratepayers £30,000 or £40,000. If the compromise is not agreed to, there is not the slightest chance of the Bill being passed, as it will receive vigorous opposition from Mr. Devlin, as the representative of three-fourths of the ratepayers who are opposed to it."

BIRMINGHAM: *Electrical Contractors' Dinner.*—The first dinner of the Midland Branch of the Electrical Contractors' Association was held on Friday. The chair was taken by Mr. F. Brown, and among those present was Dr. Gisbert Kapp, who proposed the toast of the "Electrical Industry."

BOURNEMOUTH: *Tramway Accounts.*—A report has been presented by the Joint Finance and Tramways Committee, in which the auditor states he cannot find that the accounts of the tramways department are in any way subject to examination or check by the Borough Accountant. He urges that all accounts should be subject to some systematic examination in the Accounts Department independent of any examination in the department which is responsible for the expenditure. The accumulated revenue on the Council's tramway undertaking amounted on March 31st, 1907, to £24,999, and the auditor thinks that the time has now arrived when the treatment of these monies, by the establishment of a reserve fund, should receive the attention of the Council. In dealing with this report, the Committee recommend that the Borough Accountant be instructed to report as to what would be involved by the adoption of a simple and efficient checking system in connection with the tramway accounts by his department. With regard to dealing with the accumulated revenue, the Committee are of the opinion that it is not advisable to establish a reserve fund as anticipated at present, having regard to the restrictions to which the Council would be subject in the future application of the accumulated profits if the same were now definitely allocated as recommended.

BLACKROCK: *Dublin and Central Ireland Electric Power Bill.*—This Bill was under consideration by the Urban District Council on Friday, when it was decided to present an objection against the Bill as a precautionary measure. At the same time the Town Clerk, in bringing the matter before the Council, stated that the Bill seemed to be one of the most important measures towards the development of the industrial resources of Ireland, and if it became law, the works which it was proposed to carry out would give a great impetus to manufacturers. The object of the undertaking was primarily to generate and supply cheap electric power to local authorities and other large consumers throughout the city and county of Dublin, and for this purpose to work the extensive series of peat bogs known as the "Bog of Allen." It would afford practically an inexhaustible supply of peat, from which it was proposed to manufacture gas for the purpose of generating electrical energy. Instead of subjecting the peat to elaborate drying and manufacturing processes, the peat sods, only partially dried in handling, would be transported to the gas producers, and there converted into gas. In this way peat containing fully 50 per cent. of moisture would be dealt with.

BRADFORD: *Tramway Intercommunication with Leeds.*—At a conference of sub-committees of the Leeds and Bradford Tramways Committees, the question of arranging for a permanent through service was discussed at some length, and proposals made which will be brought before the respective tramways committees. It will be remembered that the gauges of the two tramways systems in question are not identical, but through connection has been rendered possible by the extensible gauge truck, invented by Mr. C. J. Spencer, the Bradford City Tramways Manager, and Mr. W. H. Dawson. A description of this mechanism appears in ELECTRICAL ENGINEERING, Vol. I., p. 760.

BRAY: *Electric Lighting and Tramways Scheme.*—A letter has been received by the Rathdown (No. 2) Rural District Council from Messrs. B. Hooper & Co., Greenwich, stating their intention to apply for powers to construct an electric tramway between Bray and Enniskerry, and also for the electric lighting of Enniskerry and district. The scheme has been approved by the Council.

CLACTON: *Opposition to Extension of Works.*—The proposed application to the Local Government Board for sanction to borrow £4,000 for the extension of the electricity undertaking, has called forth an emphatic protest from the Ratepayers' Association, which, at a meeting last week, unanimously passed a resolution calling upon the Council to authorise an independent inquiry into the whole working of the electricity undertaking before any further extensions are made.

DARTFORD: *Light Railway Undertaking.*—The Metropolitan Police have called the attention of the Council to the fact that the cars of the Dartford light railways have become subject to the provisions of the Metropolitan Carriage Act, 1907, and the Order of the Secretary of State made thereunder, dated December 30th, 1907. Messrs. J. G. White & Co., the lessees of the tramway undertaking, are making the necessary arrangements for licensing the cars, drivers, and conductors.

DUBLIN: *Progress of Electrical Undertaking.*—The gross income for the twelve months ending March 31st, 1907, was £44,225, of which £10,736 was credited to the electricity accounts for the cost of public lighting, and the balance, £33,486, was received from private consumers, together with rentals of meters, current supplied to the Corporation offices, and work done for the Corporation, &c. The total expenditure was £22,029, leaving a gross profit of £22,196. From this has to be deducted £216, being amount of accounts written off and interest paid on consumers' deposits, and the balance of £23,000 was devoted to the repayment of principal of loans, and the payment of interest. This leaves a debit balance to be provided for of £1,720 1s. 5d. The total amount of the loans received up to March 31st is £441,747, and of this a total of £78,558 have been repaid. The average cost per unit has been about 1d., whereas in 1903 it was 2½d.

DUNDEE: *Tramway Fares.*—A report has been presented by the Tramways Manager with regard to a proposal to abandon halfpenny fares and adopt 1d. fares as a maximum. The Manager is strongly of the opinion that a 1d. maximum fare should be aimed at and adopted as soon as it is possible to do so without jeopardising the financial position of the undertaking. At present, however, he recommends that no special alteration should be made upon the halfpenny stages.

Electric Lighting Tariff.—Upon the recommendation of the Electrical Engineer, Mr. H. Richardson, the Electricity Committee has decided to abolish the minimum amount for lighting of tenements. It was stated that this regulation had been a source of irritation, whilst the revenue accruing from it only amounted to £150 per annum. The new arrangement will come into force at the beginning of the next financial year.

DUNFERMLINE: *The Electric Lighting Order.*—A special meeting of the Town Council was held on Friday to consider the report by Sir Alexander Kennedy in regard to the proposal to sell the Council's electric lighting Provisional Order to the Fife Electric Power Co., the details of which were given in our last issue. A discussion took place in which the general feeling was that the Council should not dispose of the Order, and a motion to the effect that the Order should be disposed of was defeated by 12 votes to 5. It was ultimately agreed to appoint an engineer to submit estimates as to the cost of working a generating station, and, alternatively, of taking a supply of energy in bulk from the Fife Electric Power Co.

EALING: *The Dolter System.*—As a result of a joint meetin of the Highways, Open Spaces, Tramways and Electricity Supply Committees, the Borough Surveyor and the Electrical Engineer have been instructed to submit an estimate of the cost of constructing the South Ealing tramway on the Dolter system, with a gauge of 3 ft. 6 in., and of the annual cost of maintenance and of working a service of four cars to and fro.

Bulk Supply.—The Electricity Supply Committee reports in favour of making an offer to supply electricity in bulk to the Hanwell Urban District Council in accordance with a scheme proposed by the Borough Electrical Engineer. The Council discussed the matter in private.

EDINBURGH: *Smoke Nuisance.*—A meeting of a sub-committee of the Edinburgh Public Health Committee was held last week, when it was unanimously resolved that the regulations allowing five minutes for the abatement of smoke nuisance from the factory chimneys shall in future be insisted upon. It was stated that this regulation will apply to the electric lighting works, in addition to private factories.

Condensing Water Plant Arrangements.—Mr. F. A. Newington, the Chief Electrical Engineer, reports that the work in connection with the use of sewage water for condensing purposes at the Macdonald Road power station, are now practically completed, and that the plant will be in operation at the beginning of next week.

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FALKIRK: *Proposed Tramway Extensions.*—The directors of the Falkirk and District Tramway Co. received last week a deputation of the ratepayers of Laurieston, a suburb of Falkirk, urging them to construct the tramways into that district, which were authorised a few years ago. No decision was given by the directors.

FINCHLEY: *Electricity Reserve Fund.*—A resolution instructing the Finance Committee to inquire what the annual amount required for a reserve fund in connection with the electricity undertaking would be, has been considered by the Council, but only the mover supported it, and it was accordingly negatived.

FRASERBURGH: *Electric Lighting.*—Mr. H. Richardson, the Electrical Engineer to the Dundee Town Council, has been retained by the Fraserburgh Town Council in connection with its electric lighting scheme.

GRIMSBY: *Agreement with Tramway Co.*—In connection with the proceedings relating to the incorporation of Cleethorpes with the Borough of Grimsby, the Grimsby Corporation have made an arrangement with the Grimsby Tramway Company in order to dispose of their opposition, by which the rights of the Corporation to purchase the tramways in Grimsby as a going concern in 1910 shall be extinguished in favour of the right to purchase under Section 43 of the Tramways Act in 1921. The tramway company have agreed, as a concession, to certain rearrangements of its fares, and to run certain workmen's cars, but the arrangement does not appear to have met with satisfaction locally.

HALIFAX: *Tramway Undertaking.*—A report has been presented by the Deputy Borough Accountant, dealing with the present financial position of the tramways undertaking. It is stated that the total amount of loans authorised is £685,521, of which £394,275 have been expended, namely, £255,149 on permanent way; £38,707 on electrical equipment; £60,000 on cars, and £29,518 on buildings and fixtures. The report also points out that since 1905, when the last two cars were purchased, the cost of repairs has increased considerably, and for the year 1907 amounted to £5,504, or 9·15 per cent. of the total cost. An important part of the report referred to the condition of the permanent way. It is pointed out that the cost of repairing the track during the last six years has been fairly low compared with the capital expenditure, but the time is at hand when an immediate expenditure of some thousands of pounds will be necessary to keep the track in good running order. In connection with the price which should be charged to the Tramways Committee for electrical energy, the report states that this should be 0·87d. instead of 1½d., as at present. As the result of consultations between the tramway manager and the Borough Electrical Engineer, the following list of years as the life of the various portions of the tramways undertaking has been arrived at:—Buildings and fixtures, 30 years; track and bonding, 15 years; cars and equipment, 15 years; overhead equipment, 15 years; tools and plant, 10 years.

KEIGHLEY: *Tramway Revenue.*—At the meeting of the tramway committee on Thursday, it was stated that it was not proposed to ask for any assistance from the rates in respect of the tramway undertaking for the year ending March 31st, 1909. Already they had received £280 more revenue since July than in the corresponding period, and it was probable that for the full year there would be a net surplus of £500 or £600, in addition to the unused grant of £400 from the rates, which would leave about £1,000 to be carried to a renewals fund.

LANCASHIRE: *New Tramway Scheme.*—A project is projected for constructing a tramway from Horwich through Chorley to Preston, a distance of 13 or 14 miles. A Manchester firm of solicitors have written to the Bolton Electricity Committee asking what price the committee would charge for electricity to be supplied in bulk for the purposes of the tramway. The Bolton Electricity Committee have the matter under consideration.

LIVERPOOL: *Electric Lighting and Tramway Accounts.*—The total income of the electric lighting undertaking for the past year amounts to £274,105, and, deducting generation and distribution costs, there is a balance of £158,449. After making allowance for the sinking fund, reserve and renewal fund, there is a surplus of £27,500, which it is proposed to transfer to the borough funds.

The tramway revenue amounts to £598,364, and the gross balance is £199,631. After deducting capital charges, &c., there is a surplus of £27,793, which it is also proposed to transfer to the borough funds.

LOWESTOFT: *Supply in Oulton Broad.*—As the Oulton Broad Urban District Council is opposing the Corporation's application for a Provisional Order for that district, the question was raised at the last meeting as to whether they should abandon this project. After some discussion, however, it was decided to go forward with the application.

LONDON: *London County Council.*—At the meeting on Tuesday expenditure amounting to £7,000 was authorised in order to carry out preliminary works in connection with electrification of the Nine Elms Lane to East Hill, Wandsworth, tramways.

A supplemental vote of £2,000 was passed in respect of the construction of the Embankment tramways. The additional expenditure is mainly due to the cost of alterations required to the carriage way and riverside footway having been considerably greater than was expected.

The Chairman of the Highways Committee, in reply to a question, said that, although the matter of approaching the City Corporation with a view to the trams being carried over Southwark Bridge had not come definitely before the committee, the Council's engineer had been in communication with the City engineer on the subject.

School Lighting.—The Council has approved a proposal to light the extension to the School of Building, Brixton, by means of electricity. Inverted arc lamps will be used in the workships, class-rooms, &c., and incandescent electric lighting in the rest of the building. The cost, exclusive of motors, is estimated at £1,670. Electricity will also be used at the new secondary schools at Dawes Road, Fulham, and Hortensia Road, Chelsea, at an estimated cost of £475 and £492 respectively. In the case of the Fulham School the Borough Council declined to quote a lower price than 3½d. for energy, but they have agreed to bring the service into the school free of charge in a duct provided by the County Council. The Chelsea Electricity Supply Co. will supply current to the Hortensia Road school at a reduced price of 5d. per unit instead of 5½d. In consequence of the marked success of the metallic filament lamps installed at the London Day Training College, these lamps will be used in the new schools.

Progress with the G.B. Surface Contact System.—The track work in connection with the conversion of the Mile End Road tramway to the G.B. surface contact system has been completed by the contractors, Messrs. Dick, Kerr & Co. A service of horse cars is now being run pending the arrival of new cars.

Bermondsey: Franco-British Exhibition.—The Electricity Committee has taken no action with regard to a suggestion of the Associated Municipal Electrical Engineers (Greater London) that the municipal electric supply authorities of London should make a collective exhibition or demonstration of electricity at the Franco-British Exhibition.

Camberwell: Purchase of Electric Lighting Co.—At the last meeting of the Borough Council, a resolution was on the agenda stating that in view of the expert evidence in possession of the Council, that the "option" of the Borough Council to purchase the Electric Lighting Co. was of the estimated value of £40,889, the Council should authorise the Town Clerk to open up negotiations with the company with the object of ascertaining what prospect there was of selling this valuable "option." After a short discussion, the motion was rejected.

City of London Street Boxes.—At the Court of Common Council on Wednesday, a question was asked with regard to explosions in electric lighting street boxes. The Chairman of the Streets Committee stated that only three small accidents from this cause had taken place in the City of London during the past two years, although there were about 9,000 street boxes in the city. They were so carefully attended to by the electric lighting companies, that he saw no need for proposing further regulations regarding them.

Hammersmith: Street Lighting.—The Electric Lighting Committee have had under consideration the question of alterations to the lighting system in Queen Street, the Broadway, Shepherd's Bush Road, and Shepherd's Bush Green, rendered necessary or desirable owing to the construction of the Hammersmith to Harlesden tramways. The engineer has reported that he considers that lighting will be very seriously interfered with if the present central arc lamp standards be removed. He suggests the fixing of lamps alternatively in the tramway standards, which course will require the addition of three arc lamps in order to obtain the same equal distribution of light, and which will cost the Council an additional £20 per annum each lamp. As lighting must be maintained during the progress of alterations, it will be almost impossible to carry out the work by contract, and it must be done by day. The committee has agreed to this suggestion, and has resolved that it be a condition subject to which the Council approves of the L.C.C.'s suggestions for fixing the posts and wires in connection with the tramways, that such alterations and additions to the lighting system should be carried out by the Hammersmith Council at the cost of the London County Council.

Hampstead: Electricity Estimates.—The estimates for the year ending March 31st, 1909, of the Electric Lighting Committee show an income of £65,417, and a total expenditure of £62,998, leaving a surplus of £2,419, which will permit, it is expected, of a transfer equal to a halfpenny in the £ in aid of the general rates. The expenditure estimate for the year ending March 31st, 1908, was £62,645, and it is now anticipated that the actual expenditure will be £63,635. The receipts for the same period were estimated at £67,817, but the actual amount is now only expected to realise £64,093. The falling-off in the receipts from the estimate was in the sale of current to private consumers £58,700 (as against the estimate of £60,500) and in the rental of meters £2,020 (as against the estimate of £4,050).

Hackney: Road Widenings.—The Council has decided to contribute £17,000 towards the widening of Mare Street and Clapton High Road in connection with the conversion to electric

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traction of the tramways from Whitechapel Road to Stamford Hill.

Metropolitan Water Board: Telephone Wayleaves.—The Metropolitan Water Board has adopted an agreement with the National Telephone Company, whereby the acknowledgments paid by the company for easements for the erection of telephone poles, standards, and brackets, and the fixing of wires and stays on the Board's property shall be uniform throughout all districts. The present income of the Board by means of charges to the company is £224 per annum, and under the new scale this will be increased by a net sum of £48 per annum. The scheme is to operate as from January 1st last. The Board have also agreed to enter into an agreement with the Postmaster-General that all wayleaves existing on August 28th, 1907 (the date when the Board's Various Powers Act came into force), shall be paid for on the old scale down to that date, and thereafter allowed to continue under the terms of the new statute, which empowers the Postmaster-General to erect and maintain telegraph wires upon the Board's land.

LYTHAM: *The Electric Lighting Co.*—The Lytham Electric Lighting Co. is in negotiation for a site for their works.

MALVERN: *Electrical Exhibition.*—An electrical exhibition, organised by the municipal electrical department, was concluded last week, and we are informed by Mr. Rendell Baker that it has done excellent service in the way of picking up new consumers.

NEATH: *The Electric Lighting Scheme.*—A ratepayers' meeting last week passed a resolution that the District Council should abandon its proposed electric lighting scheme.

RICHMOND: *Tramway Matters.*—Negotiations have been going on between the Corporation and the London United Tramways Co. in regard to the type of car to be used upon the tramway over Kew Bridge. The Council require smaller cars than those in use on other parts of the company's system, but to this the company raise objections. After some discussion, a resolution has been passed informing the company that the type of car would be discussed should the Bill be passed. With reference to the West London, Barnes, and Richmond Tramways Bill, the Corporation is willing not to oppose this upon certain conditions. These include a purchase clause specifying 45 years instead of 60 years, as proposed by the Bill, and the deposit with the Corporation of £300 as security for the repair and maintenance of the roadways and track. In reference to the Corporation's dispute with the Richmond (Surrey) Electric Light & Power Co., it was suggested that an agreement might be come to on the basis of a reduced scale of charges in the district, and the removal of the chimney at the electricity works as soon as a supply in bulk was received from an outside source, in order to do away with the complaints as to vibration at the works.

SHANGHAI: *Completion of Tramway System.*—The Shanghai Electric Construction Co. announce that the construction and equipment of the electric tramway system is now complete. The supply of electrical energy will be given from the municipal generating station.

SUNDERLAND: *Sir James Laing & Sons' Works.*—In consequence of the suspension of payment by Sir J. Laing & Sons, shipbuilders, of Sunderland, the Corporation, which supplied electrical energy for lighting and power purposes in the works, have cut off the supply. Sir J. Laing & Sons owed the Corporation £2,300 for current, and the action of the Corporation was in consequence of the company refusing to treat them as preferential creditors. On Monday a meeting was held, at which it was decided to voluntarily wind up the business of Sir J. Laing & Sons.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ACTON.—Tenders are invited for the annual supply of meters, prepayment meters, carbons, house fuse-boxes, meter boards, and cables. Particulars from Mr. J. M. Blair, the Electrical Engineer, 130 Churchfield Road, Acton, and tenders to the Clerk by February 29th.

BARKING.—The Council invite tenders for the supply and delivery of electrical sundries, carbons, meters, &c. Full particulars from the Electrical Engineer's office, East Street, and tenders to the Town Clerk by February 25th.

BELFAST.—Tenders are invited by the Corporation for the supply of low-tension cable during the twelve months ending March 31st, 1909.

BOLTON.—The Electricity Committee have under contemplation improvements and extensions at the Electricity Works.

BRISTOL.—The Docks Committee invite tenders for the supply, delivery and erection, and maintenance for 12 months after they have been in use, of electric cables for the supply to Avonmouth Docks. The tenders are also to include the construction, delivery, erecting in place, fitting, completion, and testing and the maintenance for 12 months after they shall have been taken into use of the electric lighting installations, complete in all details, for the various buildings, railway yard, wharves, &c., at the Royal Edward Dock, now in course of construction at Avonmouth. Specifications, &c., from the Secretary of the Docks Committee (fee £5, returnable), and tenders to 19 Queen Square, Bristol, by February 27th.

BURSLEM.—A special meeting was to have been held yesterday for the purpose of considering the question of applying to the Local Government Board for sanction to a further loan in connection with the electricity works.

DARTFORD.—The Electricity Committee recommend that an Artesian well be sunk and that a surface condenser capable of dealing with 15,000 lb. of steam be installed. Application is to be made to the Local Government Board for sanction to borrow £1,900 for the surface condenser, artesian well, &c., and £1,100, which is the estimated capital expenditure during the next two years.

DUNDEE.—Tenders are invited for E.H.T. three-phase and direct-current switchboards and substation generating machinery. Full particulars from Mr. H. Richardson, the Chief Electrical Engineer (fee £3 3s., returnable), and tenders to the Clerk by March 2nd. (See an advertisement last week.)

GLASGOW.—The Tramways Department invite tenders for the supply and erection of two movable bridges over the Forth and Clyde Canal at Dalmuir and Kilbowie. Full particulars from the General Manager, 46 Bath Street, Glasgow, and tenders to the Town Clerk by April 15th.

HANDSWORTH.—Tenders are invited for (*a*): 315 kw. generating set, (*b*) feed-pump economiser and pipe work, (*c*) switchgear for 315 kw. generating set. Full particulars from Messrs. Kennedy & Jenkin, 17 Victoria Street, fee £3 3s., returnable, and tenders to the Town Clerk by March 4th.

HASLINGDEN.—The Corporation has received sanction from the Local Government Board for the erection of refuse destructor works at Priory Hill, at a cost of £8,500. These will be worked in conjunction with the Electricity Works.

HOLYWOOD (BELFAST).—Estimates have been placed before the Urban District Council to the effect that a generating station sufficient for public and private lighting can be installed in Holywood for £2,000, excluding the cost of buildings and mains. The matter has been adjourned for full consideration at the next fortnightly meeting.

HULL.—Tenders are invited for the supply and erection of three 500 kw. 2,250 volt continuous-current dynamos to be coupled direct to existing engines running at 250 rev. per minute. Particulars from the City Electric Engineer, and tenders to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by February 27th.

ILFORD.—Tenders are invited for the supply and delivery of a 1,000-kw. steam generator, watertube boiler, &c. Particulars from the Council's Electrical Engineer, and tenders by February 28th.

LONDON: *London County Council.*—Tenders are invited for lighting the Hackney Downs secondary schools. Full particulars from the Clerk to the Council, and tenders by February 26th.

Fulham.—The Guardians invite tenders for electrical requisites, among other supplies, for the year ending March 31st, 1909. Samples and patterns can be inspected at the Guardians' offices, 129 Fulham Palace Road, Hammersmith, between 10 and 12 and 2 and 4 o'clock. Tenders to the Clerk not later than February 27th.

Hammersmith.—The Electrical Engineer has reported that it is now necessary to proceed with the installation of a battery to act as a stand-by for exciting the alternators. The installation was included in the extension scheme approved by the Council in 1904, and the estimated cost is £700.

Hampstead.—The estimated capital expenditure for the coming year ending March 31st, 1909, is £14,890, made up as follows:—Thermal storage drums, £1,060; water softener filter, £30; new boilers (after allowing for old boilers), £6,000; mains, £2,750; house services, £2,600; transformers, £750 and £400, and in case of the new Home Office Regulations being put in force an additional £300; meters and indicators, £1,000.

Islington.—Tenders are invited by February 25th for (*a*) one 1,500-kw. steam-turbine alternator, &c., (*b*) water-tube boiler, conveyor, &c.

Stoke Newington.—Mains are to be extended at an estimated cost of £332.

Woolwich.—The Council is to take up a loan of £2,394 for boiler plant required at the Electricity Works.

MANCHESTER.—The Electricity Committee invite tenders for the supply, delivery, and erection at the Stuart Street generating station of four water-tube boilers and accessories. Full particulars may be obtained from the Secretary of the Electricity Department at the Town Hall, fee £1 1s. returnable, and tenders to the Chairman of the Department by February 25th.

The Tramways Committee are inviting tenders for stores, including car wheel tyres, canopy trolley standards, overhead line material, lightning arresters, fuses, and fuse-boxes, incandescent lamps, car switches, bells, &c., telephone-

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instruments, and power and lighting cables. Specifications, &c., from the General Manager, 55 Piccadilly, Manchester, and tenders to the Chairman of the Tramways Committee, at the same address, by February 24th.

STOKE-ON-TRENT.—A special report has been presented by the Electrical Engineer, in which he states that the generating plant will shortly require extensions. The amount borrowed for the purpose of the combined electricity and destructor undertaking up to date has been £40,000.

WIGAN.—Mr. J. Slevin, the Electrical Engineer, reports to his committee that the maximum load upon the electricity works during 1907 was 2,520 h.p., which was within 100 h.p. of the total capacity, thus leaving no spare engines in case of an abnormally heavy load or breakdown. He urges upon the committee, therefore, the absolute necessity for extensions of the plant immediately.

WOLVERHAMPTON.—The Corporation have agreed to the recommendation of the Electricity Committee providing for the laying of mains, &c., in connection with the proposed supply to the works of Messrs. T. Parker, Ltd., at an approximate expenditure of £2,500.

WREXHAM.—Tenders are invited for stores. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by March 6th.

TENDERS RECEIVED AND ACCEPTED

AUSTRALIA.—The Victorian Postmaster-General's department has accepted tenders from the following firms for telephone material :—British Insulated & Helsby Cables, Ltd., Melbourne; W. H. Hunter & Co., Melbourne; J. L. Drew, Melbourne; Millars' Karri & Jarrah Co. (1902), Ltd., South Melbourne; Cole Bentley, Melbourne; and F. Vanderkelen & Co., Melbourne.

BRISTOL.—The following tenders have been accepted by the Corporation upon the recommendation of the Electricity Committee :—Extra high-tension cable, Messrs. Siemen Bros. & Co., £21,787 17s. 4d.; 10-ton hand-travelling crane, Messrs. C. & A. Musker (1901) Ltd., £221; substation superstructure, Messrs. R. Wilkins & Sons, £2,939; coal, Ashton Vale Iron Co., £1,281 5s.

BRADFORD.—The following tenders are recommended for acceptance by the Tramways Committee :—Wire and cable, The India-Rubber, Gutta-Percha, and Telegraph Works Co., Ltd., £146; steam tubing, Messrs. Taylor & Parsons, £139 2s. 5d. Tenders of a large number of firms for miscellaneous stores to the aggregate value of £5,700 are also recommended for acceptance.

EDINBURGH.—The Edinburgh School Board have accepted the tender of Messrs. John Munro & Co., of Edinburgh, for the electric lighting installation at the Portobello High Grade School.

LONDON: *City of London.*—The City of London Board of Guardians has placed an order with Messrs. Pinching & Walton for the supply of 6 doz. electric lamps, 230 volts, at 8s. 9d. per doz. Repairs to telephones are to be carried out by W. Palmer for £3 8s.

Bermondsey.—The Borough Council has received the following tenders for a recording ammeter complete for 50 and 100 amperes :—Everett, Edgcumbe & Co. (accepted), £9 10s. 4d.; Elliott Brothers, £9 12s. 6d., less 2½ per cent.; Evershed & Vignolles, £14. All these prices were less 2½ per cent. Twelve enamelled iron plates for advertising the electricity undertaking are to be obtained from the Chromo Enamel Co., at a cost (three colours), of 6s. each.

City of London.—At the Court of Common Council last week an arrangement with the Postmaster-General for ten years' telephone system in connection with the City Electric Ambulance Service at £329 12s. 6d. per annum was approved.

Hammersmith.—The Electricity Committee has accepted the tender of Messrs. Thomas Parker & Co., Ltd., for the supply of a Rees roturbo patent self-regulating pump at £470. This pump will be capable of dealing with 250,000 gallons of water per hour.

LOWESTOFT.—The tender of the Lahmeyer Electrical Co. for service cable at an average price of £248 per mile has been accepted.

QUEENSLAND.—The Postmaster-General's department has accepted tenders from the following firms for telephone, telegraph instruments, parts and material :—Oswald Haes, Sydney; G. R. Hodson, Brisbane; Lawrence & Hanson, Sydney; India-Rubber, Gutta-Percha, and Telegraph Works, Ltd., Sydney; Trackson Bros., Brisbane; Brisbane Electric Co., Brisbane; Jas. Paton & Co., Sydney; International Electric Co., London; British Insulated & Helsby Cables, Ltd., Melbourne; C. E. Bernays, Brisbane.

COMPANIES' MEETINGS AND REPORTS

BAKER STREET AND WATERLOO RAILWAY.—At the half-yearly general meeting on Monday, Sir G. Gibb, who presided, said he thought he might say the company was making rapid progress. The gross receipts showed an increase of 55 per cent. over those of the corresponding period of the previous year, and after providing for interest and rents and crediting to net revenue account the amount receivable from the Underground Electric Railways Co. of London there remained a balance of £17,670. This was the first half-year in which it had been possible to compare their position with corresponding periods. The passengers carried had increased by 3,868,981, while the traffic receipts had increased by £22,272. This rate of progress was being maintained during the current half-year, and during the first five weeks the receipts per week had shown an increase of 15½ per cent. The report and accounts were adopted.

BRISTOL TRAMWAYS AND CARRIAGE.—The report for the year 1907 shows gross receipts of £263,689, and working and general expenses £178,342, leaving a net revenue of £85,347. A final dividend at the rate of 9½ per cent. for the year is recommended, and £8,708 added to reserve fund. The company's investments on December 31st, at market value, amounted to £166,536, but since the close of the year additional investments have been made, bringing the total up to £179,826. With the addition of the sum now proposed, the reserve fund stands at £188,534. Mention is made in the report of the fact that the issue of 250,000 4½ per cent. mortgage debenture stock was oversubscribed.

Sir G. White, presiding at the annual meeting on Monday, said that their tramway receipts, which had decreased by £392 compared with 1906, had doubtless been affected by weather conditions. The total receipts of the company showed the net decrease of £3,080, the difference between this sum and £392 being upon the carriage department of their business. By rearranging the service they had been able to make a considerable reduction in the car mileage and bring up their receipts per car mile from 8·68d. to 9·27d. The number of passengers carried was 46,585,050, against 46,902,257. A special meeting was held after the ordinary general meeting, when a resolution to proceed with the company's Bill now before Parliament was carried.

BRUSH ELECTRICAL ENGINEERING.—The adjourned meeting of the 4½ per cent. perpetual debenture holders was held on Friday for the purpose of considering a resolution for consolidating the company's debenture stock. Lord Vaux of Harrowden stated that since the previous meeting (ELECTRICAL ENGINEREERING, February 13th, p. 231), the Board had communicated with several of the holders of both classes of debenture stock, and it was hoped that the scheme would now be looked upon in a more favourable light. The original proposal of the Board was to raise new 4½ per cent. stock, and in addition that a sum equivalent to ½ per cent. per annum should be provided as a sinking fund. After carefully considering the objections made to this amount as not being large enough, the Board have agreed to set aside 1 per cent. As the stock was redeemed the interest would be added to the fund, but instead of the interest on the sinking fund being £8,750, it would be £9,625. A good deal of discussion followed the speech of the chairman, and when the resolution was put to the meeting it was declared to be lost. A poll was demanded, but the chairman refused to take it at once on the ground that several of the shareholders had not had time to thoroughly consider the proposed change in the plans. It was arranged that the poll should be taken on the 27th inst., at 12 o'clock, and a meeting of the second debenture holders, which was to be held on Friday, following that of the first debenture holders, has been adjourned until after the result of the poll is announced.

BUDE ELECTRIC SUPPLY.—At the statutory meeting held on the 14th inst., the chairman stated that the number of shares allotted was 3,200, on account of which calls to the amount of £1,335 have been received. The preliminary expenses amounted to £140.

CENTRAL ELECTRIC SUPPLY, LONDON ELECTRIC SUPPLY, NOTTING HILL ELECTRIC LIGHTING, AND WESTMINSTER ELECTRIC SUPPLY.—The reports of these companies are given on page 275 of this issue.

CHATHAM AND DISTRICT LIGHT RAILWAYS.—The report for the half-year ended December 31st, 1907, shows receipts amounting to £20,207, and expenses to £12,799, leaving a balance of £7,408. Interest on debentures absorbs £1,284, and the amount written off, mainly in connection with abandoned lines, is £5,555. There thus remains the sum of £619,

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to which is added balance brought forward from June 30th, 1907, viz., £4,492, making £5,111 available for distribution. Owing to the bad weather experienced throughout the year and slackness of trade in the Chatham district, the traffic revenue has been very disappointing, there being an increase of only £1,580 over the previous year's receipts, although the Rainham extension was open for the full year, as compared with three months of the year 1906. During the half-year £1,900 debentures and £1,900 preference shares have been issued, and the proceeds utilised in reducing the company's indebtedness. Capital expenditure during the half-year amounts to £2,059, mainly expended on additional plant in power station. In September last the Board of Trade issued, on the application of the Gillingham Corporation, an order declaring that the powers of the company in respect to the lines in Pier Road (1,246 yards in length) should cease and determine. The cost of the line and reinstating the roadway, less materials taken up, amounts to £4,528 9s. 5d., and the directors in the circumstances have considered it advisable to write the full amount off, and the balance cost of the line abandoned in Westcourt Street, viz., £666 5s., and recommend that the balance profit after transferring £3,000 to reserve for depreciation be utilised in paying a dividend at the rate of 3 per cent. per annum for the half-year on the preference share capital, carrying the balance remaining of £347 to the accounts for the current year. The Rochester Corporation extension lines to Strood Hill and Frindsbury referred to in the previous report are expected to be completed before Easter and leased to the company. The meeting will be held on March 5th.

CLONTARF AND HILL OF HOWTH TRAMWAYS.—The directors' report for the year 1907, states that the new working agreement with the Dublin United Tramways Company came into operation on January 1st, 1907, and the company duly received the sum of £2,000 under the terms of that agreement. After paying debenture interest, wayleaves, and management expenses, there remains a surplus of £585 14s. 4d., from which has to be deducted £23 5s. 8d., being the balance at debit from last account, leaving a net balance of £562 8s. 8d. Out of this it is proposed to pay a dividend of 1 per cent. on the ordinary shares, absorbing £499 16s., and to carry forward £62 12s. 8d. to next year's account. Under the terms of the agreement with the Dublin United Tramways Co. the company is entitled to £2,500 in respect of the current year, and £3,000 in respect of next and subsequent years. The first-named sum will enable the payment of a dividend to be made at the rate of 2 per cent. per annum, and the latter sum at the rate of 3 per cent. per annum. As the payments are received half-yearly from the Dublin United Tramways Co., the dividends will in future be paid half-yearly. The report was adopted at the meeting last week.

DISTRICT RAILWAY.—The meeting was held on Wednes- last week at the Westminster Palace Hotel, Sir G. Gibb, chairman, presiding. He stated that the deficit of £45,551 shown in the accounts (ELECTRICAL ENGINEERING, February 13th) had been paid out of capital, but they had now practically come to the end of their available capital assets. They had carried 28,838,732 passengers, an increase of 19,605, and had earned £4,595 more in passenger receipts. They estimated that during the last half-year the loss of revenue from traffic diverted by the Great Northern, Piccadilly and Brompton Railway amounted to £22,830, after deducting the District share of through traffic with that railway. The working expenses were £12,133 more than in the June half of last year, but were practically identical with those for the December half of 1906, but this was due to the fact that they had run more trains. In order to dispel any idea that the working cost on the District Railway was extravagant or excessive, he gave some figures of the working expenses upon other London electric railways. The cost of train working, including interest on capital for generating plant, was as follows upon various London tube railways :— City and South London, 1·22d. per car mile; Great Northern, Piccadilly, and Brompton Railway, 1·59d.; Metropolitan District Railway, 1·75d.; Charing Cross, Euston and Hampstead Railway, 1·76d.; Central London Railway, 1·83d.; Baker Street and Waterloo Railway, 1·85d.; Great Northern and City, 1·95d. For the same railways he gave the following figures of traffic expenses as percentage of traffic receipts :—City and South London, 11 per cent.; Metropolitan District, 12 per cent.; Great Northern, Piccadilly and Brompton Railway, 13 per cent.; Central London, 14 per cent.; Baker Street and Waterloo, 14 per cent.; Great Northern and City, 15 per cent.; Charing Cross, Euston and Hampstead, 18 per cent. Dealing at length with the financial position of the company, Sir G. Gibb gave in detail the proposed arrangements for raising fresh capital, set forth in the circular to the shareholders in November, which was given in full in our issue of November 28th. The report and accounts given in our last issue were then adopted with one dissentient, who was a debenture holder.

A special general meeting was subsequently held for approving the Bill for making further provision respecting the capital of the company, when a resolution to this effect was passed.

DUBLIN & LUCAN ELECTRIC RAILWAY.—The gross receipts for the half-year to December 31st are £3,576 10s. 1d., being £256 5s. 11d., in excess of those of the corresponding period of last year. After providing for debenture interest there is an available balance of £987 5s. 6d., out of which the directors recommend the payment of the usual half-yearly dividend on the 5 per cent. preference shares, and that the balance of £512 5s. 6d. be carried forward to next half-year, as against £644 2s. 7d. carried forward for the corresponding period of the previous year. The meeting will be held to-day.

At the meeting on Thursday, the chairman, Mr. W. Mooney, said that whereas the receipts showed an increase of £256 over the corresponding period of the previous year, the expenditure had increased by £405, mainly due to extra cost of electric power and maintenance of permanent way and works; the increased price of coal had also contributed to this result. They had decided to continue the expenditure upon the permanent way, until the whole line had been put into a thoroughly efficient state. In order to make the line as attractive as possible, the directors, had, among other improvements, introduced electric heating in the cars. The report and accounts were adopted.

EDMUNDSON'S ELECTRICITY CORPORATION.—An extraordinary general meeting was held at Salisbury House, London Wall, on Tuesday, under the chairmanship of Mr. F. E. Gripper, to consider a report of the committee appointed in July last to investigate the affairs of the company. This report stated that the non-success of the company was due to a combination of injudicious capital expenditure, unwise management, and imprudent finance. The committee recommended that the resignation of the old members of the Board be accepted, and that Mr. Tuckett be appointed chairman of the company, and that Mr. Campbell Swinton be elected to the Board; that Mr. Stanley Beeton be invited to the Board; that Mr. J. S. Highfield, chief engineer to the Metropolitan Electric Supply Co., be invited to assist in the reorganisation of the company's business; and that Mr. F. E. Gripper should act as manager to the London office, and as the representative of the Corporation upon the Boards of the local companies. The report further stated that immediate steps must be taken to provide additional capital. After careful consideration the capital requirements for the next four years were estimated to amount to £250,000, and the committee were reluctantly compelled to suggest as the only practicable course, the issue of prior lien debenture stock. During the discussion upon this report it was stated that Mr. Gripper would subordinate his personal views and likings in his position as manager entirely to the views of the directors. There was a good deal of opposition to the issue of prior lien debentures, and a suggestion was made that the committee should take back for consideration its recommendation with regard to finance. An amendment to omit from the report the financial proposals and the recommendation with regard to the appointment of Messrs. Beeton, Highfield, and Gripper was lost, and the original resolution was carried. A demand for a poll was subsequently withdrawn.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY.—The half-yearly meeting was held on Tuesday, Sir George Gibb presiding. The Chairman traversed all the statements made in his report, given on page 227 of our issue last week, and stated that the receipts for the first seven weeks of 1908, compared with those of the first seven weeks of 1907, showed an increase of 43 per cent. The report and accounts were adopted, and at the subsequent special meeting a resolution approving the company's Bill in Parliament was passed.

HASTINGS & DISTRICT ELECTRIC TRAMWAYS.—The report for the year ending December 31st, 1907, shows receipts aggregating £24,099, or, after deducting administration expenses, £22,206 1s. 7d.; adding to this the sum of £300 12s. 6d. for interest earned on moneys in hand, and £733 6s. 10d. brought forward from last account, and deducting £9,472 10s. debenture stock interest, there remains a balance of £13,767 10s. From this has been paid during the year by way of interim dividend on the preference shares the sum of £4,000, being at the rate of 4 per cent. per annum, and the directors now propose to pay a further sum of £8,000, being at the rate of 8 per cent. per annum, making the full 6 per cent. for the year 1907, and to carry forward the balance of £1,767 10s. The Front line was opened for traffic on January 12th, 1907, and therefore the completed system has been in operation for practically the whole year. Having regard to the unfavourable weather which was generally experienced throughout the year, the directors consider the result to be satisfactory. The meeting will be held on Monday. The following statistics are given in the report :— Miles of line, 19½; number of cars, 65; car mileage, 1,436,014; passengers carried, 9,530,345; traffic receipts per car mile, 9·05d.; total expenses per car mile, 5·47d.

The meeting was held on Monday, Mr. E. C. Morgan, chairman, presiding. The Chairman pointed out that the expenses were about 60 per cent. of the receipts, and although it was hoped to reduce this rather large percentage, they did not expect to emulate the figure of other lines where the conditions were much less onerous than those of Hastings. He referred to the fact that in connection with the line along the sea front, which gave a direct communication between Hastings and Bexhill, they had been compelled to adopt some other system than the overhead. They had therefore to fall back on one of the surface contact systems (the conduit system being almost impossible), although very little was known as to their merits, and

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practically nothing of the particular system which had been put into operation, namely, the Dolter system. They were, therefore, the pioneers of this system in England, and for a considerable period they experienced many difficulties which did not tend to improve their traffic. By patience and perseverance however, they had surmounted many of the difficulties, and the line was now working in such a manner as to lead the directors to hope for fairly good results. The report and accounts were adopted.

IMPERIAL TRAMWAYS.—The gross revenue receipts from the Middlesbrough, Stockton, and Thornaby Tramways during the year ended December 31st, 1907, amounted to £54,747, a decrease of £587 over the previous year. £2,500 is placed to reserve, leaving a net profit of £16.884. The receipts from the London United Tramways were £21,111, this being the same as for the previous year. The net revenue of the Imperial Company for the year shows a gross profit of £41,573, which is reduced to £26,125 after payment of interest on debenture stock for the whole year, and interim dividend on the preference and ordinary shares up to June 30th, 1907. Dividends are proposed of 6 per cent. per annum on the preference capital, and final dividends of 10 per cent. per annum, making 9 per cent. for the year on the ordinary shares. The sum of £248 is carried forward.

The report and accounts were adopted at the meeting on Monday, the Chairman stating that the past year's experience had been without any special feature, and called for no special comment.

LIVERPOOL OVERHEAD.—At the half-yearly meeting last week, the report and accounts given in our issue for February 6th were adopted. Sir W. Forwood, the chairman, who presided, said that there were indications that they had now to some extent discounted the pressure of tramway and railway competition, and were reaping some benefit from the annual growth of dock side traffic. The receipts per passenger, he pointed out, were only 1·77d., against 1·93d., which was the figure when the company was paying a 5 per cent. dividend, and this low average was due to the heavy workmens' traffic.

ST. JAMES'S & PALL MALL ELECTRIC LIGHT.—At the ordinary general meeting, held at the office of the company in Carnaby Street, on Tuesday, the report and accounts given on page 273 of this issue were adopted. Having gone through the figures of the report, the Chairman stated that with regard to the future he was not going to make any promises, but he would state that the first result of the effect of metallic filament lamps upon their business was a sensible loss of revenue; but it need not be feared that these new lamps were going to be an unmitigated disadvantage, as undoubtedly they would tend to the greater use of electrical energy by a class of people who now regarded it as a luxury.

SOUTH METROPOLITAN ELECTRIC LIGHT AND POWER.—The report for the year ended December 31st, 1907, shows a credit balance of £27,068, which, with £7,104, the balance brought forward from the last account, makes a total of £54,172. After deducting £9,792 for interest on debenture stock paid and accrued, and for other interest, and £4,128 for interim dividend paid on the 7 per cent. cumulative preference shares, there remains a balance of £20,250, which the directors recommend be dealt with as follows:—A final dividend upon the 7 per cent. cumulative preference shares, £4,555; depreciation account, £5,500; dividend upon the ordinary shares at the rate of 2½ per cent. per annum, £3,011; carried forward, £7,182. During the year a further £19,262 debenture stock, 25,000 preference shares, and 3,000 ordinary shares of £1 each were issued. The premiums arising from the issue amount to £3,487. The directors have applied £1,987 of the amount in the reduction of preliminary expenses account, and have carried the balance, £1,500, to reserve account. Eight of the London electric supply companies, including this company, are jointly promoting a Bill in the present session of Parliament for the establishment of a joint committee, and to make agreements for mutual assistance, and for the supply of energy in bulk to and the taking of energy from one another. The Bill will be submitted for consideration, and a resolution proposed to approve the same after the general meeting on the 26th inst.

SOUTH WALES ELECTRIC POWER DISTRIBUTION.—A special general meeting was held at Cardiff last week, at which the company's Bill, of which full particulars were given in our issue for December 26th, was agreed to. A meeting of the debenture shareholders was afterwards held under the chairmanship of Mr. T. O. Callender, and the resolution to promote the Bill was also passed. It was stated that arrangements have been entered into with creditors to the extent of £79,000, for the annulment of the amount owing them by the creation of preference stock at the rate of 150 per cent. face value of the stock for every £100 of indebtedness. Creditors to the amount of £4,000 were unable to give their assent to this proposal, however, but the Bill contained a clause compelling them to accept preference shares on the terms above mentioned. Power is taken in the Bill to raise £500,000 by means of prior lien debenture stock, and to postpone the payment of interest on the £200,000 existing debentures for a period of three years, namely, until January 1st, 1910.

TYNESIDE TRAMWAYS & TRAMROADS.—The report for the half-year ending December 31st, 1907, shows a surplus of receipts over expenses of £3,785, which, with the balance brought forward from last half-year of £600, makes a total of £4,385 available, and after deducting interest on mortgages, loans, &c., there remains an available balance of £2,968 8s. 1d. The directors propose a dividend on the preference shares of 5 per cent. per annum (less income tax); a dividend on the ordinary shares of 2½ per cent. per annum (less income tax), as compared with 2 per cent. for the corresponding half-year of 1906; placing to the credit of reserves for renewals, depreciation, and other contingencies, £600, increasing this fund to £4,600. The amount carried forward is £422. The whole of the track, overhead line, and rolling stock has been kept in thorough repair during the past year out of revenue. The recent issue of preference shares has been satisfactory, inasmuch as 2,033 shares have been applied for out of a total of 3,000 offered for subscription. The following statistics are attached to the report:—Car miles (Tyneside Tramway Co.'s cars), 679,692; passengers carried (Tyneside Tramway Co.'s lines), 4,703,459; total traffic receipts, £24,068; gross profit, £8,261.

Dr. J. T. Merz, who presided at the meeting last week, said the traffic receipts had increased by 4¼ per cent., and the car miles run by ¾ per cent. In other words, though running a trifling number of miles more they had carried very many more passengers, with the result that the receipts per car mile had increased from 8·18d. to 8·49d. The cost had increased from 5·64d. per car mile in 1906, to 5·82d. in 1907. The report and accounts were adopted, and upon the motion of the chairman, the number of the directors of the company has been reduced to five.

YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS.—The report for the year ended December 31st, 1907, states that the operations of the past twelve months, after providing for all expenses, including repairs and renewals, resulted in a net income of £27,377. Adding the balance brought forward from last year, £4,443, the available profit is £31,821. This profit has been dealt with as follows:—Debenture interest (less income-tax) on 4½ per cent. stock, £11,756 5s.; debenture interest (less income-tax) on 6 per cent. bonds, £744 11s. 3d.; sundry reserves as per appropriation account, £9,856 14s. 7d.; carried forward, £9,463 8s. 11d. The number of passengers carried during the past year amounted to 8,627,247, and the miles run to 1,758,669, as against 6,169,148 and 1,414,767 respectively for the previous year. The increase of passengers is chiefly due to the completion of the Normanton and Pontefract section, but a satisfactory expansion of traffic is also shown on the old routes. The meeting takes place to-morrow at 14 Victoria Street, Westminster.

APPOINTMENTS AND PERSONAL NOTES

Sir John Gavey, C.B., late Engineer-in-Chief to the Post Office, has been appointed consulting engineer to that department.

The Woolwich Borough Council has passed increases of £10 per year each to the salaries of officials in the Electricity Department as follows:—F. H. Edwards, station engineer, and S. H. Penning (present salaries, £180); H. H. Clare, charge engineer (£140); T. W. Bunce, charge engineer (£120); C. A. Trayte, draughtsman (£100).

The salary of the Electrical Engineer to the Ealing Corporation, Mr. C. S. Davidson, has been increased £25 per annum; that of Mr. Law, the assistant in the Electricity Department, £10 per annum; and that of Mr. Kieffer, the shift engineer, £5 per annum.

The salary of Mr. A. L. C. Fell, chief officer of the London County Council tramways, has been increased from £1,500 to £1,750 per annum. In making this recommendation the General Purposes Committee point out that since Mr. Fell was appointed in November, 1903, additional tramway undertakings have been taken over, and a large proportion of the lines reconstructed for electrical traction by the Council; as an instance of the rapid growth of the service it is mentioned that the number of passengers carried has increased from 126,388,845 in 1903 to 351,407,794 in 1907, whilst during the same period the receipts have increased from £489,369 to £1,536,196. At the time the salary of £1,500 was fixed, it was not contemplated that the northern tramways system would be taken over before 1910.

Mr. E. L. Pope, resident electrical superintendent for the L.C.C. tramways, has had his salary increased from £400 to £425 per annum, and Mr. G. Dickens, superintendent of stores, from £250 to £300 per annum.

A resolution to increase the salary of Mr. H. W. Angus, the Electrical Engineer to the Eccles Town Council, by £50, was discussed at some length at the last meeting of the Council, and was defeated, the recommendation being referred back to the committee.

The Gravesend Corporation has agreed to a recommendation by the Electric Lighting Committee to increase the salary of Mr. C. F. McInnes from £300 to £400 by annual instalments of £50, £50, and £20, on condition that Mr. McInnes remains with the Corporation for a further period of three years.

Mr. Owen L. Rhys has been appointed to the position of medical officer in charge of the electrical department at the Cardiff Infirmary.

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PARLIAMENTARY INTELLIGENCE

GREAT EASTERN RAILWAY (GENERAL POWERS) BILL.—At the meeting of the Ipswich Town Council last week, when a resolution was under discussion with regard to opposing Section 19 of this Bill, which gave the G.E.R. Co. more or less general powers of electric supply, it was stated that a communication had that morning been received from the company to the effect that the clause in question had been deleted from the Bill.

PETITIONS AGAINST PRIVATE BILLS.—The period for depositing petitions against Bills originating in the House of Commons expired last week. Against the Dublin and Central Ireland Electric Power Bill petitions have been lodged by the Dublin Corporation, Dublin County Council, Rathmines, Pembroke, and Blackrock Councils, and the Dublin United Tramways (1896). The London United Tramways Bill is opposed by the National Telephone Co., Richmond Corporation, Surrey County Council, and the promoters of the West London, Barnes, and Richmond Tramway Bill. There are a number of municipal general powers Bills containing tramway clauses which will be opposed, but the above two Bills seem to be the only ones calling for special comment. The most controversial Bills, viz., the London Electric Power Bills, commence in the House of Lords, and the period for depositing petitions has not yet expired. Already, however, petitions have been lodged against the London and District Electricity Supply and the London Electric Supply (Joint Committee) Bills by the Camberwell Borough Council, City of London Electric Lighting Co., and the Gravesend, Ealing, Hendon, Hornsey, Dartford, Leyton, West Ham, Westminster, and Friern Barnet Corporations. The Bristol Corporation is opposing the Bristol Tramways Bill, the Hornsey Corporation the Highgate Hill Tramways Bill, and petitions upon minor points have been lodged against the Metropolitan Electric Tramways and other Bills.

PROGRESS OF ELECTRICAL BILLS.—The Nottinghamshire and Derbyshire Tramways Bill was read a second time in the House of Commons on Monday. The Metropolitan Electric Tramways Bill was read a first time in the House of Lords on Thursday. The Macclesfield and District Tramways (Abandonment) Bill, and the Central Ireland Electric Power Bill, were read a second time in the House of Commons on Tuesday.

RADIOTELEGRAPHIC CONVENTION.—In the House of Commons on Thursday, in reply to Sir John Dickson Poynder, the Postmaster-General stated that all the self-governing Colonies had notified their intention of adhering to the Radiotelegraphic Convention, with the exception of Newfoundland, which had not yet communicated its decision, and the Orange River Colony, which, as an inland colony, sees no necessity for adhering to the Convention.

TELEGRAPH (CONSTRUCTION) BILL.—A Bill has been introduced into the House of Commons by the Postmaster-General to amend the Telegraph Acts, 1863 to 1907, with respect to the construction and maintenance of telegraphic lines for telephonic and other telegraphic purposes. The Bill provides for the use of land near roads for telegraphic purposes, the flying of wires overland adjoining a road so used, and the lopping of trees which obstruct any telegraphic line.

In the memorandum which the Postmaster-General has published, explaining the provisions of this Bill, he states that the Department is placed in great difficulties where the most convenient road for telegraph lines is alongside a road which has no grass margin, and the owner of the land adjoining refuses permission for poles to be erected. Under the Bill, in cases where there is such an objecting landowner, the Postmaster-General may appeal to a County Court judge and the Railway Commissioners. The same procedure is allowed where the Postmaster-General desires to place his posts on private land within 20 ft. of the road not forming part of the road. The Bill further extends the provision of the Telegraph Act of 1892, which enables the Postmaster-General to obtain a Provisional Order from the Railway Commissioners giving him access to a place where he is altogether barred by the unreasonable attitude of the landowner.

NEW COMPANIES

ADDINELL & CO.—This company was registered on February 13th, with a capital of £1,500 in £1 shares, to take over the business of an electrical engineer and contractor carried on by J. G. Addinell, at Saracen Buildings, Snow Hill, E.C., as the "A. C. Electrical Co." and at Eagle House, Great Darkgate Street, Aberystwyth, Cardiganshire, as "Addinell and Humphreys." and to adopt an agreement with the said vendor. The subscribers are:—R. S. Phillips, R. E. Burnage, J. J. McIntyre, J. G. Addinell, G. H. Palmer, A. E. Timberlake, P. H. McIntyre. No initial public issue. The number of directors is not to be less than two nor more than five; the first are J. G. Addinell and J. J. McIntyre. Qualification £10. Remuneration as fixed by the board. Registered office, Saracen Buildings, Snow Hill, E.C.

ARBROATH ELECTRIC LIGHT & POWER CO.—This company was registered in Edinburgh on January 30th with a capital of £30,000 in £1 shares to carry on the business of an electric light, heat, and power supply company, to undertake the lighting by electricity, gas, or other illuminant of towns, streets, buildings, and other public or private places, particularly near Arbroath, to construct, maintain and work by electricity or other power tramways, or other undertakings, &c. The subscribers are:—G. Balfour, A. H. Beatty, J. B. White, A. Shepherd, R. F. Shepherd, W. Shearer, J. A. Ferguson. The first directors are to be afterwards appointed. Qualification, 100 shares. Remuneration as fixed by the company. Registered office, Brothock Bank House, Arbroath.

COLONIAL RAIL & TRAMWAY SYNDICATE.—This company was registered on February 14th, with a capital of £2,100 in 2,000 "A" shares of £1 each, and 2,000 "B" shares of 1s. each, to construct, work, develop, or control railways, tramways, and other public works and conveniences of all kinds in any British Colony, Dependency, or elsewhere, and to carry on the business of financiers, capitalists, company promoters, concessionaires, &c. The subscribers are:—W. H. Hodges, F. W. Gibson, E. H. Burton, A. H. Lansdowne, D. Lewes, G. Brodie, P. J. Miller. No initial public issue. The subscribers are to appoint the first managers. Registered office, 16 St. Helen's Place, E.C.

ELECTRELLE.—This company was registered on February 14th, with a capital of £10,000 in £1 shares (55 founders'), to carry on the business of manufacturers of and dealers in "Electrelles" and other mechanical contrivances or devices for playing, producing, or reproducing sound from pianofortes, organs, harmoniums, and other musical instruments, &c. The subscribers are:—H. Whitcombe, J. C. Burrows, F. Cox, J. Oates, J. Hall, F. W. Browne, W. F. Hughes. No initial public issue. The number of directors is not to be less than three, nor more than seven; the first are J. E. Prestwich, R. H. Prestwich, W. H. Fish, and A. W. Stevenson. Remuneration as fixed by the company. The holders of the founders' shares shall be entitled: (*a*) to 55 per cent. of the distributed profits, and (*b*) to 55 per cent. of the surplus assets in the event of winding up. They shall also, in addition to one vote for every share held by them respectively, be collectively entitled to as many votes as the holders of all the other shares for the time being issued shall be entitled in respect of such other shares. Registered office, 13 Spring Gardens, Manchester.

LAIDLER, RITCHIE & CO.—This company was registered on January 30th with a capital of £6,000 in £1 shares (3,000 preference) to acquire the business of electrical engineers carried on by Laidler & Co. (formerly known as "Laidler, Laidler & Co."), of Pink Bank Lane, Longsight, Manchester, and to carry on the same and the business of manufacturing electricians, makers and suppliers of apparatus used in connection with the distribution, supply, accumulation, and employment of electricity, &c. The subscribers are:—F. Raimes, W. Raimes, F. T. Nattrass, W. C. Laidler, T. E. Ritchie, J. S. Proctor, and E. E. Kellett. No initial public issue. The number of directors is not to be less than two, nor more than five; the first are F. Raimes, W. C. Laidler, and T. E. Ritchie. The two last named are permanent managing directors; special qualification, 300 ordinary shares. Qualification of ordinary directors, £200 shares or stock. Remuneration of first managing directors, £100 each per annum (£150 per annum when only one): of ordinary directors as fixed by the company. Registered office, Nutsford Vale Works, Pink Bank Lane, Longsight, Manchester.

LEE'S ENGINEERING CO.—This company was registered on February 3rd with a capital of £1,000 in £1 shares to acquire the business carried on by J. Lee at Station Road, Oswestry, Salop, and to carry on the business of mechanical, electrical, and general engineers, founders, manufacturers of, and dealers in electric light fittings, art metal workers, fitters of bells, telephones, and signalling appliances and apparatus, dealers in boiler and non-conducting composition for coating purposes, &c. No initial public issue. The number of directors is not to be less than three, nor more than seven; the first are E. B. Smith, G. Perks, W. Foulkes, and W. W. Coulson. Registered office, Station Road, Oswestry, Salop.

LEWIS & DAVID.—This company has been registered with a capital of £6,000 in £1 shares to carry on the business of electrical, mechanical, civil, and mining engineers, &c. No initial public issue. Registered offices, Port Talbot Foundry, Isaac's Place, Aberavon, Glam.

SCHREIBER ELECTRIC BATTERY CO.—This company was registered on February 5th with a capital of £7,000 in 5,000 preference shares of £1 each, and 40,000 deferred shares of 1s. each, to acquire certain inventions or processes relating to the manufacture of electric batteries, to adopt an agreement with P. Schreiber, and to carry on the business of manufacturers of and dealers in all kinds of electric batteries, accumulators, and self-propelled vehicles, electricians, electrical engineers, &c. The subscribers are:—H. Leighton, W. F. Hutchison, H. Foster, P. Schreiber, J. Bruce, S. G. Barnes, A. F. Robinson. No initial public issue. The number of directors is not to be less than three, nor more than six. P. Schreiber is managing director. Table "A" mainly applies. Registered office, 25 Brewer Street, Regent Street, W.

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MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night, was £58 10s. to £59 per ton (last week £61 10s. to £62 10s. per ton).

"TANTALUM" LAMPS.—Messrs. Siemens Bros.' Dynamo Works, Ltd., notify us that from the 10th inst., the 16 c.p. and standard "Tantalum" lamps have been reduced to 2s. 6d. The price of the "Sun" bulb lamps remains at 5s. 6d.

MESSRS. HARRIS, LEE & CO.—A meeting of the creditors of Messrs. Harris, Lee & Co., of Johannesburg and London, was called yesterday, and we understand that a statement of affairs has been prepared which shows liabilities to sundry creditors £9,517 6s. 5d., debentures and interest £4,274 7s. 10d., and partly secured creditors making the liabilities total £15,570 9s. 10d. The assets total £17,438 9s. 8d.

It appears that the company was registered at Johannesburg on February 15th, 1905, with a capital of £11,421, to carry on the business of electrical and contracting engineers. The business was conducted at Johannesburg only at the date of the incorporation, but a concession was obtained from the municipality of Heilbron, in the Orange River Colony, and the work is in course of erection. This concession, which was afterwards sold, resulted in a total loss to the company of £1,600. A similar concession was obtained in October, 1904, in the town of Bethlehem in the same colony, and, though this is being worked at a small loss, it is still being carried on by the provisional liquidators with a view to a sale. A business carried on in Pretoria, which the company took over in 1906, was carried on at a loss, as was also a business in Doornfontein, and both these businesses have been closed. A contract was obtained from the municipality of Krugersdorp in May of last year for public lighting, and a branch office was opened there. Several contracts were obtained, and these are now practically completed. A synopsis of the trading from the date of the incorporation of the company shows that losses have been made at Johannesburg and other branches amounting to £4,258, while £768 has been written off amount owing by directors, and £8,500 off goodwill. The provisional liquidators are of the opinion that the liquidation has been brought about by insufficient working capital, over-trading, and the adoption of too large a policy of expansion, with a consequent lock-up of capital; having the business too much scattered, involving difficulty of supervision and consequent loss, high expenses of administration and heavy rents; a tendency to cut prices in order to secure business, and the consequent failure to make adequate gross profits, and absence among the management of one controlling hand to watch the finance and stop extravagance. The following are the chief creditors :—Atlas Carbon & Battery Co., £33; A.E.G. English Manufacturing Co., Ltd., £56; M. Bateman & Co., £47; Berry, Skinner & Co., £79; British Prometheus, Ltd., £20; C. Conradty, £15; Cole Marchant & Morley, Ltd., £206; J. Defries & Sons, Ltd., £60; Dorman & Smith, £13; Drake & Gorham, Ltd., £16; Everett, Edgecumbe & Co., Ltd., £14; Electric & Ordnance Accessories Co., Ltd., £139; Ecco Battery & Electric Co., Ltd., £17; Estler Bros., £13; Edison & Swan U.E.L. Co., Ltd., £13; Gwynnes, Ltd., £63; Gilbert Arc Lamp Co., Ltd., £274; Hooper's I.R. Works, Ltd., £52; Hawkes, Ltd., £15; Cecil Hodges & Co., £25; Johnson & Phillips, Ltd., £12; Marples, Leach & Co., £45; Morgan Crucible Co., Ltd., £38; Plutte, Scheele & Co., £11; Rumney & Rumney, £167; Sloan Electric Co., Ltd., £10; Spagnoletti, Ltd., £20; Saxon Electrical Co., Ltd., £58; Sterling Telephone & Electric Co., £137; Simplex Conduits, Ltd., £1,236; Dr. Henrick Traun & Sons, £12; J. H. Tucker & Co., £76; Union Electric Co., Ltd., £35; Walsall Electric Co., Ltd., £10; Ward & Goldstone, £81; Zurich Incandescence Lamp Co., Ltd., £1,113. Among the South African creditors are :—A.E.G. Electrical Co., Ltd., £75; African Merchants, Ltd., £25; British General Electric Co., Ltd., £89; R. C. Brown, £25; H. Daniels, £59; C. J. Duncan, £100; W. M. Edwards, £10; W. H. Ferrar, £47; Giddey & Sparkes Clarkson, £60; A. J. Geard & Co., £55; Henley's Telegraph Works Co., Ltd., £101; Harvey & Co., Ltd., £16; D. M. Kisch & Co., £12; Natal Government Railways, £116; Parker, Wood & Co., Ltd., £11; Reunert & Lons, £11; Robson & Holton, £18; Stewarts and Lloyds, Ltd., £104; S.A. Investment Co., Ltd., £30; W. D. Smith & Sons, £10; W. P. Sole & Co., £18; Seehoff & Victor, £14; E. W. Tarry & Co., Ltd., £18; Telegraph Manufacturing Co., Ltd., £1,590; Transvaal Rubber Co., £10; Vacuum Oil Co., £115; Western Electric Co., £117.

W. F. JONES & CO.—A meeting of the creditors of C. H. Rosoman & Sidney Dicks, trading as W. F. Jones & Co., Dacre House, Victoria Street, London, S.W., was held on the 11th inst., when a statement of affairs was submitted, showing liabilities amounting to £752 2s. 9d., all of which was due to unsecured trade creditors. After allowing £18 6s. 3d. for preferential claims, the assets were expected to produce £581 8s. 9d., a deficiency thus being disclosed of £170 14s. In order to protect the estate a deed of assignment has been executed. The trustee under the deed (Mr. Abernethy) had received from the largest trade creditors an offer to purchase the stock for £212. The offer would, however, probably be withdrawn if the estate were administered in bankruptcy. The matter was discussed at some length, and it was ultimately decided to confirm the deed already executed. The following are among the creditors :—Auto Claw Co., Ltd., £25; Cutting Bros., Ltd., £22; Everett Edgcumbe & Co., Ltd., £13; *Electricity*, £11; Ferranti, Ltd., £10; Adams Manufacturing Co., £7; Armorduct Manufacturing Co., £3; Drake & Gorham, Ltd., £6; Endolithic Manufacturing Co., Ltd., £3; General Electric Co., Ltd., £6; G.P.O. telephone, £1; London Electric Supply Corporation, Ltd., £1.

MISCELLANEOUS CITY NOTES

ADELAIDE ELECTRIC SUPPLY CO.—Notice is given to holders of preference share warrants to bearer that, on and after March 2nd next, they will receive payment of a dividend at the rate of 6 per cent. per annum for the half-year ending the 29th inst., less income tax, on presentation of Coupon No. 4 at the bankers of the company, Messrs. Glyn, Mills, Currie & Co., 67 Lombard Street, London, E.C. Coupons must be left with the bankers three clear days for examination.

BRUCE PEEBLES & CO.—A circular was issued on Saturday informing the shareholders that it has become necessary to call a meeting of the shareholders for the purpose of putting the company into voluntary liquidation, with a view to reconstruction. This step has been rendered necessary owing to the need of further additional working capital. A further issue of debenture was sanctioned by the shareholders in April, 1907, but by reason of the extreme stringency of the money market it was found impossible to make such an issue, and for the same reason it has not been possible to realise advantageously the securities in which the company is interested. The auditors are at present engaged on the preparation of the accounts, and the directors are considering plans for the reconstruction of the company, which have been submitted to, and favourably received by some of the larger creditors and representatives of the preference shareholders. A special meeting will be held on February 24th, when a resolution will be proposed sanctioning the voluntary liquidation of the company, and appointing Mr. A. W. Tait, liquidator, with a committee of shareholders and creditors. In a second circular which has been issued to the creditors, it is stated that under the proposed scheme it is expected that substantial payments on account will be made to the creditors at an early date. The circular further points out that in view of the large contracts in course of completion, it is absolutely necessary to carry on the business of the company without interruption, and the directors hope that the creditors will extend their support to a course of action which they believe will secure the best results for the creditors. Mr. J. A. Robertson Durham, of Edinburgh, has since been nominated as joint-liquidator on behalf of the creditors.

BOURNEMOUTH & POOLE ELECTRIC SUPPLY CO.—The directors recommend a final dividend at the rate of 9 per cent. per annum for the half-year ended December 31st, 1907, making 7 per cent. for the year.

BRITISH ALUMINIUM CO.—A resolution has been passed authorising the division of the £10 conversion shares into two shares of £5 each, one a 7 per cent. preference share, ranking *pari passu* with the existing 7 per cent. preference shares, and the other an ordinary share ranking with the existing ordinary shares.

CAMMELL, LAIRD & CO.—At a meeting of the directors last week, Mr. Arthur Daulby Wedgwood, late of the Dennystown Forge Company, was appointed Managing Director, and Mr. Henry Edward Deadman, C.B., late of the Admiralty, and Major Arthur Handley, late R.A., were elected directors.

CITY OF LONDON ELECTRIC LIGHTING CO.—A dividend of 6s. per share upon the preference shares for the half-year to December 31st, making 12s. for the year, and 7s. on the ordinary shares, also making 12s. for the year, has been declared. After making allowance for reserve, the sum of £20,000 is carried forward.

ELECTRICAL DEVELOPMENT COMPANY OF ONTARIO.—A Reuter telegram from Ottawa states that Mr. William Mackenzie, president of the Canadian Northern Railway, has secured control of the Electrical Development Company, bonds of which, to the amount of £1,600,000, are held in Great Britain. It is officially declared that the reorganisation will result in the interest being met.

Telegraph Traffic.—A lull has occurred in the storm of interruptions to telegraphic communication during the past week, but the repairs of certain cable lines, which we had hoped to be able to announce in this issue, have not yet taken place. It is probable, however, that during the coming week the cable between Trinidad and Demerara will be once again open for traffic. The company owning it have great difficulty in maintaining it in working order, owing to the injurious effect of the mud found on the coast of British Guiana, which it is said sets up chemical action leading to destruction of the cable. The only repair we have to announce this week is of the El Arich land-line route. The date of the Telegraph Conference at Lisbon has now been fixed for May 4th.

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ELECTRICAL ENGINEERING

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SUMMARY

A new enclosed flame arc lamp has been placed on the market. Passages are provided in order to obtain a good circulation of the gases, thus preventing eddies in the glass cylinder enclosing the arc. A plain carbon is used for the negative electrode, which is uppermost, and the positive carbon has a star-shaped section, and, instead of its being impregnated, paste containing the necessary chemicals is inserted in the grooves. (Page 299.)

A short description is given of a form of electric capstan with a loose head which can be connected to the spindle when required by a clutch. Several of these capstans are in use at Clydebank. (Page 301.)

Two Papers, both received from the Newcastle Local Section were discussed at the London meeting of the Institution of Electrical Engineers last Thursday. The first, by Mr. H. Henderson, describing the electrical equipment of the new goods warehouse of the North Eastern Railway, has already been published in our columns. The second, by Mr. C. E. Taylor, related to applications of electric power in docks, and described in some detail a number of coal conveyors and hoists, wharf cranes and capstans. Particular stress was laid on the advantages of Messrs. Stothert & Pitt's free-barrel device on cranes, which enables the load to be lowered independently of the motor armature, so that the change from lifting to lowering can be practically instantaneous, greater lowering speeds are possible than with a reversible motor, and the risk of overrunning can be lessened. An automatic starting switch for electrically-driven pumping plant was also described. In the discussion Mr. Roger Smith criticised the speeds of some of the cranes, and elicited from Mr. Henderson a complaint that the traffic department were apt to requisition unnecessarily high speeds for short lifts, the time occupied by which was but a small proportion of the total time taken in handling the goods. On the other hand, as a result of his reading the Paper, the under-hung jib travelling cranes described would be adopted on the Great Western Railway. He emphasised the economy of conveyors, such as those described by Mr. Taylor, compared with jib cranes, and pointed out that their load factor was far superior, giving the relative figures as 5·3 and 30 per cent. The design of electric capstans was severely criticised by Mr. Smith, Mr C. W. Neele, of the Great Central Railway, and Mr. C. F. H. Bayley, of the South Eastern & Chatham Railway, who all agreed that the resistances, &c., should not be placed in the capstan case, which is invariably damp, due to sweating. Mr. Smith even went to the extent of recommending that the capstan case should be lagged, and contain an electric heater. He also thought that series motors should

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be employed rather than compound motors; but the contrary view was expressed by Mr. Henderson. Mr. Neele also referred to the trouble experienced with electrical devices to prevent over-running, and asked for a more sensitive controller. (Page 301.)

MR. P. DAWSON read a Paper recently at the Royal Automobile Club on "Railway Electrification," in which he gave a rapid sketch of the development and present aspect of the subject. Some prominent railway men took part in the discussion. (Page 307.)

A FIFTEEN-INCH "merchant" rolling mill at the Motherwell Iron & Steel Works is electrically driven on the slip regulation method by a 500 h.p. three-phase induction motor, at a consumption of about 40 Board of Trade units per ton of material rolled. An illustrated article describes the mill and the system employed, and also gives particulars of other electrically-driven plant used in the works. (Page 309.)

IN the discussion of Mr. J. F. C. SNELL'S Paper on the cost of electrical power supply, by the Leeds Local Section at Sheffield, further figures were given by various speakers. Mr. FEDDEN said that, in spite of the price of gas at Sheffield being about half the figure upon which Mr. Snell based his comparisons, the Corporation were adding to their power load at the rate of 200 to 300 kw. per week. Works that had previously put down their own suction and producer plants had changed over to the Corporation, and the load factor at which they supplied was now from 40 to 45 per cent. Mr. DICKINSON gave the diversity factor at Leeds as 2·4. (Page 312.)

A FORM of accumulator locomotive for use in mines, in which special attention has been paid to means for readily changing the batteries, has been developed on the Continent. (Page 313.)

THE Variable Electric Lamp Syndicate has obtained an injunction against the Bryant Trading Syndicate for infringement of a patent relating to a double filament lamp, in which the filaments are switched on and off by turning the lamp in its holder. (Page 314.)

A LARGE number of open inverted arc-lamps have been installed for interior illumination in the premises of a large West End drapery establishment. The lamps are fitted with under-reflectors, and in some cases with over-reflectors. The useful intensity of illumination is about three and a half candle-feet. (Page 314.)

THE working of the "Dick" voltage regulator, which is in use in the power-station of the Vienna-Baden single-phase railway and elsewhere is described. The voltage of the system is maintained constant by varying a resistance, which is in the field-circuit of the generator, or, in the case of alternating-current systems, in the field-circuit of the exciter, by means of a solenoid controlled switch acting by the displacement of mercury by a moving plunger. (Page 315.)

REVIEWS of the following books appear in this issue:—"Electric Arc Lamps," by J. Zeidler and J. Lustgarten; "The New Physics and Its Evolution," by L. Poincaré (translation). (Page 316.)

A PAPER on the electrical equipment of ships, read by Mr. W. D. KIRKPATRICK before the Liverpool Engineering Society, contains some interesting information concerning systems of wiring on board ship, and some comparisons between steam and electrical driving of auxiliary machines. An extract from an Admiralty specification for control gears, which must be made to operate in a similar manner to the old steam gear which it replaces, is given. (Page 317.)

A LETTER has been received from Mr. S. F. WALKER with regard to a short review of his book, published last week. (Page 318.)

IN the final of his series of Cantor lectures upon clock-making, at the Royal Society of Arts on Monday, Mr. H. H. CUNYNGHAME, C.B., dealt with electric clocks. He gave an interesting *résumé* of the history of this subject, and instanced examples of earlier electric clocks still doing good work. The main difficulty to be got over was with the batteries, the unsatisfactory nature of which, the lecturer said, was due to the impurities in the zinc. His own opinion was that the best form of battery would be a large gravity Daniell, using comparatively weak solutions. (Page 318.)

THE chief points discussed by Mr. HOULT in his Paper on "Direct-current Turbo-generators," read before the Manchester Local Section of the Institution, were the means provided for improving commutation, the use of carbon brushes for high-speed work and the balancing of high-speed rotors In the author's opinion, carbon brushes will entirely supersede copper brushes for high-speed work as well as for low-speed work. The discussion, in which several well-known engineers took part, turned chiefly on the superiority of compensating windings to the use only of commutating poles and the behaviour of carbon and metal brushes. (Page 319.)

A SERIES of tests on a boiler with and without a live steam feed-water heater have been conducted recently by Prof. GOODMAN and Mr. MACLACHLAN, the results of which are embodied in a Paper read last Friday before the Institution of Mechanical Engineers. The general conclusion arrived at was that, whereas in this particular case no great increase in the amount of water evaporated per lb. of coal was apparent, the deposit in the boiler was materially less when the feed-heater was in use. (Page 323.)

AT a meeting of the Birmingham Local Section of the Institution of Electrical Engineers on February 12th last, the Paper by Messrs. T. F. WALL and S. P. SMITH on the losses in pole-shoes due to armature teeth was further discussed. Mr. WALL'S Paper on the reluctance of the air-gap, originally read in Manchester, was also discussed at the same meeting. (Page 324.)

MR. G. FRANKLIN, presiding at the annual general meeting of the National Telephone Co. on Wednesday last week, dealt at length with the question of message rates *v.* unlimited service rates. He quoted some remarks of the Postmaster-General that some unlimited service subscribers who originally made 3,000 calls per annum had, in the course of a few years, increased this number to 11,000 per annum, using the same line. Mr. Franklin also stated that the National Company had many cases of flat-rate lines used to such an extent that 24 per cent. of the total calls had become ineffective owing to the lines being engaged. Some subscribers thought nothing of sending 250 or 300 calls per day, with the result that nobody else could get into communication with them. Moreover, it was peculiar to the telephone business that the larger the number of subscribers the greater the capital cost per subscriber, and the following illustration of this was given. With an exchange for 1,000 subscribers, the capital outlay on switchboards and junctions would be £4 per subscriber, but if there were 10,000 subscribers, the capital cost would be £13 per subscriber. (Page 324.)

UNDER "Electrochemistry and Electrometallurgy" we abstract an article upon the question whether the rusting of iron is a purely chemical or an electrochemical process. In this case actual potential measurements between unrusted iron and rusted iron and between cast-iron and wrought-iron were taken, and it would appear as if the rusting process could be described as electrochemical. We also briefly abstract the two Papers read before the Faraday Society on Tuesday. (Page 325.)

UNDER "Electrical Science" is given an account of Sir OLIVER LODGE'S Friday evening Lecture at the Royal Institution on "The Ether of Space." There are also notes in the British and American Section on the calculation of self-inductances and on phosphorescence produced by cathode rays. In the papers abstracted in the Continental Section W. RITZ formulates a new electromagnetic theory which eliminates the ether and propagates gravitation with the speed of light; STARK

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explains the mechanism of band spectra; and Deininger studies the discharge from electrodes covered with quicklime. (Page 325.)

The Birmingham Corporation Tramways Committee have adopted the brake invented by Mr. A. W. Maley, of Leeds, which dispenses with blocks on the wheels, for three new tramcars, as an experiment. The Brentford Corporation have notified the London United Tramways Company that unless the tramway track in Brentford is put into a proper state of repair, an application will be made to the Board of Trade for an inspection with a view to enforcing the daily penalty of £5 stipulated in the company's Act. An application has been made to the Brighton Corporation for permission to run electric omnibuses. Complaints having been made by the Chiswick Corporation with regard to the smoke nuisance from the power-house of the London United Tramways, the Engineer to the company has replied that the apparatus which was installed some months ago with the object of preventing the emission of smoke has entirely failed, but that new precautions are being taken. A proposal which had been put before the Douglas (Isle of Man) Town Council to engage a consulting engineer to report upon the possibility of utilising water from the reservoir in connection with the electric lighting and tramways scheme, has been rejected. Sir Alexander Kennedy has been appointed to submit estimates to the Dunfermline Town Council upon the cost of erecting a generating station, or of taking a supply in bulk from the Fife Electric Power Co. At a conference of London Borough Councils owning electricity works, resolutions were passed which, it is stated, will affect the whole question of bulk supply in London in the future. The tramway system which Messrs. J. G. White & Co. have constructed in Luton has been opened. (Pages 327–329.)

At a local Government Board inquiry at Hanley on the 18th inst. the inspector, Mr. H. R. Hooper, agreed to the principle of sanctioning sums for prospective expenditure. A loan of £8,400 has been sanctioned to the Haslingden Corporation for the erection of a refuse destructor in conjunction with the Electricity Works. The Bradford Corporation tramways committee propose to spend £21,000 on the renewal of the track in various parts of the city. Tenders are invited by the London County Council for rails, and the Australian Government requires tenders for two cables between Tasmania and Victoria. (Page 329.)

The accounts of Messrs. Mather & Platt for the year 1907 show a net profit of £141,057. At the meeting of the Scarborough Electric Supply Co. last week, it was stated that an endeavour is being made to come to an arrangement with the Corporation for the erection of a refuse destructor in conjunction with the electricity works. A profit of £12,933 is shown in the accounts of the Simplex Conduits, Ltd., for 1907. The Telegraph Maintenance & Construction Co. accounts show a net profit of £165,470 for the year 1907. The accounts of the Charing Cross, West End & City Electricity Supply Co. show a net balance upon the West End undertaking of £42,023, and upon the City undertaking to £2,256. The connections to the West End undertaking are the equivalent of 538,964 8-c.p. lamps, an increase of 28,375 over the previous year, and the connections to the City undertaking are the equivalent of 457,757 8-c.p. lamps, an increase of 42,073. Mr. A. G. Lupton presiding at the half-yearly meeting of the Yorkshire Electric Power Co., on Wednesday last week, said the directors were now confident that the Company was fairly started on its way towards success. Sir William Crookes, presiding at the annual general meeting of the Notting Hill Electric Lighting Co., on Tuesday, stated that the company now paid rates equal to 2¼ per cent. per annum upon their share capital, and that advice was being taken with a view to an appeal against the assessment. At the meeting of Messrs. Bruce Peebles & Co. on Monday, when a resolution agreeing to voluntary liquidation was passed, it was stated that the net loss was £93,671. (Pages 331–333.)

The London Electric Supply (Joint Committee) Bill has been read a second time in the House of Lords. Three tramways Bills affecting London have been referred to the Standing Orders Committee for non-compliance with Standing Orders. (Page 333.)

Three patent specifications relating to incandescent lamps by the British Thomson-Houston Co. were published on Thursday last. The first describes the preparation of a filament composed entirely of tungstous oxide, which, it is stated, has a longer life than the ordinary metallic tungsten filament. The other two refer to filament supports and treated carbon filaments respectively. Another specification by the same company describes a single-phase repulsion motor without a commutator, which has the characteristics of a direct-current series motor. The Lancashire Dynamo & Motor Co. have patented a method of control for flywheel motors working on an intermittent load. (Page 335.)

Two Papers of considerable interest both to railwaymen and to electrical engineers were discussed at the Institution of Electrical Engineers on Thursday last. Their subject was the use of electrical power in the goods warehouses and docks of the North Eastern Railway. The Tyne has the advantage of a very cheap supply of electricity for power purposes, and the North Eastern Railway have made wise use of this opportunity in displacing worn-out hydraulically-worked plant by electrically-driven plant. Their fine new goods warehouse in New Bridge Street has been equipped with electrically-driven machinery throughout, while at their Tyne Dock old hydraulic pumping machinery and boilers have been replaced by electrically-driven hydraulic pumping machinery to work existing hydraulic plant more economically. The Papers were almost exclusively descriptive. Some of the apparatus described is new and some old, but all of it is more or less interesting. It is necessary to remember that almost all railway machinery in goods warehouses is worked by the Traffic Staff and not by the Engineering Staff. It must therefore be simple to manipulate, and, since repairs will probably not be asked for until a complete breakdown occurs, designs ought to be such as to make repairing work by the mechanical staff as easy as possible. In the discussion, the speeds of the various cranes described were adversely criticised, some being much too great where very short lifts were in question, and others for high lifts being too slow. The Traffic Department who work the machinery usually specify the speeds, but it is essential that those who specify the machinery should clearly point out to the Traffic Department whether the speeds asked for are those which give the most economical results. In Mr. Henderson's Paper on electrical power in goods warehouses, and in the discussion, the present design of electric capstans was severely criticised, and there is no doubt that manufacturing firms who make this plant have been content for far too long to produce machinery which almost always gives trouble, working as it does under the most adverse circumstances. One point in the discussion which appeals to us as of value was the suggestion that all capstan electrical switchgear should, if possible, be removed from the capstan-box and be put in a totally enclosed and accessible case or pillar above ground. One of the many valuable features of electric driving, quite apart from efficiency, is the means

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it affords of making fairly accurate comparisons of the power required by different pieces of plant or machinery. This leads to questions of efficiency being discussed, which previously were frequently overlooked. For instance, in the present debate the use of conveyors and cranes for loading coal into vessels was compared, and the great saving which is arrived at by employing the former method was made apparent. A hinged belt conveyor for delivering coal into vessels alongside, at any state of the tide, described by Mr. TAYLOR in his Paper on electric power in docks, showed that in actual working, about 500 tons of coal per hour could be delivered into a vessel, requiring the continual work of a 16 h.p. motor. With a lifting and tipping coaling crane less than half the above quantity of coal required the intermittent use of 120 h.p. in the hoisting and slewing motors. The discussion brought out that one of the fairly modern type hydraulic coal-tips in a South Wales dock required, for a delivery of 400 tons of coal per hour, the intermittent use of 50 pump h.p. at the tip-rams, for which about 100 indicated h.p. was installed in the pumping station. It was further mentioned that at Fishguard Harbour the annual load factor of 11 electric wharf cranes was slightly more than 5 per cent. It seems likely, therefore, that the advance in the economical shipping of unpacked materials in bulk, such as coal or ore, will be in the direction of the use of conveyors rather than in the use of tipping hoists or special cranes. The electric motor is the ideal drive for a conveyor of any form, while the load factor of such machinery as compared with the load factor of cranes or hoists is so incomparably better that it would seem worth while for electrical engineers to give especial attention to this class of machinery, and to urge its adoption on railway and dock people wherever conveying is suitable.

A NEW arc-lamp, combining the advantages of the flame arc with those of the ordinary enclosed arc, is described on another page, and if it confirms in practice the claims made by its makers, it should have a future before it. This new "Jandus" lamp follows the same lines as the Blondel flame lamp. The carbons are arranged vertically, with the positive carbon underneath, and a system of passages for ensuring a circulation of the gases and fumes is common to both the above lamps. Comparing the new lamp with the illustration contained in the Blondel patent (ELECTRICAL ENGINEERING, Vol. I., p. 521), the chief difference apparently lies in the construction of these passages; and from an article on the commercial form of the Blondel lamp as made by Messrs. Crompton & Co. (ELECTRICAL ENGINEERING, Vol. II., p. 853), it appears that impregnated carbons are employed in this, while in the Jandus lamp the carbons are high-grade carbons, the upper one plain and the lower one of a star-shaped section with the necessary chemicals, supplied in the form of a paste, set in its interstices. It is gratifying to see that arc-lamp makers are continuing to exercise the inventive energy and constructional ability that is maintaining the arc-lamp well in advance of the incandescent gas burner for the illumination of streets and large spaces.

THE electric driving of rolling mills is gradually gaining ground in this country, and the description which we publish this week of the 15 in. "merchant" mill driven by a 500 h.p. motor will be read with considerable interest, chiefly on account of the simplicity of the method employed for regulation. While the flywheel motor-generator would appear to be a *sine quâ non* in the case of reversing mills, the present installation shows that a more direct method of control is applicable with good results to ordinary rolls. A three-phase induction motor is employed, and, when the heavy load comes on, a resistance is inserted in the rotor circuit, increasing the slip between the phases of the stator and rotor, and the decreased speed causes the flywheel to give up some of its energy into the mill. The efficiency of the arrangement should be high, and the simplicity is such that, in addition to the general economies brought about by electric driving, there should be considerable saving in the cost of labour and maintenance. Electric power companies and those makers of electrical plant who are the most alert for an increase in their field, should now be looking to iron and steel works as one of the most important class of customers in the near future, and if the few examples of electric rolling-mill drive in this country give satisfaction to the mill-owners, a large increase of work will doubtless accrue to the electrical engineering industry.

WE were pleased to hear the announcement made by the PRESIDENT at the last meeting at the Institution of Electrical Engineers that a movement is on foot among electrical men to establish a memorial to Lord KELVIN. A committee with this object has already been formed and has recommended that a Kelvin lectureship be established by the Institution, and a Kelvin lecture held annually. It is also proposed that steps be taken to place a statue of the Institution's greatest President in a prominent position in London, and that, if possible, a series of scholarships shall be founded. The fame of so great a man will continue to live by his own monumental works, apart from any reminder erected by his followers; but not only do we heartily approve of the scheme of invoking the sculptor's art to give enduring expression of the respect felt for their leader, but we particularly applaud the recommendation to establish means of furthering the knowledge of the subjects upon which his work had so much influence, and of assisting aspirants to his field of thought and action.

ARRANGEMENTS FOR THE WEEK

FRIDAY, FEBRUARY 28TH.

Physical Society.

5 p.m. Meeting at the Royal College of Science, Imperial Institute Road, South Kensington. Paper to be read:—"Contact Potential Differences Determined by means of Null Solutions." By S. W. J. Smith and H. Moss.

SATURDAY, FEBRUARY 29TH.

Institution of Electrical Engineers: Students' Section.

10 a.m. Visit to the Brimsdown power station of the North Metropolitan Electric Power Co.

TUESDAY, MARCH 3RD.

Civil and Mechanical Engineers' Society.

8 p.m. Meeting at Caxton Hall, Westminster, London. Paper to be read:—"Notes on Some Engineering Works in Austria and Bosnia." By A. S. E. Ackermann.

Tantalum Lamps for Alternating Current.—Messrs. Drake & Gorham inform us that a tantalum lamp, suitable for alternating current, will be placed upon the market in a few days. Up to the time of going to press we are unable to obtain particulars as to candle-power, &c., either from Messrs. Drake & Gorham or Siemens Bros.' Dynamo Works, but we understand that a pamphlet on the subject will be available by the end of the week.

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THE JANDUS ENCLOSED FLAME ARC-LAMP

In the ordinary enclosed arc lamp, as is well known, access of oxygen to the arc is prevented by enclosing the electrodes in an air-tight chamber. The burning of the carbons is thus considerably retarded, and providing the carbons are of a high grade and contain no impurities, this arrangement is very satisfactory. When the flame-arc was first introduced, attempts were made to enclose the arc for the same purpose, but these were not successful, as most of the light given out by the ordinary flame-arc is due to the actual combustion in the arc of the chemicals with which the carbons are impregnated. Consequently when the oxygen present in the enclosure was exhausted, the arc lost most of its brilliancy; and, furthermore, the products of the combustion and the other residues from the chemically-impregnated carbons were desposited on the globe, thus causing most of the remaining light to be absorbed. The Jandus "Regenerative" flame lamp has been especially designed to overcome these objections, and in two points is entirely new. In the first place special means are provided for obtaining a circulation of the gases past the arc, and secondly the light is mainly produced by raising certain gases to the temperature of incandescence, and not by the combustion of chemicals in the arc. The spectrum of the light from the arc is a band and line spectrum, showing that the gases are incandescing.

Fig. 1 shows the mechanism of the lamp, which is the same as is used in the ordinary Jandus single enclosed arc lamp. The lower carbon, which is the positive, is held in a fixed support. Surrounding the arc is a clear glass cylinder, and outside this again is a translucent globe. This arrangement of the carbons gives a wider distribution of light than the usual arrangement, in flame arc lamps, of converging carbons, which was necessary in order to keep the striking contacts of the electrodes free from slag. The inner glass cylinder is in communication with two metal tubes, one on either side of the globe. These tubes, shown in section in Fig. 1, are also conspicuous in Fig. 3. There is a circulation of the hot gases up the central cylinder and down the outer tubes, and the incandescing gases are carried round and subjected to the high temperature of the arc several times before finally condensing and settling in the outer tubes. (This arrangement is protected by British Patent No. 23,286, 1906.) It was for this reason that the name of "regenerative flame arc lamp" was given to the lamp.

The inner glass cylinder is kept perfectly clear of deposit for the greater part of its length, chiefly as a result of the high temperature which prevents the gases condensing, and also probably on account of the direct and strong draught past the arc. In the outer tubes the gases are condensed, partly because of the lower temperature, and also possibly as a result of the formation of eddies in the tubes. These outer tubes and the support for the outer globes are cast in iron or aluminium in one piece, as is seen from Fig. 1. The upper negative carbon is an ordinary high-grade carbon. The lower carbon is also of high-grade carbon, but is

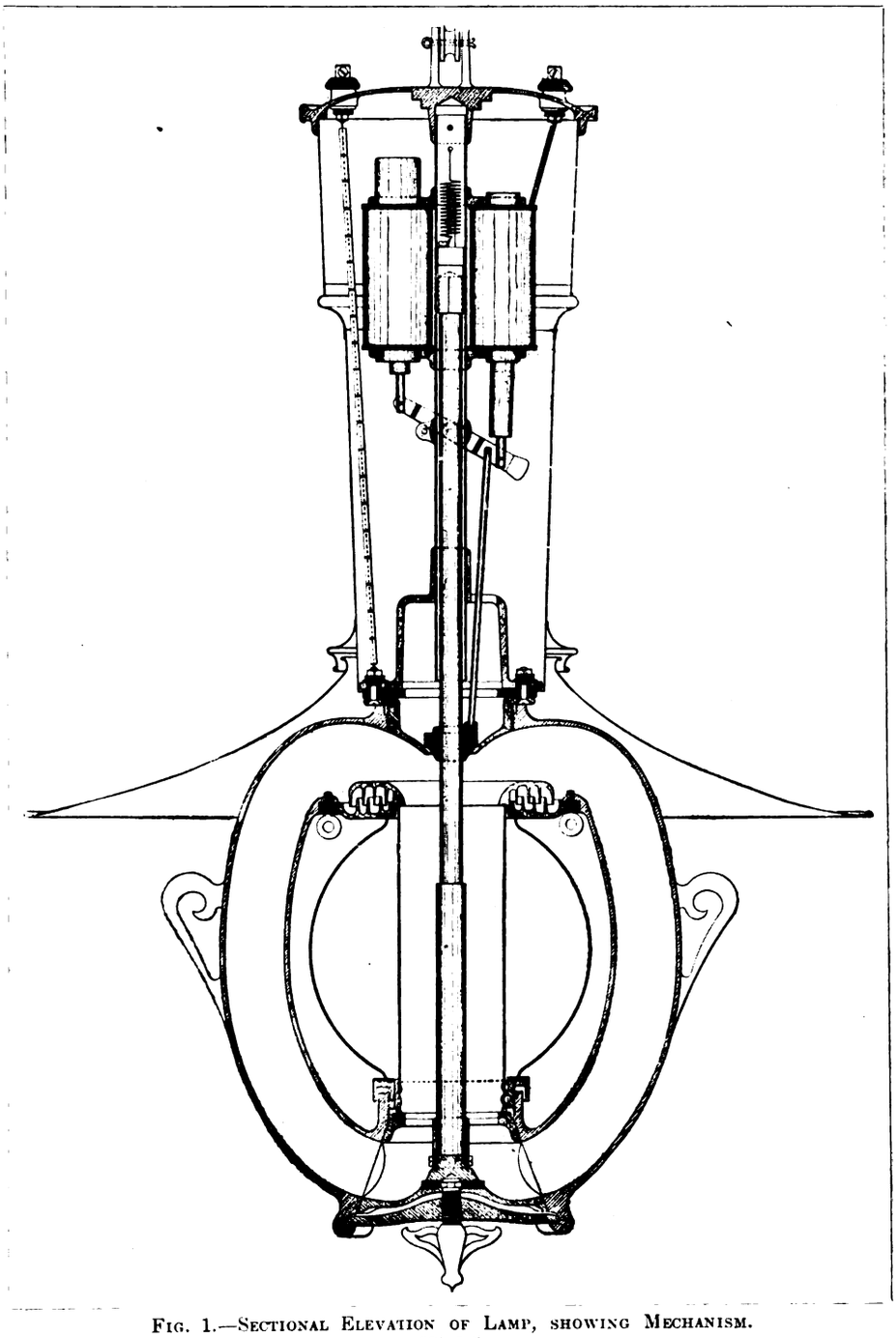


Fig. 1.—Sectional Elevation of Lamp, showing Mechanism.
One-fifth full size.

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star-shaped in section. The grooves between the eight rays of the star are filled with a chemical composition, which is laid in in the form of a paste. The rods are then baked, and the paste expands into the pores of the carbon and fixes itself firmly into the grooves. The carbons themselves are not impregnated, although this was tried at first. When impregnated carbons were used instead of the arrangement described above, the slag produced by the chemicals covered the carbon-tips and prevented the arc from forming. By the use of the star-shaped carbon the central tip of the carbon is always clean. About 15 grains of the composition are volatilised every hour, the gases rising up from the positive crater through the arc. The arrangement of the carbons and enclosing globes gives a most favourable distribution of light, as can be seen from the curve of Fig. 4. The life of a single pair of carbons is over 70 hours. The light is a yellow-white colour, but modifications can be obtained by varying the nature of the composition on the positive carbon. No shadows are thrown by the outer metal tubes on account of the diffusing properties of the outer globe, and the appearance of the lamp is improved by covering the tubes with vitrified enamel. Fig. 2 shows the illumination given by a lamp hung 30 feet from the ground, at various distances from the lamp-post. The trimming and cleaning of the lamp is a very simple process, as the outer globe is not removed. By loosening the wing-screw at the bottom of the lamp the conical plug can be removed, and with it the inner cylinder and the lower carbon. We are informed that the 550-watt size taking 5·5 amperes at 100 volts, gives a mean hemispherical candle-power of 2,200. The regenerative flame arc lamp is the invention of Mr. A. Denman Jones, the manager of the Jandus Arc Lamp Co.'s works. The lamps are manufactured entirely at the Jandus works in Holloway, and are put upon the market by Messrs. Drake and Gorham, Ltd.

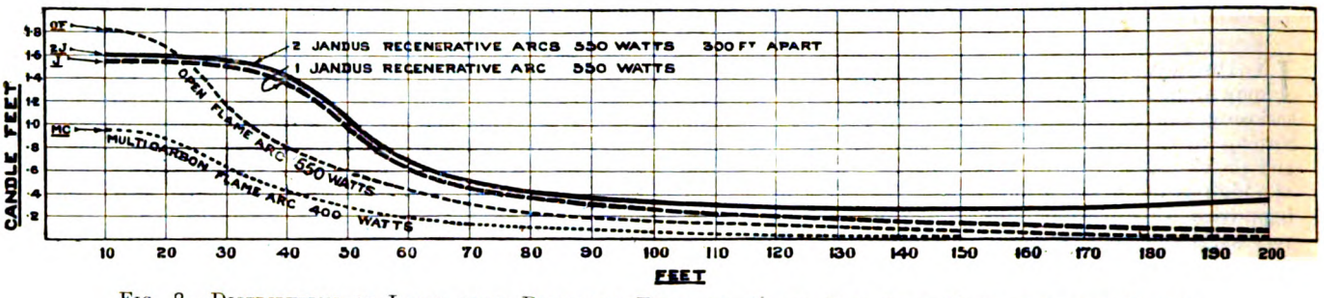


FIG. 2.—DISTRIBUTION OF LIGHT FROM DIFFERENT TYPES OF FLAME ARCS HUNG 30 FT. FROM THE GROUND.

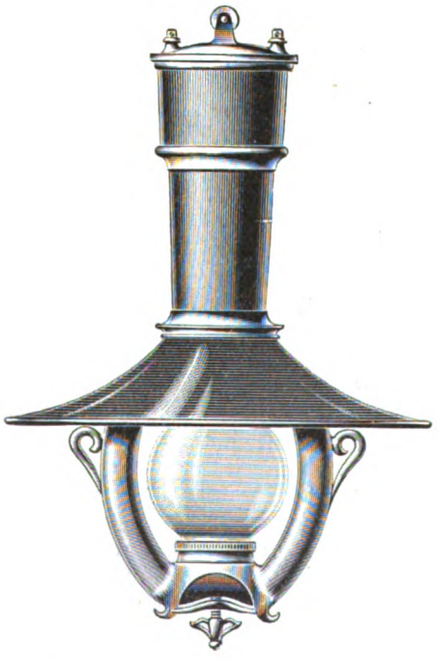


FIG. 3.—VIEW OF THE EXTERIOR OF THE LAMP.

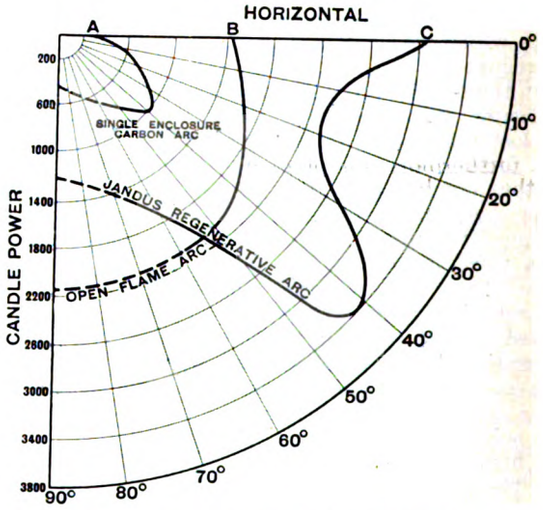


FIG. 4.—COMPARISON OF CURVES OF DISTRIBUTION OF LIGHT.

Students' Dinner.—The fourth annual dinner of the Students' Section of the Institution of Electrical Engineers was held at the Holborn Restaurant on Monday last. Among the guests were Prof. S. P. Thompson, Mr. W. M. Mordey, Mr. R. Hammond, and Mr. A. O. Laird (Chairman, Graduates' Section of the I.Mech.E.). The toast of "The President and the Institution" was proposed by Mr. C. C. Abell (Vice-Chairman of the Students' Section), and responded to by Mr. W. M. Mordey, who said that he was sorry to hear that the students' meetings were not well attended. Commercial papers especially were shunned, and this was a great pity. He emphasised the importance of these meetings, especially with regard to the opportunity they afforded for friendly intercourse amongst the students. In his opinion it would be a good thing if estimating classes were arranged for in the colleges. Estimating and drawing were, he thought, subjects to which engineering students should give particular attention. Mr. Hammond, in proposing the toast of the Students' Section, advised the students to cultivate the habit of curiosity. Curiosity, he said, was a mark of civilisation, and by curiosity all knowledge was built up. Mr. E. W. Moss (Chairman of Students' Section) responded, and in the course of his remarks said that a visit to Newcastle was being arranged for next July. The toast of "The Colleges," proposed by Mr. B. A. Cooper, was responded to by Prof. S. P. Thompson, who also urged the students to attend the meetings, and hoped that there would in future be more harmony between the different institutions. Good, honest, frank rivalry was an excellent and admirable thing, but at the same time the students should learn to work together with a harmony of purpose and a unity of desire. With regard to Mr. Mordey's remarks, he (Prof. Thompson) thought that the commercial side of engineering was better learned in commerce than at college, but he had already introduced the question of cost into his classes on dynamo design, and had found that the students took a keener interest in the work at once. It gave a reality to the work, which was most valuable.

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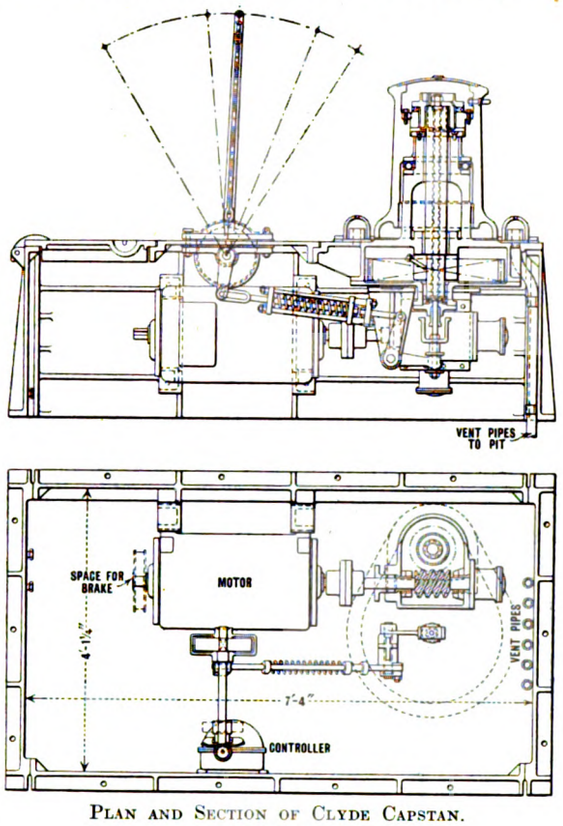
THE CLYDE PATENT ELECTRIC CAPSTAN

THE accompanying illustrations show a type of electric capstan, differing markedly from the forms more usually adopted hitherto in essential points of design. It has been developed under the patents of Mr. Walter Dixon and Mr. G. Baxter, and a number of examples of it have been manufactured by Messrs. Stothert & Pitt, of Bath, and supplied to the Rothesay Dock of the Clyde Navigation Trustees.

The principal features of the capstan, as will be seen from the drawing, are that the head is not fixed to the spindle, but is connected thereto by a clutch sliding upon the upper end of the spindle inside the capstan-head, and that a wire rope is used, permanently fixed to the capstan-head, instead of the usual loose hemp rope passing through the man's hand and given a few turns round the head. All the gear is machine-cut, and runs in oil, ball bearings being fitted to the capstan-head and also to the worm-shaft to take end thrust. When the gear is at rest, the head is loose upon the spindle, and a wire rope fixed to the head can therefore be used, a positive pull being obtained as soon as the head revolves, thereby avoiding all losses due to current consumption when the head is running light at starting. Moreover, as the rope is fixed, there is no slipping and grinding action upon the head as where loose hemp ropes are used, and the head may be made of cast-iron without fear of wear.

The starting-switch and clutch are controlled by a long lever, which, in the backward position, releases the head by throwing out the clutch, and in the other direction puts in the clutch and operates the starting-switch. The man is thus free to work his starting-switch in an upright position and see all that is going on, instead of having one foot and two hands occupied. In places where a number of wagons have to be drawn up and used one at a time as in a coal hoist, this is a very good arrangement; there is a great saving in ropes, and no wear on the capstan head.

The makers have conducted a number of comparative tests, from the results of which they claim that under varying loads an overall average efficiency can be obtained ranging from 42 to 78 per cent., according to circumstances, as compared to a corresponding figure of 10 to 32 per cent. for hydraulic capstan of modern design. Also, from a large number of observations taken, it has been found that the standard capstan with loose rope makes about three times the number of revolutions of the Clyde capstans to perform the same work, owing to the large number of useless revolutions of the former when the rope is not on the head, or is slipping. Comparative current consumption curves have been made which show a reduction of 25 per cent. in favour of the Clyde capstan as against a standard electric capstan with fixed head, and a reduction of 50 per cent. in the peak of the load demand upon the generating station.



PLAN AND SECTION OF CLYDE CAPSTAN.
Scale: 1/32nd full size.

ELECTRIC POWER IN RAILWAY GOODS WAREHOUSES AND DOCKS

TWO Papers were read in abstract and discussed at the meeting of the Institution of Electrical Engineers in London on Thursday last. The first, by Mr. H. Henderson, had already been read and discussed before the Newcastle local section. It described the equipment of the North Eastern Railway Co.'s new goods warehouse at New Bridge Street, Newcastle, which includes interesting forms of overhead jib, and other cranes, capstans and wagon hoists. The Paper and discussion in Newcastle were reported at length in our issue of January 16th.

The second Paper was by Mr. C. E. Taylor, on "Electric Power in Docks," and it had also been received from Newcastle, where it was discussed on Monday, a few days after the London discussion.

Mr. Taylor first referred to the great extension in the use of electrical power in docks during recent years. Electricity offers many advantages over the hydraulic system (which has up to recent times held this field almost exclusively), especially in places where electric power can be obtained at a reasonable rate from an outside source, and the user has not to incur the heavy capital expenditure involved in the provision of a generating station for the exclusive supply to the dock premises above. His opinion is that, where a reliable supply can be obtained from an outside source, as in the Tyne district, it is much more advantageous to take supply from that source than to generate for such loads as are obtained in docks where the total consumption is small and the maximum demand large. The installation cost for distribution is small compared with that for a hydraulic supply, and not so liable to failure, whilst the consumption is proportional to the work done. The efficiency of electric machinery is necessarily much higher than that of hydraulic plant for the same purpose, especially that of the older type, and the distribution is more flexible and lends itself more readily to alterations and additions.

At the North-Eastern Railway Co.'s dock—Tyne Dock—the steam pumping plant, being old, is being replaced by electrically driven pumps, with the intention of gradually replacing the hydraulic cranes, &c., as necessity arises, by electric plant also

COAL CONVEYORS.

The difficulty of loading bunker coals into vessels when light from the older jetties or staiths has led to the adoption of special apparatus capable of running the coals on the level or on an inclined plane. One form of this apparatus is shown in Fig. 1. Coal conveyors have recently been brought into use at the North-Eastern Railway Co.'s dock at Tyne Dock. The arrangement consists essentially in making the spout into an endless belt conveyor, coals being shipped at low level, and run over the belt in the ordinary way. When shipped into vessels, level with the spout, or above it, the latter is adjusted as may be required, and the belt run by an electric motor, the coals

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being carried along until they reach the hatch, when they drop over into the hold. The belt spout can be adjusted to any angle, but the useful maximum is about 25°, and at this angle some 500 tons can be shipped by each conveyor per hour. Some experiments have recently been made on these conveyors, and it was found that the average power working at full load on a slight inclination was 12 h.p., and the consumption during the test was 7 units, with a total quantity of coal shipped, equal to 410 tons, giving an average per ton of 0·017 unit. Whilst the test was in operation some further experiments to show the power absorbed with various inclinations of the belt were made, with the curious result of a constant absorption of power for any inclination was obtained. Practically the power remained constant at 12 h.p., and it was found that the belt automatically regulated the quantity of coal carried according to the inclination. This was a result that had never been anticipated.

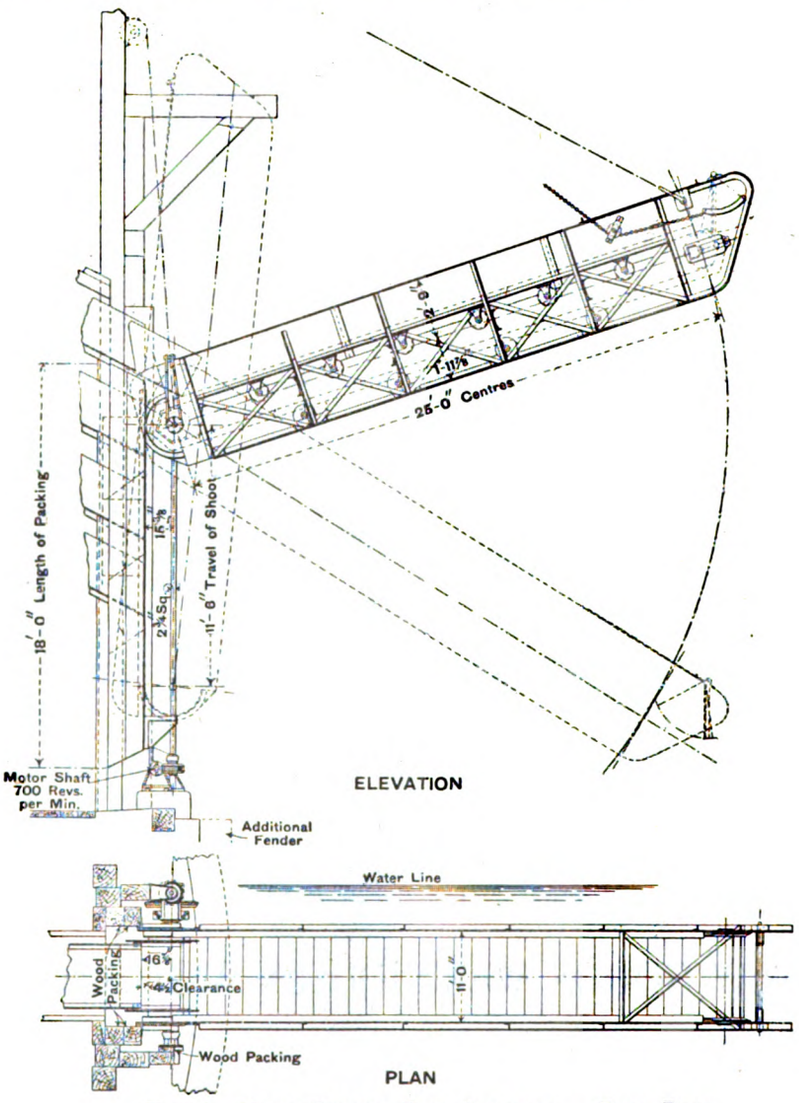


FIG. 1.—MOTOR-DRIVEN COAL CONVEYOR. TYNE DOCK.

A three-phase motor, capable of developing 16 b.h.p. at a speed of about 800 revs. per minute, drives the spout by a suitable reduction gear at a velocity of 120 ft. per minute. A margin between the average absorbed, and the total power of which it is capable, is allowed for cases where the belt is required to start with a considerable amount of coal upon it, or to take the load if coal is dumped upon it very freely, as often happens.

The arrangement is extremely efficient for the purpose for which it is intended; no other motive power could have been used in this case, and the adoption of the system has obviated the necessity for reconstruction of the staiths for a very considerable time. In this way there has been a great saving on capital expenditure.

ANTI-COAL BREAKER.

The more modern staiths for shipping coal at North Blyth have shown another defect which the use of electric power has done much to remedy. The staiths are very high, and coal has a long way to drop into the holds at low tide, with the result that much coal is broken, and its value is diminished thereby. The anti-coal-breaker arrangement consists essentially of a system of buckets balanced to run over the suspended shaft, the whole being suspended from the jib of an electric crane fixed on the upper part of the staith. Coal from the ordinary spout is run into the buckets on one side of the chain, and these are carried by gravity into the hold of the vessel, where they are emptied and the buckets begin the return movement. The whole arrangement is clearly shown by Fig. 2. The jib crane is capable of carrying 8½ tons, and the lifting and slewing motors are 20 and 8 b.h.p. respectively. The lifting speed is 25 ft. per minute. As will be seen from Fig. 3, the speed of the bucket chain is capable of being regulated by an automatic centrifugal brake to a velocity of 120 ft. per minute.

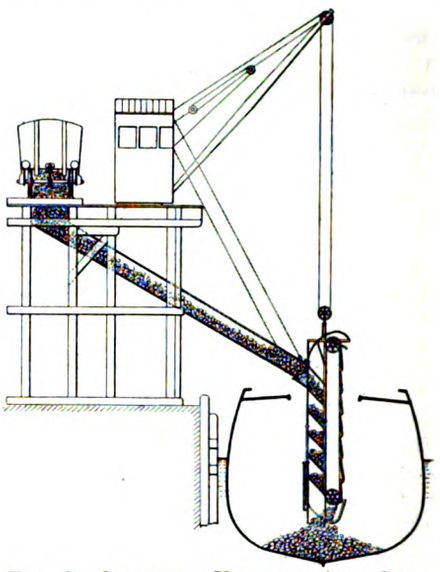


FIG. 2.—SECTIONAL VIEW OF ANTI-COAL BREAKER, SHOWING METHOD OF OPERATION.

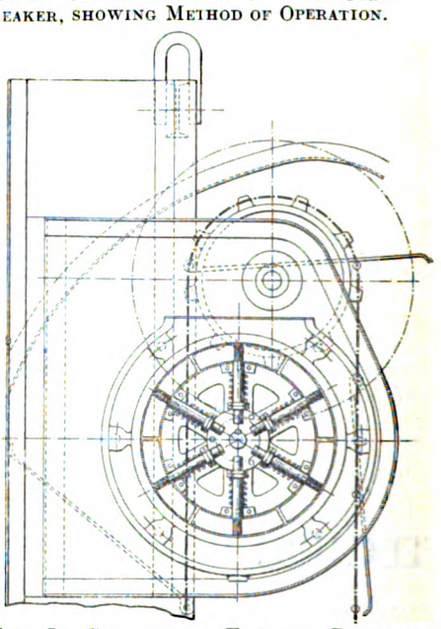


FIG. 3.—CENTRIFUGAL FRICTION BRAKE FOR AUTOMATICALLY CONTROLLING SPEED OF ANTI-COAL BREAKER.

COAL HOISTS AND COALING CRANES.

In cases where the ground-level is low, coal hoists are used to a great extent and also coaling jib cranes. With regard to coal hoists this is a field in which hydraulic machinery has hitherto been universally adopted. The wagons are raised by a hoist and tipped by means of another ram attached to the platform, the wagons being fitted with end doors; the wagon is then lowered again and the platform lowered to a high-level empty wagon road, where the wagon is run off and the platform lowered to the ground-level for another full wagon. Electrically driven coal hoists, which perform exactly the same

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operations, have recently been erected at Rothesay Dock, Clydebank, by the Clyde Navigation Trustees.*

In some cases coaling cranes are displacing hoists, or are being provided as additions. A typical example is the 25-ton crane installed on Humber Dock Quay, Hull. The lifting is done by two 50-b.h.p. motors, both coupled to the same shaft, and controlled by a series parallel controller—the tipping motor is 50 b.h.p., and the slewing motor 20 h.p. Fig. 4 shows the arrangement of the ropes for lifting and tipping the wagons, the slack of the tipping rope is taken up by another barrel, which is geared to the lifting barrel, the rope being taken over a pulley which is fixed to two square thread screws. These screws are driven by the tipping motor and draw the pulley backwards

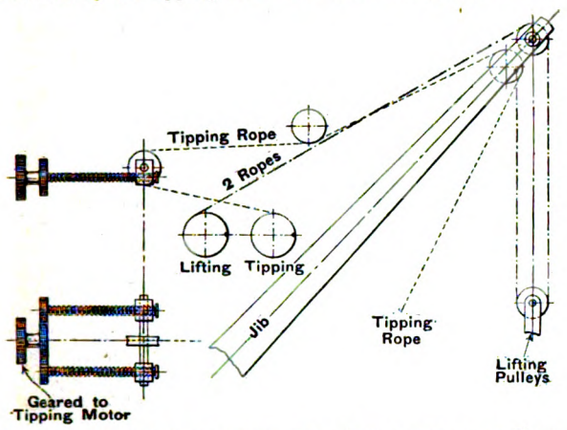


FIG. 4.—DIAGRAM SHOWING THE ARRANGEMENT OF LIFTING AND TIPPING ROPES FOR 85-TON ELECTRIC COALING CRANE.

and forwards, thus effecting the tipping motion. The radius of this crane is 31 ft., the height of jib from road-level is 50 ft., and the approximate amount of coal which can be shipped by this crane is 230 tons per hour.

WHARF CRANES.

For loading and unloading material of a general kind, and iron ore, &c., cranes of a high gantry type are in universal use. These cranes take up a minimum amount of space on the quay, and allow wagons, &c., to pass under them. In cases where a warehouse is built on the quay, a slight alteration is made by having one side of the gantry running on the quay wall, and the other running on a girder let in to the building. This still enables wagons to pass under the cranes as before.

Cranes of the high gantry type are in use at various docks, those at Middlesbrough and Hartlepool, on the North-Eastern Railway Co., being capable of lifting 10 tons and 3 tons at 150 ft. per minute, 1½ tons at 250 ft. per minute, and slewing at 400 ft. per minute. The jib radius is 45 ft., and the height of the jib top from the quay-level is 60 ft. The hoisting gear is driven by a 50-h.p. motor at 300 revs. per minute, and is geared direct to the barrel.

On the motor shaft is fixed a band brake operated by a special electromagnet in series with the armature of the lifting motor. The two poles of the magnet are similar to a small two-pole dynamo with upright poles, and revolving between them is a solid steel armature, connected by a lever to the brake, which is held on normally by weight. When the fields are excited and motor is started this armature turns through 90°, and raises the weight, thus releasing the strap. The brake can also be operated by a lever near the controller, so that lowering can be carried out without the power being applied to release the brake. The slewing gear is driven by an 8-b.h.p. motor at 1,000 revs. per minute, coupled to which is a worm driving a worm-wheel. This gears with a spur-wheel on a vertical shaft, carrying the driving pinion, which engages with a circular rack fixed on the top of the gantry.

The motor is controlled by a foot brake on the motor spindle. The cranes revolve on twenty-four cast steel rollers. A universal controller is used for both motors. The collector gear is fixed to a pillar in the centre, and cables pass up the centre column, and are attached to two rings mounted on ambroin, upon which are brushes fixed on porcelain insulators attached to the cabin floor, and from which wires pass to the controller.

The cranes are moved along the quay wall by a 4-b.h.p. motor at 30 ft. per minute, the gearing being arranged for hand working if necessary, each side being driven by means of a cross-shaft and bevel wheels. Current is taken from underground mains on the quay, which are connected at intervals of 50 ft. to plug boxes. The crane plug is bell-shaped, to prevent water entering the boxes whilst the cranes are in use, and can only be attached in one way, so that the correct motion is obtained.

The 10-ton cranes are of the same design as the 3-ton cranes. The lifting motor is 60 b.h.p., and the revolving motor is 12 b.h.p. The lifting motor in single gear drives directly through a pinion on to the barrel, the ratio being 8 to 1, and a double part of rope is used. With single gear loads up to two tons are lifted, and double gear is provided for loads over two and up to ten tons.

When lowering, the motor is driven by the weight, but a new device is now in vogue on similar cranes, patented by Messrs. Stothert & Pitt. The lifting barrel is not keyed directly to the shaft, but runs loose on it, and is connected or disconnected by a friction clutch. The barrel shaft carries the main spur-wheel rigidly keyed on to it, and this spur-wheel gears directly by single reduction with the pinion attached to the armature spindle of the lifting motor. The hand lever actuating the lifting controller, also actuates an electric solenoid which controls the lifting friction coil clutch, the arrangement being such that on moving the lifting handle forward from the off position, current is switched on to the solenoid, the clutch is put into gear, and the lifting motor started simultaneously; after the clutch is in gear, a further movement of the lever cuts out resistance and speeds up the motor. Provision is also made of a mechanical connection between the lifting controller handle and the coil friction clutch as an alternative to the electric solenoid. A large friction brake drum is keyed directly on to the lifting barrel, the brake strap being lined with willow blocks. The lifting controller does not reverse the motor, as the lowering is carried out independently by the loose drum.

The great advantage of this arrangement is the large increase in speed of working, both in lifting and lowering, and also the reduced liability of accident to the motors, owing to the impossibility of suddenly stopping the armature. In cranes with the barrels always in gear with a reversible motor, care has to be taken to check the lifting motor when the hook is a sufficient distance from the jib head, so that the momentum of the revolving armature may be absorbed before the hook is overwound on the jib pulley, with the possible result that the jib itself is lifted and the tie rods bent. With the system described above, lifting can be continued at full speed, and the load brought to rest instantly by pulling over the handle, the only revolving parts which have to be brought to rest being the barrel and brake drum, which have comparatively small inertia and do not revolve at an excessive speed. The great gain in

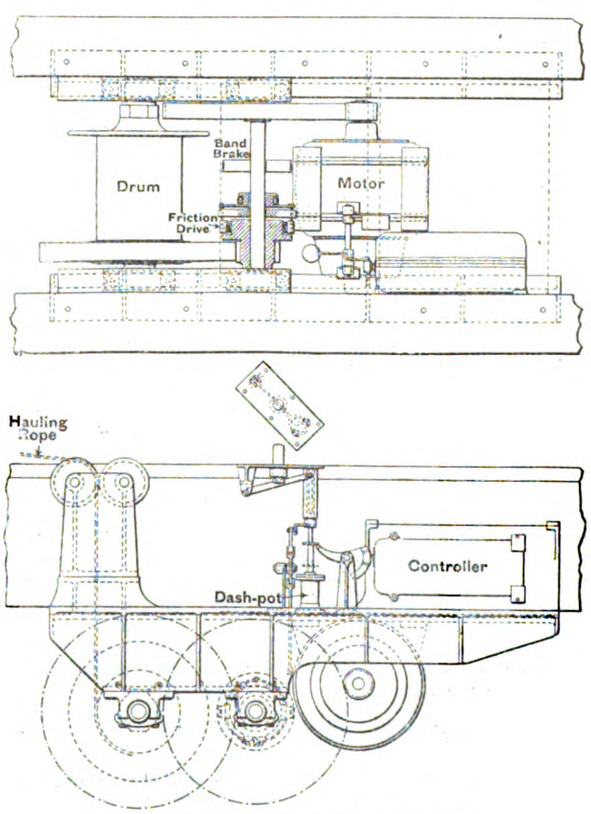


FIG. 5.—UNDER-DECK TYPE CAPSTAN.

* See *Electrical Engineering*, vol. ii., p. 747.

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speed is in lowering, which can be performed at a vastly greater speed than is possible by a reversible motor, there being a perfectly free run out under the control of the foot brake, and what is of equal importance, lowering can be commenced instantly without perceptible pause from lifting at full speed; the lifting armature can continue to revolve with slackening speed during the period of lowering, and then comes to rest quietly without shock. As a matter of practice it is found that a load can be lowered 60 ft. before the armature has ceased to revolve.

CAPSTANS.

Under this head, the author first referred to the special capstan at Rothesay Dock, a detailed description and drawing of which appears on another page. Electric capstans, he added, can be fitted in many cases where other forms could not be used. On the North-Eastern Railway Co.'s staiths at Dunston an under-deck type of capstan, fixed entirely under the floor of the staiths is being experimented with. In this case the capstan is not furnished with the usual head, but the rope is carried round a horizontal drum. This type of capstan is shown by Fig. 5. The motor is a 30-b.h.p. three-phase motor, running at 770 revs. on a circuit of 440 volts 40 ~, and drives by means of a pinion a first shaft which has fixed upon it a friction drive for operating the barrel shaft. The barrel has on it a fixed rope which passes over the horizontal drums placed level with the floor of the staiths, so that the rope may work in

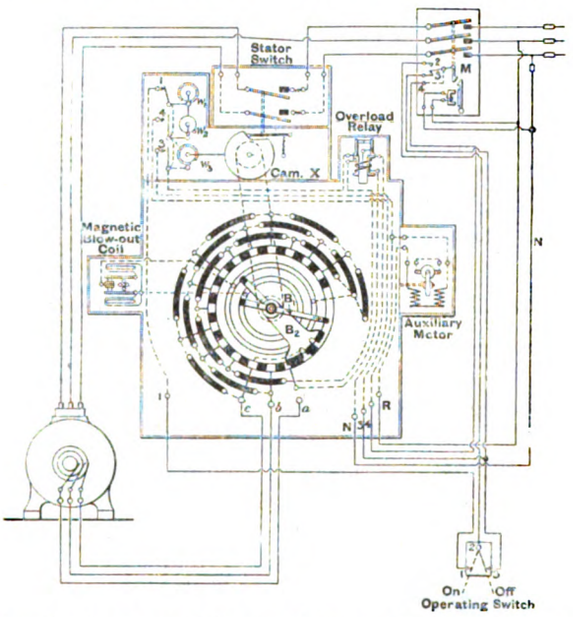


FIG. 6.—AUTOMATIC 3-PHASE STARTING SWITCH. DIAGRAM OF CONNECTIONS.

either direction as required for hauling purposes. The method of working is such that, when the treadle is depressed, the stator is made alive, and the motor brought up to speed by cutting resistance out of rotor circuit; at the same time the band brake is released, the friction clutch engages with its drum, and the rope is wound round the barrel. When the treadle is released the clutch allows the rope barrel to stop immediately, and the momentum of the motor is pulled up gradually by the band brake. This is a very essential point, as the wagons are drawn down a slight decline over the cross-over roads to the spouts, and each wagon must be stopped immediately over them; otherwise, if they run past, the whole train of wagons must be hauled back up the gradient. The motor is only operated in one direction, the drum running freely when slack rope is needed, which is drawn off by hand as required according to the number of wagons to be hauled.

ELECTRIC-DRIVEN HYDRAULIC PUMPING PLANT.

Any new dock which may be built would probably be fitted with electrical power throughout, as at Rothesay Dock,* Fishguard,† &c., but it cannot be expected that the hydraulic plant in use at an old dock should be pulled out and replaced by electrically-driven machinery until worn out. An improvement can, however, be made by installing electrically-driven hydraulic pumps supplied by power from a power company, and working these automatically.

* See *Electrical Engineering*, vol. i. p. 747, and vol. ii. p. 730.
† See *Electrical Engineering*, vol. i. pp. 385 and 433.

A change of this kind is at present being made at Tyne Dock, where three engines and five boilers are being replaced by four electrically-driven pumps with three-phase motors of 132 b.h.p. each. These drive three-throw crank pumps through a flexible coupling. Each motor is provided with a three-phase automatic starting switch driven by a small motor $\frac{1}{12}$ h.p., which is connected between two of the phases and brought into action by a switch attached to the accumulator.

Fig. 6 shows a full diagram of connections for this starting switch, the method of working being as follows:—Each automatic switch is connected to the mains through a three-pole switch M, which has a no-voltage release, and is fixed on a separate switchboard. From this switch one main passes direct to the motor, whilst the other two pass through a magnetic blow-out switch fixed to the auto-starter, and operated by cam X. The circuit for working the auxiliary motor is coupled to two phases on the live side of switch M.

Current passes along wire N, through overload relay, to cams marked W_1, W_2, W_3, which make and break contact with points 1, 4, and 3, as required. In starting, current passes down No. 1 to the operating switch on the accumulator, and as the accumulator is down passes to No. 2 on the switch, across to No. 4 on switch M, from this point to No. 4 on the starting switch, through the auxiliary motor, and on to the other phase. The auxiliary motor now runs and drives the rotor switch, cam X, and cams W_1, W_2, W_3.

This closes stator switch and No. 4 wire by cam W_2, No. 1 is then opened by cam W_1, the auxiliary motor continues to run through No. 4 wire contact until all resistance is cut out of rotor circuit, when cam W_2 opens contact No. 4 and puts in contact No. 3. This operation stops the auxiliary motor until the pump raises the accumulator sufficiently high to change over the operating switch to the off position, thus putting the auxiliary motor again into circuit, and revolving the rotor switch to the off position, and opens the stator switch by cam X. On switch M is a contact No. 3, which is used, in case of failure of supply, to prevent damage when supply is resumed. When supply fails, switch M opens, putting contacts 3 and 4 in connection with each other; thus, when the power is again put on, current can pass to the auxiliary motor by way of cam W_3, through 3 and 4 on switch M to auxiliary motor, revolving automatic switch to the off position immediately, and preventing switch M being closed with all resistance out.

Between arms B_1 and B_2 is coupled an automatic magnetic blow-out coil, which is opened and closed in conjunction with the automatic switch to prevent sparking on the rotor switch.

DISCUSSION.

The President (Col. R. E. B. Crompton) invited Mr. W. M. Mordey to open the discussion, but, as he did not respond,

Mr. ROGER T. SMITH (Great Western Railway) was called upon. He said that both Papers were interesting, not only to electrical engineers, but to railway men generally, as showing the amount of electrical working of railway apparatus that was being carried out by one very progressive railway. He would first like to draw attention to the lifting speeds of the various cranes referred to in Mr. Henderson's Paper. The under-hung jib crane at the New Bridge Street warehouse hoisted at 150 ft. per minute, and the height of the hook above the rail was about 20 ft., so that it could not lift a load for more than about 12 ft. This meant that at the above speed one ton was lifted in rather less than five seconds; as the average load would be a quarter of a ton, it appeared to him to be very much too fast, and that the motor would always be running on its resistance and would never get on to its own proper curve. He thought the speed should not exceed 50 ft. per minute instead of 150 ft., and in that case the motor would be reduced from 15 h.p. to 6 h.p. The travelling hoists at the same warehouse, working at the rate of 150 ft. per minute, lifted one ton in about 28 seconds. This appeared to him too slow, and it would be a great advantage if the speed had been 200 or 250 ft. per minute. The jiggers at New Bridge Street lifted 70 ft. at the rate of 100 ft. per minute; this meant that three-quarters of a ton was lifted in about 40 or 42 seconds. This speed might very well have been 200 ft. per minute, and he would like to ask the author whether, in the event of this apparatus being redesigned, these speeds would not be altered. The travelling and traversing speeds appeared to him to be very good. The under-hung jib travelling type of crane, described in the Paper, and the travelling hoists were a most excellent arrangement, and on reading the Paper he went to Newcastle to see these cranes, and they were going to be adopted on the Great Western Railway in consequence. Another very excellent arrangement was the interlocking of the jigger lifts at this warehouse, and he quite agreed with the author that this was entirely satisfactory. Referring next to the design of the electric capstans, he stated that these pulled one ton at 250 ft. per minute, and, allowing about 85 per cent. efficiency of the gear, the brake horse-power would be about 20. In the Paper the actual rated brake horse-

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power of the motors was stated to be about 26, and he would like to ask the author if the reason for having such a much larger rated capacity than seemed necessary was not due to the fact that the motor was not a compound motor. The author had given some very interesting particulars as to his ideal of a capstan, and with most of these he agreed. But he would go a little further, and should say in the first place that, as sweating within the capstan case was absolutely inevitable, they should do away with all fine wire coils and have only a series motor. Secondly, he quite agreed that the treadle should only close the main switch by a spring or counterweight, and the apparatus shown by the author seemed to be admirable in every respect. There must be some sort of resistance in series with the motor, however, and this, in his opinion, should be cut out independently, either mechanically or electrically, preferably electrically. Then a brake was necessary to prevent the series motor running away when it was running light, and that might be put on either electrically or mechanically; preferably mechanically, possibly such an apparatus as the centrifugal form of brake described by Mr. Taylor. Further, the capstan head should be driven direct by worm gearing, the worm being cut at such a low angle, less than 10°, that the capstan head can at once pull itself up. If possible, the overload circuit breakers should be outside the box altogether, so that they could be reset easily by hand independently of the box. If, as in many cases in railway work, the cables were overhead, the circuit breakers could easily be placed upon the posts. Again, he would have an electric heater inside every capstan box, with proper ventilation holes, and lag the whole of the inside so as to prevent sweating as far as possible. Mr. Henderson had described in a very few words a most interesting runway in the Forth Bridge warehouse which serpentined in and out. He had been up to see this piece of apparatus, and was convinced that travelling cranes of the sort described, and this sort of runway for dealing with goods in goods stations, were going to oust jib cranes altogether. He could not, however, congratulate the author upon the electrical arrangements of that runway. The whole of the lattice-work was alive, and the arrangement was very similar to that in which in carrying a tramway across the bridge, the whole of the bridge was electrified and the electricity collected from the top booms. He did not think that this was necessary or advisable. The very magnificent wagon hoist described was most ingenious, and was a very fine piece of apparatus, but would it not have been far simpler and cheaper to have had a conveyor from the top level to the bottom, and put the goods on the conveyor and run them into the warehouse instead of going to the expense of lifting and emptying the whole of the wagon weight? Turning to Mr. Taylor's Paper, he thought the example of the coal conveyor at the Tyne Dock was a striking tribute to the economy of conveying as opposed to jib cranes. In the words of the Paper, 500 tons per hour required the continuous use of a 16 b.h.p. motor running at an average output of 12 b.h.p.; *i.e.*, 500 ton per hour for 16 b.h.p. installed. In Mr. Taylor's description of the hoisting, lifting, and tipping cranes, 230 tons per hour could be lifted and tipped, requiring the intermittent use of 120 b.h.p. in two motors, about ten times as much for about half the amount of coal delivered. He had worked out the brake horse-power required in two of the most modern tips in the Alexandra Dock in South Wales using hydraulic power, and they required 50 pump horse-power in the tipping-rooms and 100 i.h.p. in the pumping station. The Paper pointed out a very great economy in capital cost in structures and working costs, and he was quite sure that, before long, conveyors for shipping coal into vessels would be used to a very large extent. The enormous maximum power required for cranes was a very important point, if they had a generating station of their own at a dock, for the load factor of cranes was so extremely bad. At the Fishguard Harbour during the past year the annual load factor for both lighting and power, calculated from the amount of work done compared to the working of the plant installed at full load, but exclusive of spares, came out at 9 per cent., and the annual load factor for eleven cranes was 5·3 per cent. A conveyor would probably have an annual load factor of 30 per cent. Mr. Smith then asked of what material the belting used in the conveyor was made? It looked from the illustration as if it were a series of plates, but the speed, namely, 100 ft. per minute seemed rather fast for plates. In the anti-coal breaking arrangement was there any trouble with the centrifugal brake which controlled the speed? Finally, he referred to the three-phase pumps just touched upon by the author. He had happened to be in the makers' works when they were being tested before delivery, and he had noticed that they were centrifugal pumps with a single impeller, but with a special arrangement by which eddy currents in the water were prevented. The instantaneous efficiency of these pumps came out at 80 per cent.: he did not mean to say that they would give this efficiency working steadily, but he believed that this was the highest efficiency ever obtained for a single impeller pump not being a turbine pump.

Mr. C. W. Neele (Great Central Railway Co.), referring to Mr. Taylor's Paper, asked if there were any switches or circuit breakers in connection with the jib cranes to prevent over-winding. The Great Central Railway Co. had installed several electric cranes, but they found a very great difficulty in the small amount of head room available. For instance, if Fig. 4 was to scale, the clearance between the jib and the rail level was about 12 ft. or 13 ft., the ordinary height of a wagon was 7 ft. from rail level to the tip of the wagon side, and allowing 2 ft. for the weight and the hook, this only left 3 ft. or 4 ft. independent of any chain slings. He had installed cranes at the Liverpool warehouses, having a clearance of 18 ft., and had provided safety switches, but these had to be done away with because they could not get the load over the side of the wagon. In consequence, they were continually getting broken ropes, and the crane boys in endeavouring to get the load on to the wagons used the jib of the crane as a lever and tried to drag the load over the top of the wagon. In consequence, teeth were broken in the slewing gear, and the shaft of the slewing pinion was sheared right off. The goods department of the Great Central Railway was working with speeds of over 100 ft. on short lifts, and, with a view to minimising any danger from overwinding, he had been specifying, in connection with some of the cranes they were about to instal, taper winding barrels, so that the load could be lifted at the maximum speed at the commencement, and gradually decreased to its minimum at the top. What was very badly wanted was a more sensitive controller. Liquid controllers met the difficulty to some extent, but they were not altogether satisfactory, and he considered there was room for a really sensitive controller which would be more akin to the control of hydraulic lifts.

Mr. C. F. H. Bayley (South Eastern and Chatham Railway Co.) referred to the awkward design usually associated with capstans; there was so very little room in them for repairs, and the wires, switches, and controllers seemed to be so fragile that with continued damp the insulation broke down. Another criticism was the difficulty of keeping a foot on the pedal with a strong spring acting against it, and at the same time handling a rope. It was necessary to keep a certain weight upon the rope to make the drum bite, and it was very awkward to keep a foot on the pedal at the same time. It was a mistake to work the capstans at too high speeds. His company had a capstan working at 250 ft. per minute, but had found it impossible to draw the rope from the barrel at such a high speed. With such a speed it was found necessary to have one man standing at the pedal whilst another man walked away with the end of the rope.

Mr. Henderson, in reply, said he quite agreed with all the speakers about the speed of cranes; it was undoubtedly a very great mistake to make them too high. Apparently, traffic people on the different railways thought that by having a high speed they probably saved a certain amount of time. But when a complete set of operations connected with a crane was considered, lifting, lowering, slewing, &c., the amount of time occupied in lifting, even at a very slow speed, such as 40 ft. or 50 ft. per minute, was very small compared to the total time taken to handle goods. The apparatus which he had described was designed five or six years ago. His cranes were provided with over-running switches, which were gradually run out with a little worm on the end of the shaft, so that when the load was at the top the switch knocked out. The action of the switch, however, depended upon the amount of the load. If it was a light load it would not knock out in time, and if it was a heavy load it knocked out too soon, due to the momentum of the crane barrel. His own experience was that it was best to get a good man to drive the crane and dispense with such a device. With regard to capstans, here again the speed was very high, but a very large percentage must be allowed for slip in the rope, viz., the head slipping inside the rope which, of course, ran away with a good deal of the power. Electric capstans were notorious for wearing out ropes; this was always a fault of high speed. If it were possible to reduce the speed, far better work would be done. It would certainly be the best plan to mount all switches outside in a sort of box, even if the cables were underground. He did not see why the switchgear should not be put in a small pillar box, which would not cost much extra money; in fact, it would very soon save itself. All the trouble which the North Eastern Railway Co. had had with capstans was due to the gear being inside. They had 200 in use at different places, and the trouble had always been caused by dampness inside. Heaters had been tried in one or two places, but they were too expensive, and had been taken out. They had also tried keeping the shunt circuit of the motors alive, but this again was found to cause trouble occasionally. At West Hartlepool it was responsible for the generators breaking down on several occasions. Weak points in the dynamo armature were broken down when the station single-pole cut-outs went, owing to the inductive rise in these field circuits. He could not agree that hoisting at New Bridge Street would have been better if conveyors had been used. It would have meant a great deal of handling, especially for the type of goods being used, viz., potatoes, which came from Scotland in wagon-loads, and the only satisfactory way was to drop them wholesale into the cellars and unload the wagons afterwards. The only other way would have been to make a slip and run the wagons down with a capstan or hoist at the top. Referring again to the awkward design of capstans, Mr. Henderson said that those at New Bridge Street had a very heavy lid, and it meant a very

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heavy item in handling them. The method in which the resistances were connected upon some of these capstans was another source of trouble. In fact, with the added cost of maintenance, it was sometimes hardly worth while putting in electric capstans, whereas a little careful thought on the part of those who designed and made them would make things so easy that electric capstans could be made a very great boon. Dealing with Mr. Smith's question as to compound motors, he thought these ought to be the best for capstan working; they really would be better than series motors, because they did away with the necessity for any special machinery such as the friction brake described in Mr. Taylor's Paper.

Mr. TAYLOR, in reply, said the belt of the conveyor described in his Paper was composed of plates 4 in. or 5 in. broad, but the conveyors which were now being installed had a belt composed of a mixture of canvas and rubber. With iron plates, of course, it was possible to use the conveyor as an ordinary spout for gravitation, which was impossible with rubber. So far as he was aware, the centrifugal governor on the anticoal breaker had given every satisfaction.

DISCUSSION OF MR. TAYLOR'S PAPER IN NEWCASTLE.*

Mr. C. FARADAY PROCTOR, referring to the cranes in which the lifting barrel is not keyed directly on to the shaft, asked whether the method of allowing a free run out under the control of the foot-brake only was not apt to induce too great speeds of drop, and consequently very heavy strains on the crane when the brake was suddenly applied.

Mr. CLUTWORTHY asked whether the curious fact that the inclined coal conveyors showed a consumption of practically the same horse-power at any inclination was not explainable by the shape of buckets used, or, alternatively, whether it was not a question of the bulk of the power being used in overcoming mechanical friction.

Mr. TAYLOR, interposing in reply, said that the conveyors were not on the bucket system, but were either canvas belts or a series of iron plates. The buckets were only used in the anticoal breaker. Moreover, the horse-power absorbed in running light was only 1·5 to 2 h.p. The explanation was rather that the belts automatically regulated the amount of coal borne by them according to the angle at which they were placed.

Mr. SLEIGH noted that, in the test of the coal conveyors, the height through which the coal was lifted had not been recorded, and the necessary data were therefore not given to determine the efficiency of the gear. He would like to know whether the figure of 0·017 unit per ton was high or low for the work done.

Mr. LAW drew attention to the fact that, whereas the installation under consideration was driven by three-phase motors, continuous-current motors would be considerably more flexible in working, and he would like further particulars of how the motors were controlled in this instance. In a scheme considered for the Dublin Docks, the question of supply from a power company was settled by the fact that the company's mains were only on the other side of the river, and were not brought across. Therefore, a generating station for the particular work was put in, and 500-volt continuous current was used. Having regard to the special conditions existing in this case—alternate current supply being available, and direct current only obtainable through motor generators—he would like to know whether the question of using alternate-current commutating motors had been considered.

Mr. FARADAY PROCTOR drew attention to the fact that in the older days it was considered unsafe to attach a rope direct to the turning head of a capstan, as any accidental starting of the gear might involve very serious results in pulling the load about when it should not be moved. For this reason it had become standard practice to throw two turns of the rope round the bollard and then start the movement by pulling on the loose end.

Mr. BROOKING referred to the question of the plugs used for taking current from the underground mains on the quay for the cranes. When a plug-box is level with the surface of the quay it usually gets full of dirt and water, due to the cover not always being replaced after use of the plug. This leads to short circuits and general unpleasantness. Had Mr. Taylor any special arrangements to avoid this? In his opinion a device, such as a feeder pillar, should be employed, so that water could not get in unless put there by a fire-hose. Five or six years ago there were more cranes of this type stopped by trouble in the plug-boxes than by breakdowns on the motors.

Mr. CARRICK said that supply of power from a steam station at Tyne Dock had been rather discountenanced in the Paper. At the same time, there were such things as failure of electricity supply, and this had occurred. Supposing such a failure took place at night, and dock-gates are not closed, if steam is not available to get them closed some of the ships in the dock would be on their sides in the morning. Another point was that the motors driving pumps at Tyne Dock start at full speed and remain at constant speed. Variable speed would prevent the accumulators coming down so frequently.

Mr. J. ANDERSON asked if any trouble had occurred with the use of friction clutches in capstans and the like. He would also like to know if the auxiliary motor of the hydraulic pumping plant automatic starter was of the same voltage as the main motor. In his opinion a standard controller operated hydraulically would be better from the point of view of simplicity and sureness. An objection might be that of possible freezing of the water in winter, but in plant of this type, under his own observation, no trouble from this cause had been experienced for four years. He would have thought, unless the fluctuations of the load were very great, that automatic control of two pumps would have been sufficient. It was possible to use ordinary squirrel-cage motors and bye-pass the water, the running losses being very small; £150 per motor or more could be saved in starting gear by this method.

Mr. F. O. HUNT wished to know, with reference to the inclined conveyor, what happened if it were worked on a downward incline. Would it be used just as a shute or as a brake on the coal going too quickly?

Mr. TAYLOR, replying to the last speaker, said that the lifting and tipping barrels are geared together, so that they revolve at the same speed. Mr. Proctor feared that lowering too quickly would throw an excessive strain on the crane on pulling up. No ill-effect from this cause had been experienced, and no special precautions had been taken except the ordinary dashpots and the factor of safety of the crane. In reply to Mr. Sleigh, the vertical height through which the coal was lifted on test was about 11 ft. Mr. Law had raised the point regarding the types of motors in use. As a matter of fact, the crane motors were direct current. The motors adopted for driving the pumping plant were three-phase, because a definite speed must be maintained. Also, they were used on the coal conveyors as a uniform speed was necessary. He agreed with Mr. Brooking that trouble is experienced with surface boxes, unless they are very good. Difficulties in connection with this had, however, now been got over.

* The Newcastle discussion on Mr. Henderson's Paper has already been reported (ELECTRICAL ENGINEERING, Jan. 16, 1908).

LONDON TRAFFIC AND RAILWAY ELECTRIFICATION

A PAPER with the above title was read at a meeting of members of the Royal Automobile Club on Thursday, February 6th, by Mr. Philip Dawson. In the first portion of the Paper he mentioned some of the early landmarks in the history of railway electrification, and pointed out how the three principal causes which in the past have produced electrification had been :—

(1) Difficulties of ventilation, such as exist in the case of tube railways, ordinary underground lines such as the Paris Metropolitan, the Budapest, and the Berlin Underground, the Orleans line in Paris, the Mersey tunnel, and the Metropolitan District Railways; or such as exist on Alpine routes like the Simplon Tunnel.

(2) The costliness of fuel, and the abundance and cheapness of water power. This was principally responsible for such electrification as the Valtellina, the Burgdorf-Thun, and the Milan-Varese lines, as well as the Swedish State Railways.

(3) The desire to increase the earning capacity of existing lines, and station facilities, and to handle more rapidly and more effectively heavy suburban traffics. This is responsible for the very large scale on which electric traction has been introduced on the New York Central and on the New York, New Haven, and Hartford lines, and for its adoption on the Hamburg-Blankenese line, on the Lancashire and Yorkshire and North-Eastern, and for the decision of the London, Brighton and South Coast Railway to adopt it provisionally on their South London line with a view of confirming its technical merits before finally adopting it for the whole of their suburban system. Shortly after this work was put in hand, the Prussian Government decided, for reasons similar to those which weighed with the British Company, to electrify the whole of the very large suburban system in and around Berlin, involving some 200 miles of lines and an expenditure of £2,000,000.

As far as this country is concerned, he continued, the only railway electrification which need be seriously considered is that of suburban lines which will have to be operated electrically in order to enable a better utilisation of existing traffic facilities and with a view to meeting tramway competition.

Mr. Dawson then reviewed at some length the advantages which electrical working presents over steam, and said :—

Generally speaking, some of the principal reasons which may be expected to eventually cause a saving in cost when electric

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is substituted for steam haulage on a large scale may be summarised as follows:—(*a*) Fewer electric motor trains or electric locomotives are required than steam trains for a given service, in consequence of higher rates of acceleration and of less time required for repairs and maintenance. (*b*) The reduction in fuel consumption and also in the quality, as well as in the cost of the fuel required. (*c*) The fact that, with the same number of tracks and terminal platforms, a much better service can be given with electricity than with steam.

In dealing with the question of cost and general results of electric traction, reference must be made to the District Railway, which is often held up, and constantly being quoted as an argument against electrification. In this connection it is only fair to point out that the conditions which obtain there are totally different from those which exist in connection with the operation of suburban trains on our big railways. The District is principally suited for short distance traffic, and, therefore, motor omnibuses and tramway competition cannot be combated with success. What would have happened to the District, as regards decrease of traffic, had steam been retained, it is difficult to foresee. Furthermore, the location of a great portion of the line, as, for instance, under the Embankment, is far from ideal from a traffic point of view. Electrification was not carried out in an ideal manner, a considerable amount of the rolling stock is unsatisfactory, both in design and construction, and troubles have been experienced with side doors, axles, and bogies. The services have not always been materially improved as regards frequency above what existed in the time of steam trains.

In considering the District, it is only fair to remember that the rolling stock operated by steam was of the lightest possible description, and of such a nature as would not be tolerated by the passengers accustomed to main line rolling stock, and, furthermore, that, during the many years before electrification took place, undoubtedly very insufficient allowances were made for renewals, not to speak of depreciation. There is also this great difference between the case of the District and the one under consideration, that the electrification of the District involved a scrapping of the whole of the rolling stock, locomotives, and practically the whole plant and equipment used in connection with steam traction; whereas, in the case of the electrification of a suburban railway, this would go gradually, and the rolling stock and locomotive plant superseded would not be scrapped, but would be used on other portions of the line, and would therefore not have to be written off.

The electrification of the District cannot have been carried out on the best conditions, and it is fortunate that there are figures available of a very similar line, the Mersey Railway, where electric traction entirely replaced steam in the course of one day. These figures show that for an increase of 10 per cent. in the total expenditure the train miles have been increased 167 per cent., whilst locomotive expenses for 1901, when worked by steam, were 13·65d. per train mile, and the expenses for the same items, when worked electrically in 1906, were 5·95d. per train mile. The apparent saving is not as great as appears at first sight, as the electric trains on an average are smaller, having a seating capacity on the average of half of that of the steam trains.

Having thus discussed the problem of electric traction in general, he briefly referred to the various systems of electric traction now in use, pointing out, amongst other things, that the three-phase system was in general only economically satisfactory for long distance work. The limitations of voltage and the consequent unwieldy conductors in continuous current working were also alluded to, and finally particular attention was called to the more recently developed single-phase system adopted by the London, Brighton and South Coast Railway, and decided upon by the Midland for their Lancaster and Heysham experiment. This system has also been chosen for the electrification of the Prussian State Railways in and around Berlin.

In the case of the Brighton railway, a pressure of 6,700 volts has been adopted on the overhead working conductor, although the insulation used is of such a nature and design as to enable 10,000 volts being used at a later period, should this be found advisable. These currents are led from the overhead conductor to the transformer situated underneath the car, in which the currents are transformed to a pressure of about 300 volts, and this is the only pressure accessible either in the motors or any of the conductors running along the coaches, and, therefore, none of the employés of the company are subject to any danger from shocks.

The author briefly summarised the position as regards railway electrification as it appeared to him as follows:—

(1) Electrification of the suburban portions of railways dealing with heavy local traffic appears to be essential, both in order to meet the very serious tramway competition, as well as better to utilise existing track and terminal facilities, and in order to save the enormous capital expenditure which an enlargement of the number of tracks and terminal facilities would involve—when, indeed, this is possible.

(2) As regards the system to be adopted, it should be such as to easily lend itself to extensions, even to considerable distances, and so as to interfere as little as possible with existing structures and permanent way, and to cause no fresh source of danger and annoyance to railway employés.

(3) It is useless to expect satisfactory financial results except when electrification is adopted on such a scale as to make it possible to fully reap its benefits, and unless it is so installed and operated as not to be constantly interfered with by existing local steam trains sandwiched in between the electrical ones.

(4) It is no use adopting electric traction if rolling stock of such a nature and design is adopted as will neutralise the benefits resulting from electric traction at termini.

(5) Economies in working may, and will, no doubt result, if and when the system has been sufficiently developed, but if electrification is only resorted to in order to decrease working expenses, and not in order to increase the earning capacity, then nothing but disappointment must be expected.

(6) It is no use electrifying unless frequent as well as rapid service is given.

DISCUSSION.

(*Abstracted from the "Royal Automobile Club Journal."*)

After a few words from the Chairman (Mr E. MANVILLE), The EARL OF BESSBOROUGH, C.V.O., C.B. (Chairman of the London, Brighton, and South Coast Railway) opened the discussion with some appreciative remarks, and was followed by—

Mr. FORBES (General Manager, London, Brighton, and South Coast Railway), who said that he must claim, like his Chairman, to have only a small technical knowledge of the subject. When Mr. Dawson approached the London, Brighton, and South Coast Railway Co. with the electrification proposal, he (the speaker) was impressed by the advantage to be gained at the terminals. They had spent at Victoria Station about one and a half millions, in order to be able to bring a greater number of trains into the station. To tackle the same problem at London Bridge would mean four or five millions, an expenditure that was, of course, out of the question. The time taken in getting trains into and out of that station was on an average 7 or 8 minutes per train, but for an electrical train only from 2 to 2½ minutes were required. There would thus be a gain of something like 5 minutes per train in the terminal accommodation. If the new system did not enable them to do anything else, he hoped that it would, at any rate, enable them to put on additional trains for their longer-distance passengers.

Lord RIBBLESDALE spoke of the influence of electrification upon overcrowding.

Col. Sir HERBERT JEKYLL, K.C.M.G., R.E., referred to the work of the Traffic Commission, and emphasised the importance of that co-ordination of tramways and railways that Lord Ribblesdale had recommended. It did not look as though railway companies would be able to widen their lines very much near London, as the cost was prohibitive, and the only way of increasing their capacity was, as Mr. Dawson suggested, to make the existing lines carry more traffic.

Mr. W. WORBY BEAUMONT said that with regard to some of the railways in England, it was to be remembered that, although the increase in the number of trains rendered possible by the substitution of electric for steam locomotives, would secure a very considerable return to those railways, there was another question—the accessibility of the railway stations to the public.

Mr. W. R. COOPER hoped that people would not regard electric traction as capable of regaining lost local traffic, whatever the conditions. For distances of a mile or two, electric railways could not expect to compete successfully against tramways or motor omnibuses along parallel routes. It was for longer distances that, he thought, electrification was advantageous.

Mr. OLIVER BURY (General Manager of the Great Northern Railway Co.) said that the problem was a commercial one. There were many railways round London with a longer distance traffic in which they had been able to cloak their suburban traffic, and it was not always known whether that suburban traffic paid or not. On the Great Northern they had been at great trouble to find out whether their suburban traffic paid or not, and they had recently had electric tram competition in their district. Those trams had taken quite a million of their passengers in the last six months, but such passengers were those who travelled between two or three suburban stations, and perhaps lived in the road through which the trams passed. The company still had to run those trains, and they missed those passengers. No amount of electrification was going

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to get them back again. Some time ago he asked for tenders for the electrification of the whole of their suburban lines. The company gave every sort of information to the gentlemen sending in those tenders, but the gentlemen in question told the company that it must not expect to carry the passengers any cheaper. He agreed that they might get trains in and out of a terminal station a little quicker, but not much quicker. He was prepared to admit that by electricity the trains could be accelerated, but, as one of the greatest firms in this connection told them, they could run more trains for the company, but even then the company could not carry more passengers. He did not see in those circumstances how a case could be made out for a board of commercial gentlemen who wanted to see a successful result. Sir Herbert Jekyll had said that they must cultivate their traffic a little further out. The Great Northern did that, and they did it with steam just as well as with electricity. If the nearer suburban traffic did not pay, why should they put 1½ millions sterling into electrifying it? He had had the biggest firms come to him, but they could not make out their case. Where was the advantage in carrying people if it did not pay? They could not get at the actual facts as to the results after electrification, either from the States or anywhere else.

Mr. A. C. ELLIS (General Manager, Metropolitan Railway) said that his line had been steam, but now was electric. They had in this way obtained experience, but they had had a bad time of it. That was due to electrifying a steam railway, which was quite a different thing from starting quite fresh; the conditions were not at all comparable. Coming first of all to the commercial question, they were less comparable still. In their case they were running a steam railway, and fairly successfully, paying as much as 3 and 3½ per cent. They had to electrify whether they liked it or not. The facts were that they had gone down from that percentage to a half per cent., but that was not due entirely to electrification. When they were running their concern by steam they had the plant and everything going, and it earned the money. Then when they came to electrify, they had an entirely different plant, and they had to pay for it. When they came to put aside and realise the old plant they could get very little for it; it had to be practically scrapped. Capital had to be raised by preference stocks, and that largely accounted for the drop in interest on the ordinary stock. Then, after the arbitration, they had to adopt a system they did not want to adopt. He (the speaker) agreed that the arbitrator took the only course he could take, having regard to the time at which the question was brought forward. The subject of electric traction had moved on since then. They had to adopt the direct-current system with a positive rail and also an insulated negative rail, and so were using the most expensive system of railway traction in existence. If they had been able to use either the three-phase or the single-phase system, their capital might have been perhaps a half less, and their maintenance expenses a third less. At least, so they were advised. But they had to have electric traction then and could not wait. The contractors paid the expenses of that inquiry, and they failed, he thought, because electrical traction other than the direct-current system was then only in the experimental stage. Mr. Bury had severely criticised electric traction. Mr. Bury's suburban traffic was not the suburban traffic of the Metropolitan or of the District or of the Tube Railways, and although Mr. Bury said that he could work very quickly at the terminals, yet he (the speaker) thought that, if he came to Baker Street, he would find there that they did it as quickly as any company could do it, and with no very marked difference between the time taken, even when using an electric locomotive. They found that where they could bring a train in and out in from 2 to 2½ minutes, they could do it now in from 1 to 1½ minutes in a busy time, with the passengers getting out on one side and in on the other. Then there was the question of rolling stock. They had the corridor trains with the gates. There must be more control over each train when they were running electrically, if they were going to have an acceleration of 1·5 ft. per sec. per sec., which was about as much as the passengers could stand. The system had many advantages, but it also had its disadvantages. On the Tube railways they had gates at the end, but the Metropolitan found that on running into the country there was such a tremendous draught that they had to have a closed vestibule. Over here people did not like standing in gangways, and there were certain public departments which did not think it was proper. Then the company had to consider the complaints of people coming from 14 or 15 miles out, and so they thought that they might use some of the old stock, and accordingly converted their ordinary rolling stock of the type always used in England, put motors on, and ran block trains. Those trains ran very well, and were much appreciated by the public. The travellers had suited themselves to the circumstances, got in and out quickly, and did not try to get into the train after it had started. The Metropolitan had been the victims of experiments, but they had got over that, thanks to the very excellent staff. Mr. Dawson had stated some running times taken by steam and by electricity, and he would like to tell them that on the Inner Circle Railway of 13 miles they had 27 stops, and they took 70 minutes to do it formerly; they could now do those 13 miles, with 27 stops of 20 seconds each, in 50 minutes. That brought him to the fact that those trains started quicker, and that they would brake quicker, which meant a greater wearing on the tyres and on the rails. In England one did not see a broken rail; at any rate, they were very rare. Abroad the percentage was very much higher. That was due very largely to the composition of the steel in the rails. The engineers were afraid to make the steel of the rails too hard, but they were now making it harder. The Metropolitan had hardened the check rail, and thereby practically solved the problem of electric trains running over the permanent way. Then they found that they must go in for automatic signals. He would like to go even further, and say, "Light the tunnels and run by sight." He would be willing to reduce the speed and the weight of the trains for that. He knew that their rails had some nasty curves, but these curves could be provided for, and they must get a system of following more quickly. If they came next to the question that Mr. Bury asked as to the cost of running, either per train-mile or per ton-mile, comparing steam with electricity, he would say that the balance would be in favour of steam. He had got out some figures, and after taking out the weights of the steam trains, and taking the electric trains, putting them all evenly, he found there was a difference of something like a penny, but to get that he had to include a certain number of steam trains and goods trains, and compare them with the all-steam trains up to December, 1904. If they eliminated the steam and goods trains at present run, there would only be about five-hundredths of a penny per train-mile in favour of steam as against electricity. It was quite true they gave the passengers more by electricity than they used to get by steam, but they would never get those passengers to travel now if they went back to steam. Mr. Bury had said that they must look at this financially; but, of course, they must also look at the fact that electricity was improving every day. He wondered that, having started three-and-a-half years ago, what they started with was not now out of date. They had come to the conclusion that depreciation was a very serious thing, and had put by a very considerable sum for it. It must also be remembered that when they had steam the "tubes" had not been started, and the other forms of competition were not in existence. It was hardly fair, therefore, to say that the old Metropolitan and the old District were not a success run electrically without considering the other facts that had brought them to their present position. The more one was in the position of a wholesale merchant of electricity, the more one was likely to be financially successful. The Metropolitan was now big enough to consider itself a wholesale merchant, and he believed that they would be able to show better results.

Mr. DAWSON, in his reply, said that he believed that electric traction was going to be one of the few solutions—if not, indeed, the only solution—of the overcrowding problem. They must look forward to people going, not four or five miles out, but 10 or 15 miles away from their work. The solution of the rolling stock question was an easy one; it consisted simply in a slight alteration of the side-door type. It was well known in Europe—particularly in Germany, where those trains were used for suburban traffic. It consisted simply in cutting away a portion of the compartment and converting it into a sort of corridor train. Everybody—railways and tramways and the travelling public—rejoiced to see that the Board of Trade had followed the recommendations of the Commission, of which Lord Ribblesdale was such a shining light, and had appointed Sir Herbert Jekyll to consider the whole question from the broad point of view. Mr. Beaumont also touched upon the question of the accessibility of the stations. He (the speaker) did not think that that was so important as it appeared at first sight. If they were considering distances of only three or four miles, that would be very important, but for distances beyond that it did not matter so much. Trams were running at their highest rate of speed, and with the crowded state of the streets that would not increase, but railways would very materially increase their speed—would, in fact, nearly double it. If those trains were now travelling 10 or 12 miles, there was not much to choose between them and the trams, but if they were going to be able to travel 25 miles an hour, there would be a great advantage in their favour. Mr. Bury apparently did not suffer from traffic difficulties. He (the speaker) agreed that the electrification question was a financial one. If they were not going to increase their receipts, but were going to increase their expenditure, then it would not, of course, be wise to electrify. He thought that Mr. Bury must have got the tenders of experts some years ago, and electricity had travelled very far since then. Mr. Bury was numbered that evening among the doubters; perhaps in a few years' time he might be numbered amongst the faithful. Mr. Bury seemed also to be in an exceptionally happy position, because he could run the same service of 10 or 15 miles at the same speed as by electricity. There were not many lines in that position. Mr. Ellis had confirmed his most sanguine expectations—namely, that, under the most difficult conditions in which he had been placed, he had been able to operate at practically the same cost as with steam. If the Brighton Co. were as successful as that, they would be perfectly satisfied.

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ELECTRIC DRIVING AT THE MOTHERWELL IRON AND STEEL WORKS

An Electrically Driven 500 h.p. Rolling Mill

By the courtesy of Mr. J. Frood, General Manager of the Motherwell Iron & Steel Co., Ltd., we were recently permitted to inspect an important application of electric driving at these iron-works. The works contain two steam-driven mills, and a new 15" "merchant" mill has recently been added, in which electric driving is employed. The mill in question is utilised generally for rolling sections and strips, and is driven by a 500 h.p. motor. In addition to this, the hard rolls, live rolls, shears, straightening machine, and other appliances used in connection with the mill are electrically driven.

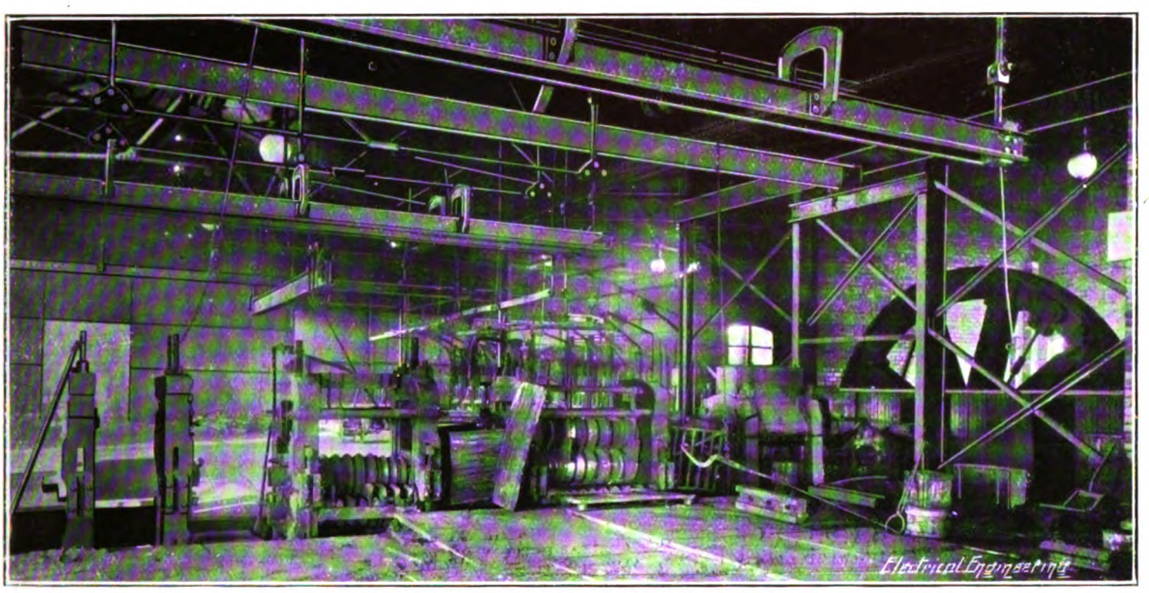


Fig. 1.—General View of Rolling Mill.

Most interest, of course, attaches to the large mill which is worked on the slip regulation system by a 500 h.p. three-phase motor. A general view of the mill is shown in Fig. 1. The motor is shown in Fig. 2. This motor, as already stated, is a three-phase motor rated at 500 h.p., and it runs at 145 to 150 revs. per minute. Between the motor and the mill is a 28-ton flywheel 19 ft. 6 in. in diameter. The frequency is 25 cycles per second, and there are 20 poles. By means of the slip regulator, to which reference will be made presently, the speed can be reduced momentarily to 110 revs. per minute if necessary, to allow the flywheel to give up extra energy to the mill during the short periods of very heavy load. The motor has a bar-wound rotor, and current is supplied to the stator at 2,000 volts. The weight of the rotor, together with its coupling, is 7 tons. Fig. 3 shows the coupling employed to connect the rotor to the flywheel. A flexible packing is employed to relieve the machine, to some extent, from the shock which it will necessarily experience as the work is put into the rolls.

The slip regulator is based on the following system:—The windings of the rotor are connected to a liquid resistance, and this resistance is made to increase automatically as the load on the motor increases. The insertion of resistance in the rotor naturally causes it to lag behind the stator in phase, and, as the speed decreases, the flywheel supplies energy to the system, as already explained. A similar type of slip regulation is used both for the large merchant mill and also for the smaller hard rolls, which are driven by a 125 h.p. motor. A photographic view of the two regulators, showing the smaller one in the foreground, is given in Fig. 4; and Fig. 5 is a drawing showing the regulator more in detail.

The same piece of apparatus includes both the starter and the regulator. The upper part of the vessel contains a number of horizontal pipes, through which water is circulated to keep the liquid cool, and below these are large horizontal plates which can be lowered into the liquid to decrease the resistance between them and fixed electrodes at the bottom of the tank. As the liquid is

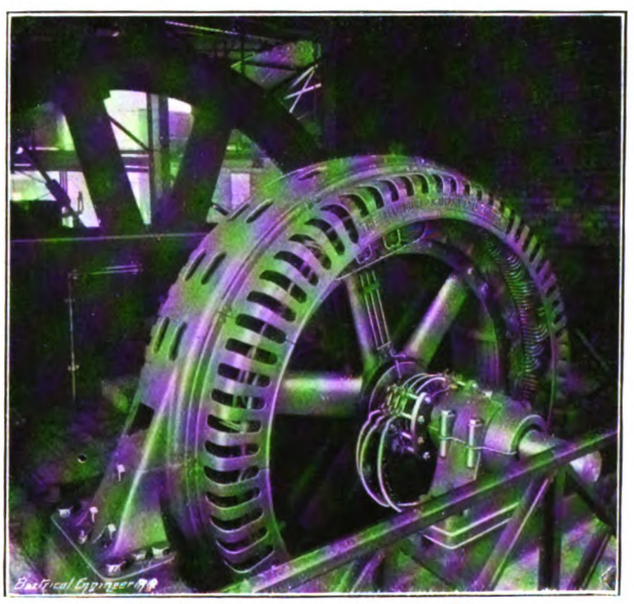


Fig. 2.—500 h.p. Rolling Mill Motor.

heated it rises and is cooled by the cold-water pipes, so that there is a continuous circulation. The moving plates are actuated by a hand wheel, and are also independently attached to lever carried on a projecting spindle by a small brake motor. The other end of this lever carries counter-balance weights.

To start the mill motor, the plates are lowered by

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means of the hand wheel after the main stator switch has been put on. After they have been lowered a certain distance, the lever engages with the lever attached to the brake motor. In the stator circuit of the rolling-mill motor there is a small three-phase series transformer, the secondary circuits of which are connected to the stator winding of the brake motor; the rotor of the brake motor is an ordinary short-circuited rotor. As the current supplied to the rolling-mill motor increases, the potential across the primary of this series transformer also increases, and the potential of the secondary rises sufficiently high to start the brake motor, the speed of which will, of course, depend on

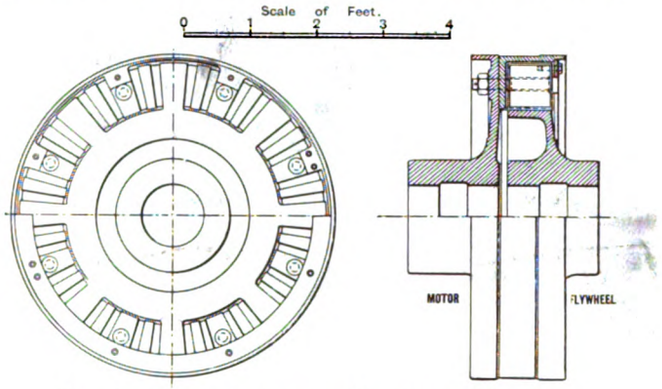


FIG. 3.—COUPLING BETWEEN MOTOR AND FLYWHEEL.

the amount of extra load on the main motor. As the brake motor turns, it lifts the plates which are in the liquid and thus increases the resistance of the rotor carried in the main motor, and the speed of the main motor drops. When the load diminishes again, the brake motor no longer exerts sufficient torque to counter-balance the difference in weight between the moving plates and the counter-weights, and the former again fall, decreasing the resistance of the stator circuit in the main motor, and allowing it to speed up again, thus restoring to the flywheel the energy that it has given up to the mill during the heavy load period.

high-tension board, where the oil switches and 'bus-bars are placed. The three isolating links are manipulated by one handle, and there is a main switch so arranged that the door of the chamber cannot be opened unless the switch is off.

The oil switches at the back of the board are arranged with an overload release in the usual way, and there are no independent circuit-breakers. The board to the

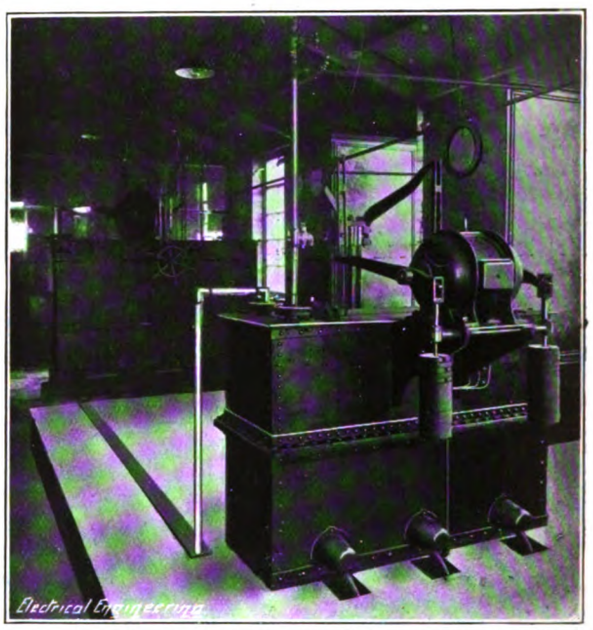


FIG. 4.—SLIP REGULATORS FOR THE 150 AND 500 H.P. ROLLING MILL MOTORS.

left hand of the drawing are used for the large mill motor and the smaller motor on the hard rolls. The right-hand board supplies current at 400 volts three-phase for the other motors employed. It should be mentioned that the two slip regulators are shown more or less diagrammatically on this drawing, and that the

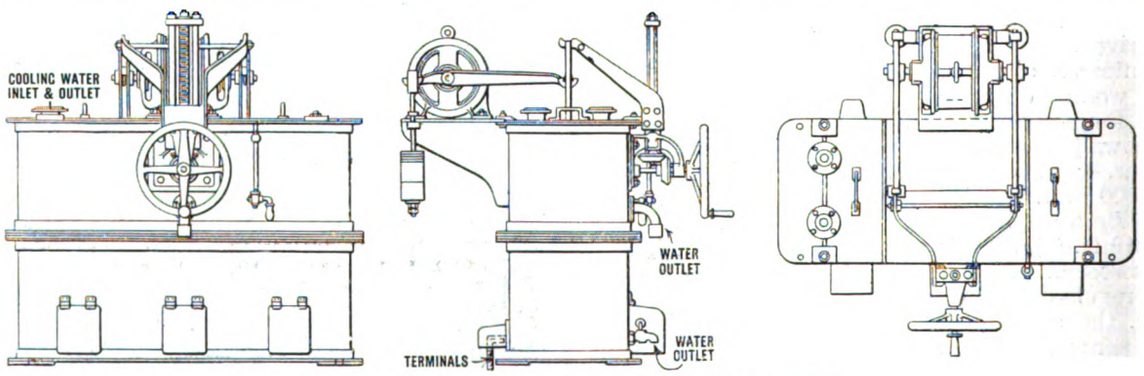


FIG. 5.—GENERAL ARRANGEMENT OF SLIP REGULATOR.

The mill has only been in operation for a short time, so that it is difficult to give any figures as to the consumption of electricity; but, roughly speaking, 40 Board of Trade units are used per ton of iron rolled.

Current is supplied by the Clyde Valley Electrical Power Co., Ltd. 11,000-volt overhead E.H.T. mains are taken from the company's North Motherwell sub-station, and the current is transformed down to 2,000 volts in a small sub-station which the Clyde Valley Company have erected close to the mill, and thence the mains go underground to the switch-room in the basement beneath the slip regulators, entering through the cable duct seen in the cross-section of Fig. 6, which shows the general arrangement of the plant. In the chamber just above this are the isolating links, and a narrow passage is left between these and the back of the

one used for the smaller rolls is of a considerably smaller size than that used for the 500 h.p. motor. In the case of these smaller rolls, the motor is also connected directly to them, and the whole system is exactly similar to that in use with the large merchant mill, but on a smaller scale.

The live rolls on which the material travels as it passes out of the mill are driven by a 20 h.p. 400-volt three-phase motor running at 750 revs. per minute, through a spur gearing with about 10 to 1 reduction. A connecting rod attached to the last wheel of the train drives the rollers themselves. The motor is beneath the floor, but is readily accessible for inspection and repairs by lifting a plate. Its speed is regulated as usual by resistance in the motor circuit, and the arrangement is such that some resistance is always left in circuit.

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A vertical hot saw, shown in Fig. 7, is driven by a 30 h.p. motor; its controller switches are on the gallery

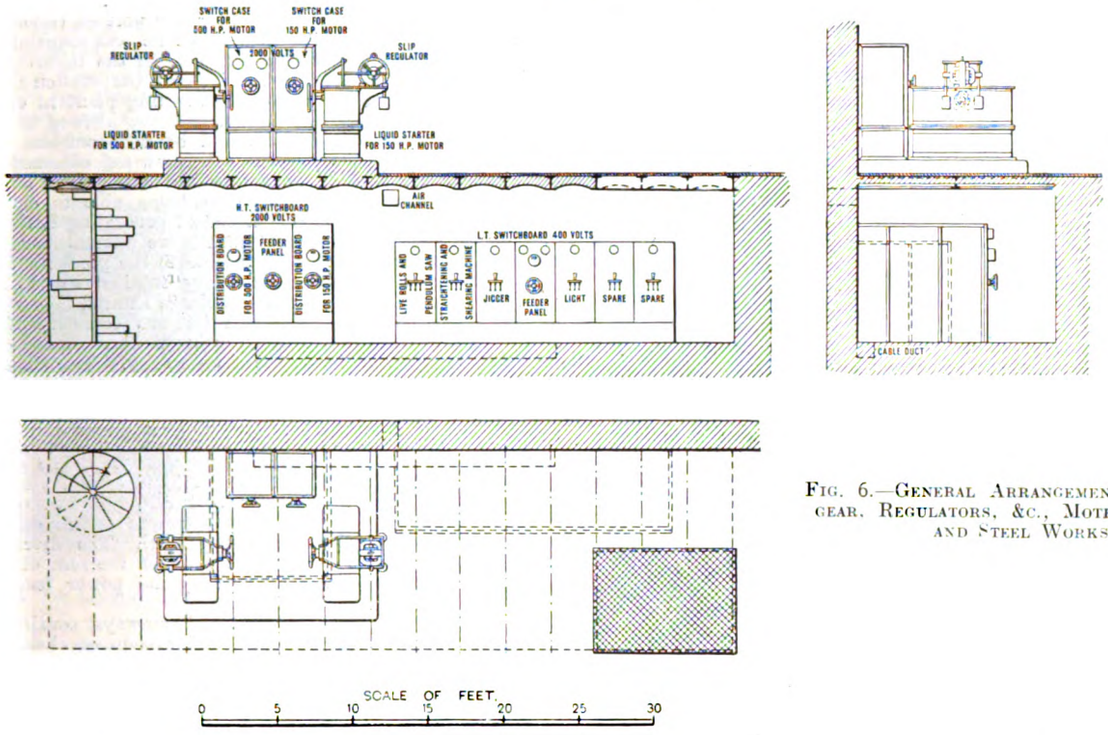


Fig. 6.—General Arrangement of Switchgear, Regulators, &c., Motherwell Iron and Steel Works.

seen in the illustration. The main switches and ammeter are contained in a watertight case, and there is

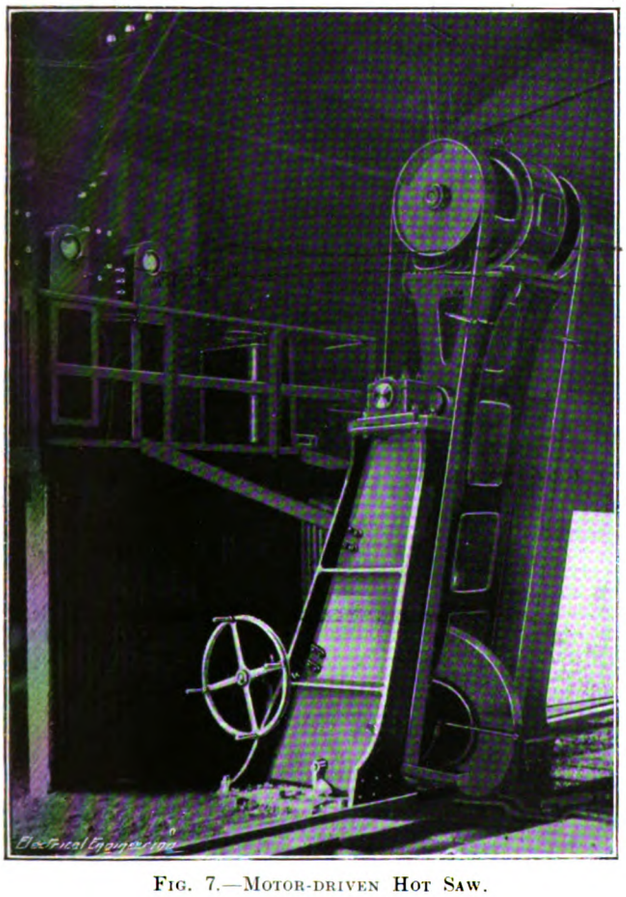


Fig. 7.—Motor-driven Hot Saw.

a controller on the front of the platform that puts resistance into the rotor circuit.

The shears shown in Fig. 8 are driven by a 20 h.p. motor running at 720 revs. per minute. At the top is a flywheel, which is driven from the motor through single reduction gear; and a triple reduction gear, independent of this, drives the shears. In addition to the starting switch and the resistance switch in the rotor circuits, there is a short-circuiting device on the motor itself, as there may be to some extent a variable resistance between the brushes and the slip-rings owing to

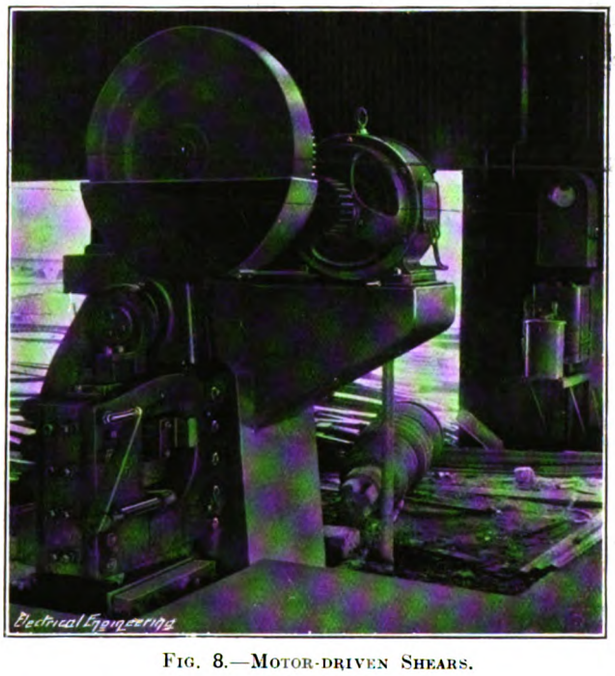


Fig. 8.—Motor-driven Shears.

the jarring of the machine. The motor is not mounted on springs, as is done in some works to prevent it from receiving mechanical shocks, but a raw hide pinion is used.

Two other motors, rated at 30 h.p. and 20 h.p. respectively, drive a reeling machine and straightening machine. The latter is used for polishing bars and taking the scale off them. Both these motors are fitted

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with the same short-circuiting device as is used on the shears motor.

All these motors are connected on separate circuits on the 400-volt board in the basement, and the fuses, switches, and ammeter near the machines are in each case enclosed in the waterproof iron case already referred to in connection with the hot saw. This case is again clearly seen in our illustration of the shears.

The arrangements for driving the two mills, and also the other motors, have been installed by the Electrical Company, and their Glasgow representative kindly accompanied us to the works, supplied us with much of the data included in this article, and made arrangements for photographs to be taken for us. We have also to thank the Clyde Valley Electrical Power Company for their assistance.

This is not the first introduction of the Motherwell Iron and Steel Company to electrical driving, as many of the machines used in connection with the two steam-driven mills are electrically driven. These take current at 460-volt continuous-current from the Motherwell Burgh Electricity Works network.

THE COST OF ELECTRICAL POWER SUPPLY

MR. J. F. C. SNELL'S Paper on this subject was discussed at Sheffield last week by the Leeds Local Section of the Institution of Electrical Engineers. The Paper and reports of the discussions in London, Glasgow, and Dublin will be found in our issues of January 16th, 23rd, 30th, and February 20th.

Mr. H. E. YERBURY (Sheffield Corporation Tramways Department) opened the discussion by remarking that some of the author's axioms and tables were open to criticism; he did not, however, make any direct attack on them. He agreed that the cost of equipping large power stations could not be reduced to less than £12 or £13 per kilowatt installed. He was sorry to see that in Table VIII. the Sheffield costs had been omitted from the comparison. Their charge for power was 0·6d. per unit, and the works costs 0·36d. Viewing the Paper as a whole, he considered the arguments advanced for centralisation, and the contention that local generating stations should obtain extensions of supply from a power company or by co-operation among neighbouring towns, was more applicable to London than the provinces, where he was sure it would be impracticable.

Mr. WILSON HARTNELL (Leeds) was of the opinion, as the result of considerable experience among manufacturers, that where existing factories are already supplied with efficient power plant, they could generate electrical energy for themselves more cheaply than it could be obtained from outside sources. At the same time owners would prefer to avail themselves of an outside power supply, even at an enhanced price, to sinking a large amount of capital in extra plant. They would be prepared to pay up to 1d. per unit, although they might generate for themselves at, say, 0·6d.

Mr. S. E. FEDDEN (Engineer and Manager, Sheffield Corporation Electricity Supply Department) considered the author's tables fairly accurate, although they were not quite to his way of thinking. In many of the Sheffield works the load factors are of the following order:—300 h.p. load factor 18 per cent., 600 h.p. 14 per cent., 1,000 h.p. 7 per cent. These works could not put down their own plant with the necessary spares and supply themselves at as low a rate as they could obtain current from the Corporation. The running load factor in the Sheffield generating station is from 40 per cent. to 45 per cent.* Referring to Table I., he pointed out that the price of town's gas is taken at 2*s.* per 1,000 cubic feet, but in Sheffield it can be obtained for half that amount, and yet his department are adding to their power demand at the rate of 200 to 300 kilowatts per week. The examples of suction and producer gas plants in the Paper must, he thought, have been very perfect producers, engines, and men. After taking into consideration the expenses incurred by shutting down for cleaning and repairs, wages of attendants, explosions, &c., many users of such plants in Sheffield had changed over to the Corporation supply. The speaker doubted if a power company could supply in Sheffield as cheaply as the Corporation, because their diversity factor would be very small for several years. The average price obtained by the Corporation for their full power load was 0·9d. per unit.

Mr. A. J. CRIDGE (Sheffield Corporation Electricity Supply Department) criticised Mr. Snell's contention that the prices charged for power were not high enough to enable undertakings to conduct their business on a sound commercial basis, and said that if higher prices were charged they would get no customers at all.

Mr. J. W. BEAUCHAMP (Chief Assistant Engineer, Sheffield Corporation Electricity Supply Department), referring to Table III. and the column "Units per Capita," asked if it was possible to obtain the consumption of power per unit of turnover. In a jobbing engineering works with which he was acquainted, the cost of power worked out at 5 per cent. on the turnover.

Mr. H. DICKINSON (Engineer-in-Chief, Leeds Corporation Electricity Supply Department) said that generating plant in engineering works is often run very badly, and was allowed to get into a very uneconomical condition, and he felt confident the figures quoted by the author in Table I. were not obtained in regular practice. He wished the author had laid greater stress on the convenience to manufacturers of being able to obtain their power from outside sources, instead of generating it themselves. Works managers found it much more advantageous to be able to devote the whole of their time to the production of work, than to have the additional worry entailed by the responsibility of a power plant. His experience showed they were learning to appreciate this fact, and he was confident they would continue to obtain their power from outside, even if called upon to pay a higher price than to-day. Referring to Table VI., he did not agree with the figures quoted for cost of distribution. It was imperative to lay down cables larger than called for by present requirements; the capacity should not be less than double. It would, therefore, be many years before the figure of £12 per kilowatt was obtained. The great difficulty engineers had to face was the high capital cost of the older stations. What originally cost £15 per kw. could now be obtained for £5. They must therefore endeavour to reduce these charges to the present-day level. The diversity factor in Leeds, which he took as the ratio of the sum of the consumers' maximum demands divided by the power load at the station was 2·4.

Mr. E. J. MARSH (Sheffield Corporation Tramways) considered the whole matter a question of a rational system of charging. There had been many systems devised, but all were more or less unsatisfactory. Everyone seemed to have a different way of calculating the diversity factor, which led to much confusion.

Mr. WARDALE (Sheffield) advanced the opinion that the present attitude of the Board of Trade in the case of accidents and the imposition of heavy fines would be an inducement to power users to come on the mains.

Mr. F. W. WARDROBE (Sheffield) laid stress on the question of capital cost, which he considered to be the deciding feature. When manufacturers found they can get reliable power without having to lay down large capital sums, they would readily become customers of a power supply company. The question of spare plant in large works was not such an important item as it was often thought to be. Low power costs could, he thought, only be obtained by the use of alternating current.

Mr. SNELL once more responded to the repeated request for the definition of Diversity Factor, and said it was the sum of all the consumer's maximum demands divided by the maximum demand at the generating station. Despite Mr. Yerbury's criticism, he must still adhere to the opinion that concentration would necessarily result in economy, and was the only practical way to secure reduction in costs. He was glad Mr. Hartnell confirmed his figures with regard to the generating costs of local plants; at the same time there were several points to consider which were favourable to obtaining a supply from outside sources. Space became valuable, and a manufacturer was sometimes glad of an opportunity to get more room by clearing out his own plant. Local nuisances sometimes arose which could be avoided in this manner. During brisk times he was glad to have the opportunity of supplementing his power without installing extra generating plant. When it became a question of permanently increasing the power, he found it advantageous to avail himself of an outside source, when such power was available, rather than to lock up capital in new plant. Replying to Mr. Fedden with reference to the critical load factor and size of plant beyond which it would not be commercially possible for an outside power company to supply, he said, no company could afford to supply a paper mill at a cost of 0·2d.; it would not pay for the cost of the transmission system involved. He knew of two examples where the load factor in steel works is over 20 per cent. With a diversity factor of 1·8, and actual cost per unit of 0·65d., it did not necessarily follow that a consumer could be supplied at that figure. It was necessary to have a maximum demand indicator on a consumer's premises to get at the diversity factor. He did not find any definite ratio between kilowatts installed and kilowatts demanded. Mr. Dickinson had criticised the figure of £12 per kw. for transmission, which he considered too small. Although the present price was about £30, yet it would be quite feasible to obtain the low figure named. Referring to a suggestion made by one speaker that electrical energy should be generated at the pit and transmitted direct to London and other large centres instead of sending the coal by rail, he would say that such a scheme had been seriously considered involving transmission at 30,000 volts, but it was found that the cost would be prohibitive.

* This is extremely high in view of the fact that the tramways are supplied from their own generating station.—ED. E.E.

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ACCUMULATOR LOCOMOTIVES FOR MINES

When considering the replacement of steam haulage by an electrical system, two alternatives are available: either a stationary motor driving a rope haulage or electric locomotives may be employed. The former possesses appreciable advantages over a steam gear, in that the power costs are lower, owing to the fact that the generation of power for all purposes is centralised, and the transmission losses are reduced to a minimum. There is also a greater freedom in the choice of the locality of the gear, and the maintenance costs are lessened

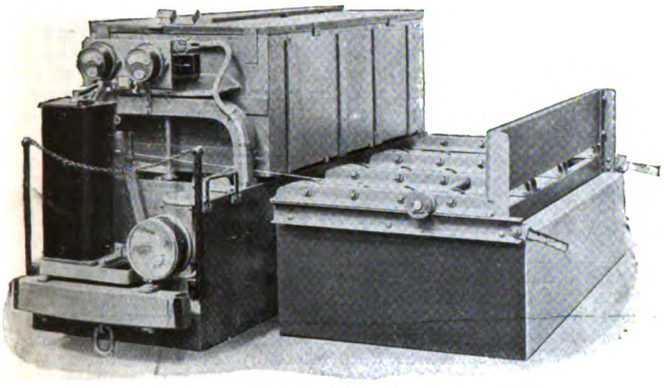


Fig. 1.—Locomotive with Battery in Place.

by the reduced wear and tear of the ropes and track owing to the steadier drive. These gears share with the steam-driven gear, however, two disadvantages. The first of these is the presence on the track of moving ropes and guide rollers, and the second is inflexibility. They are not suitable for rapid extension as the workings progress, and their use is therefore confined to the main galleries, while the coal is usually hauled from the working face to the main track by ponies. On all scores it is advisable, if possible, to replace animal hauling by a quicker, more efficient, and less costly mechanical system. The only method available is to employ electric locomotives. In a fiery mine, these must be of the accumulator type, on account of the difficulty of rendering the collection of current from an overhead wire absolutely sparkless. Moreover, a system involving the use of accumulator locomotives is more flexible, as it may be extended or removed to a different part of the mine

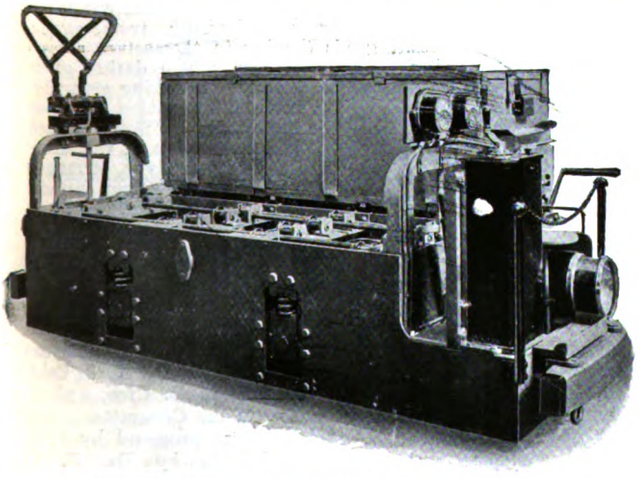


Fig. 2.—Locomotive with Battery Removed.

more easily than a line with a trolley or third rail for collecting the current.

The chief point militating against the success of accumulator locomotives is, of course, the difficulty of obtaining a suitable battery, having a sufficiently large capacity combined with a comparatively small weight. In the system described below, which has been developed by the Felten & Guilleaume-Lahmeyerwerke Co., of Frankfort, this point is in a large measure disposed of by the ease with which the batteries are changed, and the arrangements made for rapidly re-charging them. They are, moreover, of a special type, having a large capacity in proportion to their weight. Charging benches, alongside of which the locomotives may be run, are erected at suitable places.

The locomotive frame is of angle iron, and is covered with iron sheets. It carries three or four rows of four rollers each, which revolve about axes parallel to the longitudinal axis of the locomotive. In addition, two small winch barrels, to which ropes or chains are fastened, are attached to the back and front of the framework. They are keyed to a common shaft, and are turned by means of a crank handle fixed at the back of the locomotive. The charging bench is the same height above the rail level as the top of the locomotive frame, and is equipped with rollers and winches in a similar manner. The battery cases are fitted with two sets of hooks at either end (see Fig. 3), and are fastened to the locomotive by means of catch pins inserted in the end pieces of the framework, which also prevent any tendency of the battery to move backwards or forwards while travelling. To transfer an exhausted battery from a locomotive to the charging bench, the catch pins are removed, and the chains fastened to the charging bench winch barrels are attached to a pair of the hooks on the battery case. A few turns of the handle then rolls the battery on to the bench, and leaves the locomotive free to receive a fresh battery from an adjoining bench. All that remains to render the locomotive ready for

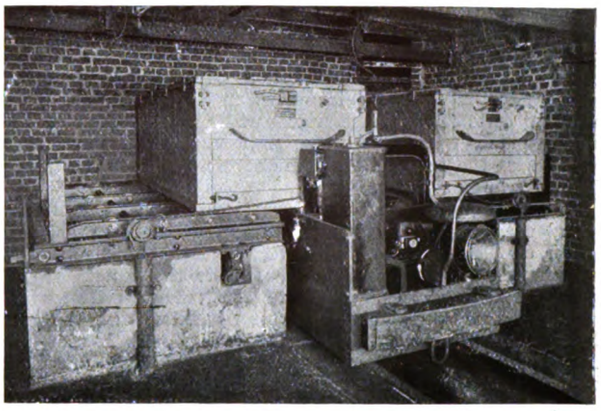


Fig. 3.—View of Locomotive showing Method of Changing Batteries.

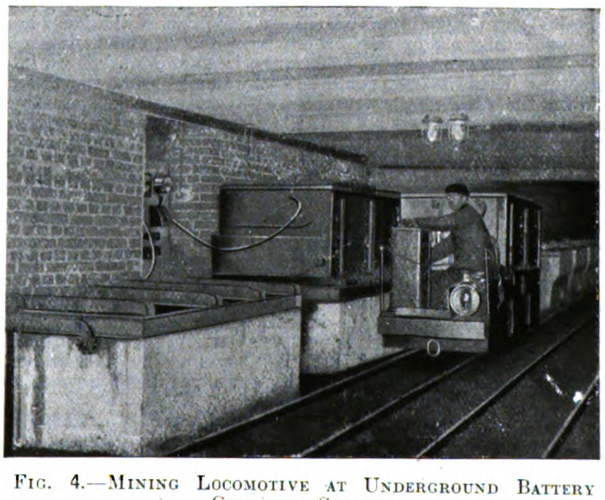


Fig. 4.—Mining Locomotive at Underground Battery Charging Station.

another journey is to insert a plug in a socket on the battery case. The whole process of exchanging an exhausted battery for a fully charged one occupies a minute at most; and is easily accomplished by one man.

The front of the locomotive is fitted with a seat for the driver, round which are grouped in convenient positions the controller, measuring instruments, brake lever, &c. The motors are two in number, and are arranged for series-parallel control. Their combined rating is 19 h.p. The total weight of a locomotive is about 5½ tons, 2½ tons being accounted for by the battery,

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which consists of 84 cells, type H. J. 100, manufactured by the Accumulatorenfabrik A.-G., of Berlin. At the one-hour discharge rate the battery has a capacity of 74 ampere-hours, which suffices to haul a train of 30 loaded tubs, having a gross weight of about 27 tons, for a distance of two miles on a gradient of 1 in 250 at an average speed of 6½ miles an hour, and to make the return journey with empty tubs. If desired, a battery designed for extremely rapid charging may be supplied, its capacity then falling to 60 ampere-hours on a one-hour discharge rating.

A large number of these locomotives have been delivered by the Felten & Guilleaume-Lahmeyerwerke, and are understood to have given satisfactory results. At the Zeche Margarethe, Sölde, Westphalia, for example, they are now employed in place of ponies, and have resulted in a saving of 50 per cent. in the working costs. In other cases, the economy has been even greater, on account of the conditions of hauling, and the costs of pony-tending. A further point in its favour is that the working costs of a haulage system with electric locomotives may be computed with exactitude, as a contract can usually be made with the accumulator manufacturers to keep the batteries in good working order.

It will be noticed that the locomotive shown in Fig. 2 is provided with a current collector. This may be connected to the motor circuit in place of the battery by means of a change-over switch, and current is then supplied to the motors from an overhead wire. The addition of the current collector is of value in some special cases, as, for example, when the coal is brought out from the mine through a drift, for in this case a large portion of the line is permanently in use, and as the tunnel is well ventilated from the surface, no danger is to be apprehended from slight sparking at the overhead wire. Current may thus be supplied to the motors from this source for part of the journey more economically than from the battery, and the latter will require re-charging less frequently than would otherwise be the case.

DOUBLE FILAMENT LAMP PATENT ACTION

MR. JUSTICE SWINFEN EADY had before him last week the case of True and the Variable Electric Lamp Syndicate, Ltd., *v.* The Bryant Trading Syndicate. The action related to a double filament lamp, and it was alleged that the defendants had infringed two patents taken out by a Mr. Robert Quain, and assigned to the plaintiffs.

The first of these, No. 15,689 of 1901, described a specially designed lamp-holder. This was a ring or tube, the upper end of which was fitted with transverse pins, which fitted into the bayonet points of the ordinary socket. The lower end of the ring or tube was divided into a number of strips by vertical slits, the lower ends of which were opened out. A short distance above these lower ends there was formed a recess with a corresponding rim projecting outwards, and the cap of the lamp had a corresponding rib or ring projecting round it, and fitting into the spring recess in the ring when the lamp was pushed up into its place. Thus the lamp could be freely turned round its vertical axis on the spring recess, and as different contacts were thus put in circuit, either or both of the filaments were rendered incandescent. Thus revolving the lamp a short distance changed its candle power. Although the patentee first described this specially designed holder as an intermediate fitting between the ordinary socket and the lamp, he also pointed out that the special holder might be formed upon a permanent socket, and as part of it, and without any intermediate fitting, and if the upper socket was so formed it would be adapted to receive his lamp with its projecting ring or rib. The third claim in the patent claimed this modified form of the apparatus as a portion of the patented invention. This form of the invention, the judge decided, was practically identical with the apparatus described in the patent of Edison and Hill, 22,327 of 1895, which was a clear anticipation, and the patent No. 15,689 was therefore invalid for want of novelty.

The novelty in the second patent sued upon, No. 18,569 of 1901, was to be found in the cap of the lamp. No special form of holder was required. The lamp was adapted for the bayonet socket-holder in common use. The device which enabled the filaments of different resistance in the same lamp to be used separately or together, consisted of a wire passing completely through a transverse opening in the upper part of the cap, its ends projecting sufficiently to engage in the slots of the bayonet socket. The opening on each side of the lamp through which the wire passed was elongated horizontally, and the wire was pointed in the centre of its length to a vertical point in the centre of the cap. The wire could thus move freely backwards and forwards to the extent of the length of the slot in the cap, and either or both of the contact pieces connected with the filaments could thus be put in circuit.

Until this invention, the judge continued, there was not any variable lamp on the market, without a switch upon the lamp itself, which was capable of being used in the ordinary fittings in common use, and unless some intermediate or adjusting piece was also employed. He had arrived at the conclusion that the invention was new, useful, and had not been anticipated. Hunter and Jacks' patent 3,426 of 1894, he said, was quite different, and Edison and Matthews, 7,530 of 1894, which was also relied upon by the defendants, had nothing to do with the plaintiff's invention. It had also been contended that the plaintiff's claim was invalid, as the second claim was an independent claim for the use of a screw nut upon the end of a wire affixed to the holder, to permit it to change its position, and that the use of such a nut for such a purpose was one of the oldest devices. In the judge's opinion the patentee was merely describing a method of affixing the invention to the holder as an advantageous method of using it where special circumstances rendered it expedient in case of vibration, for instance.

The objection to the plaintiff's second patent failed, and he decided in favour of the validity of the patent. There would be an injunction restraining any further infringement of the plaintiffs' second patent, and the plaintiffs would have the costs of the action, except so far as they were increased by the claim in respect of the first patent.

AN EXAMPLE OF INTERIOR ARC LIGHTING

ONE of the latest examples of interior arc lighting is the extensive installation which has been recently carried out at Messrs. Debenham & Freebody's large premises in Wigmore-street, London, W. Large floor space illumination had to be combined with artistic and hygienic treatment, and the open spaces and considerable freedom from obstruction due to partitions and columns gave opportunity for the use of large units of light spaced at wide intervals, thereby conducing to a considerable economy in current consumption; while at the same time the requirements of even diffusion of light and intrinsic brilliancy at every point were met by the adoption of the indirect as opposed to the direct method of illumination. The type of lamp adopted was that of the Union Electric Company's open inverted arc, and these were fitted with inverted reflectors for the purpose of throwing the light up to the ceiling, where this was sufficiently near the correct hanging level of the lamp to afford a good, even illumination. The reflector used was a 19½ in. diameter enamelled cone, whose interior surface of white threw the light up strongly to the ceiling.

In cases where the ceiling was not sufficiently near the crater of the arc to give a sufficiently strong illumination, it was necessary to fit over-reflectors similar in shape to a Chinese umbrella, and constructed with a surface of vitrified white enamel, measuring 35½ in. in diameter. These were placed approximately 12 in. above the arc, and a small under-reflector measuring 12 in. diameter, was placed immediately below the arc, so as to catch any rays which might fall at an angle greater than about 5 degrees to the horizontal.

The ampere rating of the lamps varied with the illumination required in the different parts of the building. Care was taken to avoid an appearance of shadow on passing, from, say, a department showing light goods (having in themselves a high co-efficient of reflection) to a department where darker goods are displayed and more light is absorbed. Speaking generally, the calculations were based on a useful illumination of about three and a half candle-feet, but in some cases the figure reached the value of five candle-feet. The greater portion of the lamps for the interior lighting were of the 8-ampere type, arranged on the basis of one lamp per 450 to 600 sq. ft. of floor surface. Approximately, 200 arc lamps were used in the building.

Central Technical College Old Students' Association.—The Annual General Meeting and Dinner of the Central Technical College Old Students' Association was held on Saturday last, Prof. W. E. Dalby, President, in the chair. Prof. A. G. Ashcroft, Messrs. M. C. Booth, A. E. Childs, and H. Crompton were elected as additional Vice-Presidents, and Dr. R. J. Caldwell, Messrs. F. C. Lea, F. K. Stevens, E. B. Cree, and R. Whymper were chosen to fill vacancies on the Committee. The toast of the Old Students' Association was proposed by Prof. Raphael Meldola, and was responded to by Dr. E. F. Armstrong, who is the Honorary Secretary and Treasurer of the Association. Prof. H. E. Armstrong proposed the Imperial College of Science and Technology; he alluded to the important research work that had been carried out by old students of his (chemical) department, and expressed the hope that great attention would be given to the subject of fuel economy in the research work of the new college. Sir William White, K.C.B., and Prof. W. A. Tilden (Dean of Royal College of Science) replied. Sir William White said that the new college must be no mere engineering school, but it must be devoted to the highest specialised technical instruction, and Prof. Tilden put forward the claim of pure science for greater recognition. Prof. Dalby gave the health of visitors, and this was acknowledged by Mr. F. G. Ogilvie and Prof. J. Adams. There were over a hundred old students present.

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THE "DICK" AUTOMATIC VOLTAGE REGULATOR

IN a previous issue (ELECTRICAL ENGINEERING, Vol. II., page 929) we gave a full description of the electrical equipment of the Vienna-Baden single-phase railway, in which was included a short note referring to the construction and action of the "Dick" voltage regulator, which is in use in the power station of that railway at Leesdorf. We are now able to give some further details of the construction of this regulator, which is manufactured by the Austrian Siemens-Schuckert Co. There are two types manufactured, one for direct-current, and one for alternating current, but the principle is the same in both. The diagram in Fig. 1 shows the connections for either type of

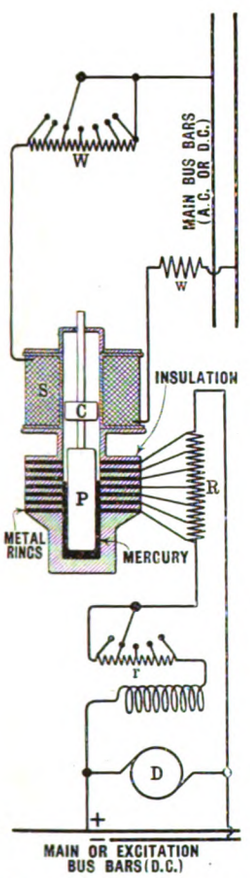


FIG. 1.—DIAGRAM OF CONNECTIONS FOR A REGULATOR OF EITHER TYPE.

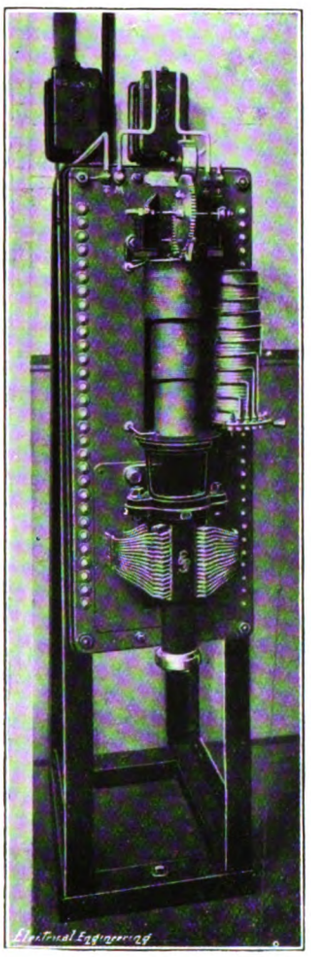


FIG. 2.—REGULATOR FOR USE ON ALTERNATING-CURRENT CIRCUITS.

regulator. The machine D is the main generator, or, in the case of an alternating current system, the exciter. In the shunt field circuit of this machine is an adjusting resistance r, and a regulating resistance R. The latter is divided up into a number of sections, connections being made from these sections to metal rings in the lower portion of the regulator, as shown in the diagram. These metal rings are separated from one another by rings of insulation and are piled up to form a cylinder, the lower end of which is closed, and which contains mercury. A plunger P floats in the cylinder, and by its movement alters the level of the mercury, thereby varying the number of sections of the resistance R, which are short-circuited. To the plunger P is attached an iron core C, which is lifted up by the action of the solenoid S. This solenoid is connected across the mains, the voltage of which is to be regulated, in series with an adjusting resistance W and a series resistance w.

The action is as follows:—If the voltage of the mains falls, the ampere-turns of the solenoid S decrease; the plunger falls and causes the mercury to rise and short-circuit more sections of the resistance R; this causes an increase in the exciting current of the machine D, and a consequent rise in voltage. In the case of a high-pressure alternating-current system, the solenoid S and the resistances W and w are connected in series with the secondary of a transformer, the primary winding of which is across the main high-pressure bus-bars. Fig. 2 shows the type of regulator for use on alternating-current circuits. That used for direct-current working differs only very slightly in external appearance. The solenoid, the connections to the metal rings, and the adjusting resistance are visible, as well as the balance-weight at the top, by which the sensitiveness of the regulator can be varied. The adjustment, in the first place, is made by means of the hand-regulated resistances W and r.

The regulator is supported on a bracket on the wall for the smaller sizes, and, of course, must always be placed upright. The amount of mercury varies from about 8½ oz. in the smallest size to about 6 lb. in the largest size. The mercury must be chemically pure in order that the ring-contacts shall remain clean, and care must be taken that dust does not enter into the cylinder.

Where several alternators are working in parallel and are supplied by one exciter, only one regulator is needed. This is placed in the field circuit of the exciter, as is shown in Fig. 1, and by this means the voltages of all the generators are regulated simultaneously. This is the method in use at the power-station of the Vienna-Baden single-phase railway at Leesdorf. The solenoid S, in series with an adjusting resistance and a series resistance, is in this case in the secondary circuit of an oil transformer which transforms down from 10,000 volts to 110 volts.

An alternative arrangement in the case of an alternating-current generating station is that in which each generator has its own exciter, which may be either shunt or compound wound. Each exciter has a regulator of the continuous-current type in its field circuit, the solenoid of which consists of two windings. The inner windings are connected in parallel across the terminals of a small auxiliary continuous-current generator, driven by a synchronous motor connected to the alternating-current mains. The outer windings are in series, and are in the main circuit of the auxiliary continuous-current generator. In this main circuit are also an adjustable resistance and the variable resistance R of a regulator of the alternating-current type, the solenoid of which is connected to the alternating-current mains, either direct or through a transformer, according as to whether the main voltage is low or high. This arrangement works in the following manner:—The inner windings of the continuous-current regulators tend to hold up the plungers, thus leaving all the sections of the resistances R in circuit. The outer windings act in an opposite direction, and tend to overcome the ampere-turns of the inner windings, thus letting down the plungers and short-circuiting some of the sections of the resistances R. Should the voltage of the system fall, the resistance of the alternating-circuit regulator is short-circuited; the current in the main circuit of the auxiliary generator increases; the outer windings overpower the inner windings, and the field currents of the exciters are increased. The regulators can be adapted to suit practically any arrangement for excitation.

Agricultural Hall Motor Exhibition.—We understand that the thirteenth of the series of annual automobile exhibitions organised by Messrs. Cordingley and Co., at the Agricultural Hall, is to be held from March 21st to 28th. The display of heavy vehicles is to be a feature, and there will be a special "inventors'" section.

Institution of Electrical Engineers.—The following is the result of the ballot for new members at the Institution on Thursday:—*As Associate Members.*—W. Clark, H. Cooch, G. F. Dewynter, I. H. Jenkins, C. O. Jolly, A. G. Lee, W. U. Lonnon, F. Pape, H. S. Thompson, A. Wallis. *As Students:*—S. M. Hills, E. Pogson, E. H. Webb.

Post Office Telegraphs and Telephones.—A return has been issued giving a statement of the gross amounts of income and expenditure for the Post Office telegraphs and telephones during the year ended March 31st, 1907. The accounts for the telegraphs and telephones are, unfortunately, not shown separately, but a committee has under consideration modifications in the arrangement of the accounts to render it possible to separate the working of the two branches in future statements. The amount of expenditure in respect of salaries, superannuations, and maintenance is given as £4,027,665, to which is added £118,642 for interest, capital expenditure to the extent of £748,979, and £116,639 expended by other departments, making a total of £5,011,925. The total receipts amounted to £4,369,227, so that the balance of expenditure over receipts was £642,698, a lower deficit than has been shown since 1903.

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REVIEWS OF BOOKS

Electric Arc Lamps. By J. Zeidler and J. Lustgarten. 188 pp. 8½ ins. by 5½ ins. 163 illustrations. (London: Harper & Bros.) 5s.

THIS book is an eminently practical study of modern arc lamps, appealing mainly to lighting engineers as a handy unbiassed work of reference, showing the leading types of lamps available, their distinctive features and performances, and the practical conditions determining their choice and arrangement. The descriptions are rigorously confined to modern apparatus suitable for the systems of supply available in the United Kingdom; we have not been able to find, for example, any reference to arc lamps for use on constant-current series circuits. This rigorous limitation adds to the value of the book as an up-to-date guide to the practical man, and argues a praiseworthy self-abnegation on the part of the authors in the use of historical matter. Whilst the preface describes the book as an English edition of a German work written by one of the authors, it reads more like an original work, as descriptions of English apparatus predominate; and it may be added that the style occasionally lapses into a species of colloquialism that is rather distinctly British. An example of this is the repeated statement that the regulating mechanism of alternating-current lamps may be constructed "with an induction motor principle." The first chapter gives a highly compressed statement of the main physical facts and properties of electric arcs, including the relations established by Mrs. Ayrton for the length, P.D., and current in continuous-current arcs. Bremer's discovery is represented—not very happily—as being "that by impregnating carbon pencils with *a metallic salt-like calcium or other rare metallic earth* he was able to obtain a very luminous gas." (The italics are ours.) It was rather the discovery that the fluorides of the earthy metals gave manageable slags or ashes that made it practicable to utilise the previously known qualities of their vapours in the arc.

The second and third chapters describe the "Electrical Principles" and "Construction" of arc lamps, and are generally excellent in clarity and conciseness, covering a number of types of lamps in general use, and their adaptations to different supply conditions. The classification under "Electrical Principles" is determined by the electrical regulating arrangements under the headings "Series," "Shunt," and "Differential"; but this classification cannot be followed when dealing with "Construction," where the natural divisions are "Open Arc," "Flame Arc," and "Enclosed Arc" lamps. This change, combined with rather frequent references backwards and forwards, and to figures on distant pages, produces a somewhat irritating effect when reading the book consecutively, but will probably detract little from its use for reference.

The descriptions of actual lamps are generally clear, and are not too full of detail; and the instructions for testing and adjusting lamps and their accessory resistances, choking coils, &c., are practical and easy to follow. The descriptions and diagrams of circuit connections in Chapter V. will be found particularly useful. The important subject of the choice of carbons is inadequately treated. It is one on which information from the user's point of view is badly wanted.

Chapter IV., on the "Application of the Electric Arc," commences with a study of the yield and distribution of the light given by arc lamps of the various classes, profusely illustrated by diagrams; but the polar diagrams require the current and power consumption to make them complete and comparable. The comparison of efficiency under various supply conditions is not complete, and the alternating arc is particularly sinned against by the omission. The utilisation of the qualities of different kinds and arrangements of arcs is illustrated by certain examples, in which the calculations take due account of the reflective power of the surroundings. This is a very useful chapter.

The book is profusely but somewhat unequally illustrated. The diagrams and detail illustrations of parts are generally clear and good. The poorer blocks are mostly unimportant. Figures 56 and 58 have been exchanged, and therefore disagree with the text references. The two illustrations of interior lighting would have been more instructive if photographed by arc light instead of daylight. We cannot say a good word for the index, but the "Contents" is an admirably full and well-arranged guide to the book; which is, on the whole, so good that a very early opportunity ought to be available for its improvement in the process of revision for a second edition.

The New Physics and its Evolution. By Lucien Poincaré. (Authorised translation of "La Physique Moderne, son evolution.) 344 pp. 7¼ in. by 5 in. (London: Kegan Paul, Trench, Trübner & Co., Ltd.) 5s.

THIS is one of the International Scientific Series, and is translated from the French. It represents an attempt to pass in review all the changes that have taken place in the views of physicists, and all the principal discoveries made in physics, and its practical applications, during the past ten years. The pages of this small volume contain space far too small for the carrying through of such a feat adequately, even though the technical side of the subject is touched upon very slightly. But the principal difficulty in the accomplishment of the task the author has set himself lies in the fact that it is scarcely conceivable that a single brain can grasp all provinces of modern physics, and give expert opinions upon subjects ranging from, say, modern methods of accurate measurement to chemical thermodynamics and the relations of the ether and matter. Nevertheless, on looking through the book, one has to admit that the author proves himself to be a sound scholar, possessed of exceptionally catholic taste and of a rare power of getting at the best route to the heart of many a labyrinthine subject. But though the author professes to set forth the fundamental facts of each branch of physics before discussing the modern developments of that branch, we fear that the extremely condensed form of the preliminary pabulum will prove almost completely non-nutritive to the average reader. Indeed, we think that even ardent students of physics, when they come across portions of the book dealing with branches unfamiliar to them, may find these portions of but small instructiveness. Further, if the reader be a physicist and also a specialist in some technical matter, and will read carefully the part of the book touching upon his own branch of work, he may easily find various evidences of slightly imperfect grasp of proportion. The author is at his best, on the other hand, in the art of taking a broad view of some large region of theoretical physics. For example, he is excellent in the first chapter, on the evolution of physics, where he convinces the reader that the torrent of modern discoveries is not revolutionary, but only evolutionary, and that to-day we add to ordered knowledge at a greater rate than did our grandfathers, only because the number of seekers has increased in all countries, while their quality has not diminished. In such vein the author very happily and very cleverly discusses many matters of wide and general interest to physicists, and thus makes the book well worth perusal by all to whom physics is important.

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ELECTRICAL EQUIPMENT OF SHIPS

A PAPER dealing with the electrical equipment of ships was read on February 12th by Mr. W. D. KIRKPATRICK, before the Liverpool Engineering Society. The author commenced his Paper by referring to the important objection which had been raised to the introduction of electrical machinery on board ship, that is, the effect upon the compasses. Various devices, he said, had been designed to overcome this difficulty, and about 1895 the ironclad dynamo was introduced for this purpose, and was largely used by the British Admiralty. The external magnetic field in this type of machine is reduced by about one half. The armouring also forms a valuable protection against shot and shell if the machine is in an exposed position. It has, however, also the effect of increasing the total weight by about 60 per cent. for the same output, compared with an ordinary unenclosed dynamo. This has led to the general adoption of the 4 and 6 pole machine of the open type, which combines a minimum of external leakage with a maximum of accessibility to the brushholders, and is at the same time self-ventilating.

With regard to the system of wiring on board ship, the usual insulated two-wire system is now used; but in the early days of electric lighting a single wire was used throughout, the ironwork of the ship being treated as a negative or return conductor. The protection of the cables is to a large extent done by means of wood casing, a form of protection which is especially applicable to cabin and saloon fittings. When, however, cables and wiring have to be carried through engine and boiler rooms and cargo space, screwed conduit or galvanised iron tubing is used for this purpose. Cables armoured with galvanised wire have also been used with some success, but this has been found unsuitable for cargo space work, especially if cattle are carried, as the iron wire appears to perish rapidly. Cable tarred and braided over the armouring has proved itself most durable under these conditions. In the British Navy only vulcanised rubber lead-covered cables are used, run on teak battens fixed to the bulkhead, and secured by brass clips. In some foreign navies, notably that of the Japanese, the cables and wires are attached directly to the bulkheads, without teak backing being used. This method, in the author's opinion, is for some reasons preferable to the British practice, but he points out that it entails considerably more holes being drilled in the bulkheads, which is at all times objectionable, owing to the difficulty of making them efficiently water-tight afterwards. The standard voltages for ship work are much lower than those in use for shore purposes, and it is only within very recent years that 100 volts has been exceeded or indeed become general. These low pressures are becoming inconvenient owing to the large sectional area of cable required to convey the current for power purposes.

In a modern steamer there are auxiliary engines distributed all through the ship, affording quite a parallel to a large engineering or shipbuilding works where machinery is widely scattered. In these cases it has been proved by the large adoption of the electric system of power distribution that this system is by far the most economical. The saving is largely due to decreased steam consumption resulting from the use of one well arranged and closely governed engine situated in close proximity to the boilers, instead of a large number of engines at various distances from the boilers, using enormous quantities of steam per i.h.p. The main causes of loss with steam-driven auxiliaries may be taken as:—(1) Condensation. (2) The use of too great a range of temperature in the cylinders. (3) Leakage past valves and pistons due to wear. In order to emphasise the uneconomical use of steam under the second condition, the author considers the case of winches, which must necessarily exert a powerful effort throughout the stroke. When steam at a boiler pressure of, say, 250 lb. is used with cut-off at three-quarter stroke, the waste in not using the steam expansively is very great. The advantages of cables over steam pipes are obvious.

The modern traction type of electric motor with a few modifications would answer all the requirements laid down as essential for ships' use, because the conditions under which it actually works on land are as bad as, if not worse, than those which would have to be contended with at sea.

The main factor is, after all, the question of cost, and in this connection the case cited of a steamer built for a Glasgow firm in 1906 is of interest. She is a boat 350 ft. in length, by 48 ft. beam, and 27 ft. depth, and carries 6,000 tons deadweight. Her main engines are capable of indicating 1,600 h.p., and she has a sea speed of 10·5 knots. When at sea the full load for auxiliary work may be taken as follows:—Air pump, 9 h.p.; circulator, 9 h.p.; feed pumps, 20 h.p.; bilge pumps, 3 h.p.; forced draught fans, 6 h.p.; and lighting dynamo, 20 h.p. This totals up to 67 h.p. The ship is also fitted with eight winches, of which six only would be working at full load at once. Each is capable of developing 12 h.p. The full load in port would therefore be as follows:—Six winches, 72 h.p.; feed pump, 10 h.p.; and lighting dynamo, 12 h.p.; or 94 h.p. in all. To deal with this load it was proposed to install three direct-coupled generating sets, each capable of developing 52 kw. at 100 volts. The cost of the three generating sets, switchboard, and wiring was estimated at £1,870: the cost of the eight winches, including control gear, £848; and the rest of the auxiliary plant, £810. Total, £3,528. The estimated cost of the corresponding steam plant, including a dynamo for lighting, was £2,690. Thus the electrical installation cost £838 more than the steam. The saving in fuel, however, is considerable.

In general, the average steam consumption of the best steam-driven auxiliaries has been shown to be in the neighbourhood of 70 lb. per i.h.p. hour, whilst that of electrical generating sets of the size under consideration is often specified not to exceed 26 to 27 lb. per i.h.p. hour. Taking the b.h.p. : i.h.p. of the latter engine at 93 per cent., the dynamo at 86 per cent., the cables at 95 per cent., and the motors at 78 per cent., an overall efficiency of the electrical installation of 59 per cent. is obtained. This shows that the steam used per b.h.p. on the motor shaft is 44 lb. per hour, representing a reduction of 35 per cent. on the steam consumption of the best steam-driven auxiliaries. In this calculation, however, the assumed i.h.p. of the steam-driven plant is compared with the b.h.p. of motor-driven auxiliaries. The average mechanical efficiency of steam engines, as generally used for this work, may be taken as 70 per cent.; therefore 70 lb. of steam per i.h.p. represents 100 lb. per b.h.p., and the saving of coal due to electric driving is 56 per cent. instead of 35 per cent. On this basis it would be reasonable to expect in the case under consideration a daily saving of 1,800 lb. of coal, or about 240 tons per annum on a working year of 300 days. This coal could not be put on board at much under 15s. per ton, which represents a saving of £180 per annum.

The author then described the electric plant on the new Cunarders *Lusitania* and *Mauretania*. Four electric motors are employed for opening and closing the main exhaust sluice valves, another four for turning the main shafts, whilst six more operate the turbine cover lifting gear. There are also two electric bilge pumps, and three sets of electrically-driven refrigerating machines are fitted forward. These steamers have a generating station composed of four sets of Parsons turbo-generators, each capable of supplying 375 kilowatts or 4,000 amperes at 110 volts. There are altogether about 160 motors on board, varying from the 50 h.p. ones, which drive the forced draught fans, to ¼ h.p. motors, for boot and knife cleaning machines, potato peelers, &c. The passenger lifts, and hoists for the mails, baggage, and galley stores are all electrically driven, as are also the four jib cranes aft. There are some 6,000 lamps of 16 c.p. distributed throughout the ship, of which over 700 are in the engine and boiler rooms. It is interesting to note that nearly 100 tons of copper cable were required to distribute the power about the ship. The Admiralty requirement that the main cables should be placed as far as practicable below the water line, necessitated their passage to the forward parts of the ship to be through the boiler rooms, and in order to withstand the heat they had to be specially prepared with a heat-resisting compound, and afterwards covered with two thicknesses of asbestos braid. In the boiler spaces they are run along the bunker side on porcelain insulators, and are cased in with sheet iron for protection.

One objection to the use of electrically-driven winches, capstans, &c., is that special men are required to work the controllers, as a man accustomed to work with steam would not be able to operate them properly. The gear, however, can be adapted to suit the man who has to work it, and in this connection it is interesting to note one of the latest British Admiralty specifications for control gear, which reads as follows:—

"All control gear is to be designed and constructed so that it shall be unaffected by heavy continuous vibration, such as may proceed from machinery in motion, or sudden, violent shocks as produced by gun-fire. All hand wheels, handles, and levers used in operating the gear are to be of ample size and great strength, and constructed so as to give a good non-slipping grip. They should be of the size and shape usual with steam and hydraulic gear, even though this should be wholly disproportionate to the work they have to do, as they will be used by men accustomed to mechanical gear, and inevitably handled with the usual amount of force. The movement of all levers must be limited by extra strong mechanical stops, and their connection to the gear itself must be such, that the operation of the gear is entirely independent of the force used.

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All levers to have a motion arranged to move in a manner harmonious with the motion to be produced. All hand wheels are to be arranged so that motion in a counter-clockwise direction completes the circuit, increases the speed or otherwise compares with the effect of opening a steam or hydraulic valve."

The author then referred to a new type of starting switch, the multiple lever switch. This consists of a number of switches, instead of a single contact-arm and a row of contact-segments. These are arranged so that each time a hand lever is moved forward and backward, a switch is closed, and the resistance in the armature circuit of the motor is gradually cut out. In this device each single switch is arranged to be held in position electrically until the last one is closed and the handle released, when all the switches open except the last.

CORRESPONDENCE

ELECTRIC WIRING FOR PLUMBERS.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—A few weeks ago I renewed an appeal which I made a good many years ago, in the columns of one of your contemporaries, on behalf of the suppression of anonymity, on the ground that where reviewers, writing anonymously, make definite statements of fact, it is against the interests of the profession generally, that owing to the anonymity the statements cannot be tested. I now beg to make a similar appeal to you, on the stronger, I trust in your opinion, the far stronger ground, of the dignity of literature, and of the good name of the journal you have so recently established, and for which you claim our suffrages. I need hardly explain that my appeal is caused by the very small review of my book on "Wiring for Plumbers, &c.," which appears in your current issue. I venture to say that the statement made in the review is such as should never be made in a journal having a good name to maintain. It is such a statement as might have been made by a giggling boarding-school miss of the early Victorian era. The modern athletic girl would scorn it. I submit that both the dignity of literature, and the position of your own journal, as a serious representative of what is now an important industry, are distinctly compromised by the insertion of such childish matter under the name of a review.

The ridiculous nature of the so-called review is perhaps somewhat accentuated by the fact that, if your reviewer is able to earn a living more or less directly owing to the establishment of an electrical industry, he owes it very largely to the work that was done by myself and others, who were in the fighting line when probably he was in his cradle, possibly before he was born.

I trust that I am not mistaken, even in this very effeminate reviewer, when I say that he would hardly have written such stuff over his own signature.

Yours very truly,
SYDNEY F. WALKER.

Bath. February 21st, 1908.

[The review to which Mr. Walker takes exception was on his book, "Electric Wiring and Fitting for Plumbers and Gasfitters," and was as follows:—"In the unlikely event of our employing a plumber or gasfitter for electric wiring and fitting, we should give the preference to one who had not read Mr. Walker's book." In reply to his letter we need only quote a few passages from the book:—

"In many towns also, an apparatus is fixed in the neighbourhood of the meter, known as a demand indicator, an arrangement for discriminating between the current taken during certain hours when everybody wants it, and that taken during the remainder of the 24 hours when scarcely anybody wants it, the charge for the former being very much higher than for the latter."

"The terms 3-watt, 3½-watt, 4-watt lamps, &c., refer to what is called the efficiency of the lamp, the amount of light given for a given expenditure of current and pressure."

"The watt is the electrical unit corresponding to the foot pound in mechanics."

"Two kilowatts expended in half an hour equal one kilowatt hour, and 20 kilowatts expended in 20 hours equal 20 kilowatt hours."

"To the author's mind this arrangement [looping in] is only allowable in very special cases, such as where there are several lamps in the window of a tradesman's shop, or several lamps close together, pendant from a ceiling, as in a drawing office, or in an office with a number of desks. He very much prefers that each lamp should have its own pair of wires from the last distribution board."

"Thus each lamp should be protected by its own fuse; each branch circuit, as explained, is also protected by its own fuse, and so on, the fuses being larger in proportion as the currents they have to deal with increase."

"The connection made between the tube and one conductor will do no harm, so long as no second connection is made between the tube and the other conductor."

"Another simple test that plumbers can carry out if they have access to the current for which the wiring is to be done, but which requires care, is to take a piece of tube, say 2 ft. in length, being careful that the enamel is perfect on it everywhere, and make a circuit, as for an electric light service, from the supply wires to the tube, including a switch and an ampere meter. [This figure shows the length of conduit connected through fuses and an ammeter across the supply cables.] Connection may be made to the tube by binding a clean, thin, naked copper wire at each end of the tube, outside of the enamel, but so as not to injure the enamel. . . . In place of using binding wires in the manner described, metallic plugs may be pushed into the ends of the tube."

We leave our readers to judge whether the book merited a longer or more favourable notice.—ED. E. E.]

Electric Clocks.—Mr. H. H. Cunynghame, C.B., delivered the sixth and last of a series of Cantor Lectures upon "The Theory and Practice of Clock-making," at the Royal Society of Arts on Monday, and devoted himself to electric clocks, which he regarded as the clocks of the future. The main advantages of electric clocks were that the wheel train was done away with altogether, and they were much cheaper and simpler. The great obstacle was to get a constant battery, one that would continue in good working order for four or five years. This would be quite possible once the difficulty of the contacts was got over, as he had every belief it would at no very distant time. Electric clocks could be divided into several groups. The earliest form was to have an electromagnet which attracted a mass of iron placed at the end of the pendulum rod. The drawback to this system was that in making and breaking contact the spark which occurred tended to oxidise the metal and create an imperfect contact. In connection with this primitive form of clock, instead of having a battery, the inventors sometimes buried zinc and copper in the garden. The objection to it was that the accuracy depended upon the constancy of the battery. One of the first attempts to obviate this difficulty was made by Hipps, although, he believed, the principle was invented by the French experimenter, Foucault. This system, known as the Hipps' butterfly escapement, consisted of a pendulum having an armature at its end moving over contact springs; to the pendulum is attached a flipper which, when the swing of the pendulum becomes too slow, causes the pendulum to make contact with the springs and thus to receive an electrical impulse, which sets the pendulum moving again. This system did away with the difficulty of the want of constancy in the battery to a great extent, because the number of impulses were largely reduced. On the whole, it had done its work very well, and one clock driven in this manner was still working satisfactorily in the Swiss Government Observatory at Neuchatel. The reason advanced for this working better than any others Hipps' clock made, was that very great care had been taken to make the electromagnet of the finest iron. In other places this type of clock had not worked so well. An ingenious clock had been invented by Féry, which the lecturer could not describe on account of patent questions. But it worked with a polarised bob, and the inventor believed he had obtained a really constant battery. Another class of clock was that known as *train remontoir*, or self-winding clocks, the general principle of which was that a falling weight operated a tumbler switch which closed an electric circuit, and put into motion a motor which wound the clock up, the circuit being broken when the weight made another contact at the end of the wind. There were many systems of this nature, including those of Allen, Webber, and Hope Jones. Next there was the "Magneta" system, which was based upon the principle adopted by Wheatstone in his early telegraphic experiments, in which he dispensed with the use of a battery and contacts. Against this advantage was the disadvantage that the clocks had to be wound up every day, although, of course, this could be accomplished electrically if necessary. A new system was the Cunynghame—Hope Jones electro gravity detached escapement, in which a flipper on the pendulum catching in a small arm frees it and allows it to drop upon a finely jewelled roller fixed to the pendulum, and this gives the latter an impulse forward. The arm is only weighted with 1½ grammes, but the armature flies forward on to the arm in such a violent way that an excellent contact is secured. Mr. Cunynghame stated that he had had this arrangement under test, and had never known the electrical part to fail. Coming to electric synchronisation, the lecturer regarded as the most simple arrangement that adopted by the Standard Time Co., in which an electromagnetic plunger drops into a cam on the minute hand and thus corrects it if either slow or fast. Cornu's method was very similar. Another plan, invented by Rudd, involved the use of two pendulums, one for time measuring and the other the working pendulum. If the working pendulum is working inaccurately it is corrected each hour by the time pendulum. In conclusion, the lecturer had a few words to say upon the unsatisfactory nature of batteries, which, he said, was mainly due to the impurities in the zinc setting up local action, and the formation of zinc crystals on the carbon side. His own opinion was that the best form of battery would be a large size gravity Daniell. He advocated the use of large batteries with not too strong chemicals.

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DIRECT-CURRENT TURBO-GENERATORS

THE Paper read by Mr. W. Hoult before the Manchester Local Section of the Institution of Electrical Engineers, on Tuesday, February 18th, dealt chiefly with the commutation and other commutator difficulties in the design and construction of large direct-current turbo-generators. The author referred to the pioneer work of Messrs. Parsons, and then went on to point out that owing to the high peripheral speed of the armature and commutator, great difficulties have arisen in the mechanical and electrical design, requiring much experimental work and careful attention to each detail. Until the last few years the position of the brushes had to be adjusted for variations of load. Messrs. Parsons have an automatic brush control which is actuated by the initial pressure of steam in the turbine. This control gear is working very successfully on many sets, even on traction loads. It has, however, a tendency to lag, and other disadvantages, and is not now fitted, as special windings are used to obtain a fixed brush position with varying loads.

The methods mostly used may be put under three headings :—(1) By compensating windings; (2) by commutation poles; (3) by a combination of compensation windings and commutation poles. In the first method windings which are in series with the armature are placed in slots in the pole-shoes, so that at all loads their ampere-turns are equal but of opposite direction to the armature ampere-turns, thus balancing all armature reaction. Sparking due to distortion is thus prevented, but that due to the current reversal in the short-circuited coil is left, to overcome which either the brushes are given a lead or the machine is over-compensated. This method, which in principle was first suggested by Fischer-Hinnen, was patented in 1893 by Prof. H. J. Ryan, but was allowed to lapse for the reason that manufacturers, being able to build machines to give every satisfaction with natural commutation, would not take it up. A patent for a similar winding was taken out in 1903 by Messrs. Parsons and Stoney. In the second method auxiliary poles placed midway between the main shunt poles are used, through the winding of which the main current or a portion of the main current passes. The object is to give a magnetic field so as to produce in the coil undergoing short circuit by the brush an E.M.F. acting in opposition to its reactance voltage, and of such a value as first to reduce to zero the current present in the coil, and then, while still in opposition to its reactance voltage, to induce a current in the opposite direction, which as the coil leaves the position of short circuit shall have become equal in strength to the current

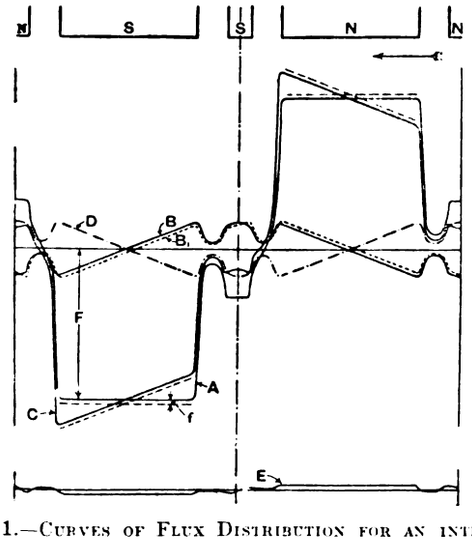


FIG. 1.—CURVES OF FLUX DISTRIBUTION FOR AN INTERPOLE MACHINE WITH COMPENSATING WINDINGS.

of which it then becomes a part. In the third method both compensating windings and commutation poles are used, the former preventing distortion of the main field, and the latter providing a reversing field to overcome the E.M.F. in the coil undergoing short circuit by the brush.

In Fig. 1 curves are drawn showing the flux distribution due to the various windings. Curve *A* shows the flux distribution of the main shunt field and the commutation field separately excited with normal full-load current. Curve *B* shows the flux distribution due to the current in the armature. Curve *C* shows the resultant flux distribution of curves *A* and *B*. Curve *D* shows the flux distribution due to the compensating winding, which for the purposes of making the diagram clearer has been assumed to exactly neutralise that due to armature reaction. Curve *B* being neutralised by curve *D*, the resultant field is that shown by curve *A*, except that the commutation pole flux is much smaller, as in this case ampere-turns are not required on the commutation pole for the armature ampere-turns.

Figs. 2, 3, and 4 are flux distribution curves of a 700-kw. 600-volt generator running at 1,500 revs. per minute, and fitted with commutation poles. The curves were taken by a Duddell

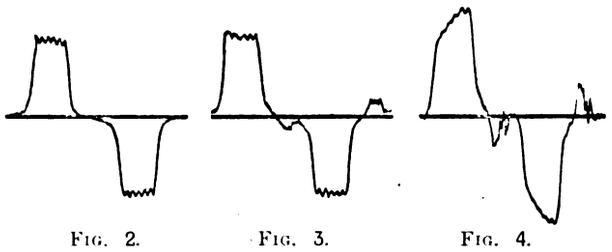


FIG. 2. FIG. 3. FIG. 4.

OSCILLOGRAPH CURVES OF FLUX DISTRIBUTION.

high frequency oscillograph, which was connected to an armature coil by brushes pressing on two of the steel binding rings on the commutator which in turn were connected to two adjacent commutator segments. Fig. 2 shows the shunt field excitation only. Fig. 3 shows the shunt field excitation with the commutation coils separately excited with 300 amperes. Fig. 4 shows the flux distribution with the machine at full load, the current through the commutation coils being 950 amperes. They show plainly the effect of the armature reaction on both the main field flux and the commutation flux. It will be noticed that the commutation flux does not distort the main field at no load.

Fig. 5 shows the field-magnet system of a Siemens 750-kw. 420 to 550-volt direct-current turbo-generator, the photo being taken during the connecting up of the compensating windings. Fig. 6 is a diagram showing the general scheme of connections for a generator with compensating windings and commutation poles. The main drawback of machines fitted with commutation poles alone is that the main field is distorted by the armature reaction, so that the maximum voltage per segment is considerably increased on approaching full load, thus giving a greater tendency for "flashing over" with dust on the commutator. Machines fitted with commutation poles alone can be built about 10 per cent. to 15 per cent. cheaper than those fitted with compensating windings, and for machines in which the maximum voltage per segment can be kept below about 30, and in some cases below 45, they are perfectly satisfactory. It is necessary that the iron of the commutation pole should be worked on the straight part of the magnetisation curve, and consequently at a very low density, in order that the reversing field may increase in the same proportion as the armature current. The correct reversing field can be obtained by adjusting the air-gap of the commutation pole or by means of a diverting resistance in parallel with the commutation pole windings. The former method is that now mostly in use, especially with machines fitted with compensating windings. The air-gap in this case should be designed so large that the correct commutation field can positively not be obtained. When the machine is on test the poles, or preferably the pole-shoes, can be slacked back and iron plates inserted until sparkless commutation and minimum heating of the commutator is obtained. It is quite possible to have perfect commutation and still have considerable heating due to currents in the short-circuited coil.

With large machines fitted with commutation poles only, the correct reversing field is often obtained by means of an adjustable diverter. If new brushes are put on the machine of a quality different from those with which the diverter was set,

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it is quite possible that to regain sparkless commutation the resistance will require to be altered, which can readily be done if the diverter is adjustable. If an ordinary non-inductive resistance is used as a diverter in parallel with commutation coils, the latter, owing to their being highly inductive, will take less than the normal amount of current on a sudden increase in the load, thus causing momentarily very bad conditions for commutation, which, if the variation is large as on a "short," would cause the machine to flash over on the commutator. To overcome this the diverter winding should

The prejudice created against carbon brushes has been caused to a large extent through their being used on commutators that were not suitable. It is essential for their successful operation that the brushes be kept cool, and consequently the commutator should be specially ventilated and be of a thoroughly sound mechanical construction. The author has made many experiments with carbon, metal, and graphite brushes, and although the latter type of brush is very satisfactory on slow-speed machines, he considers that they are as yet hardly mechanically strong enough for the high speeds of

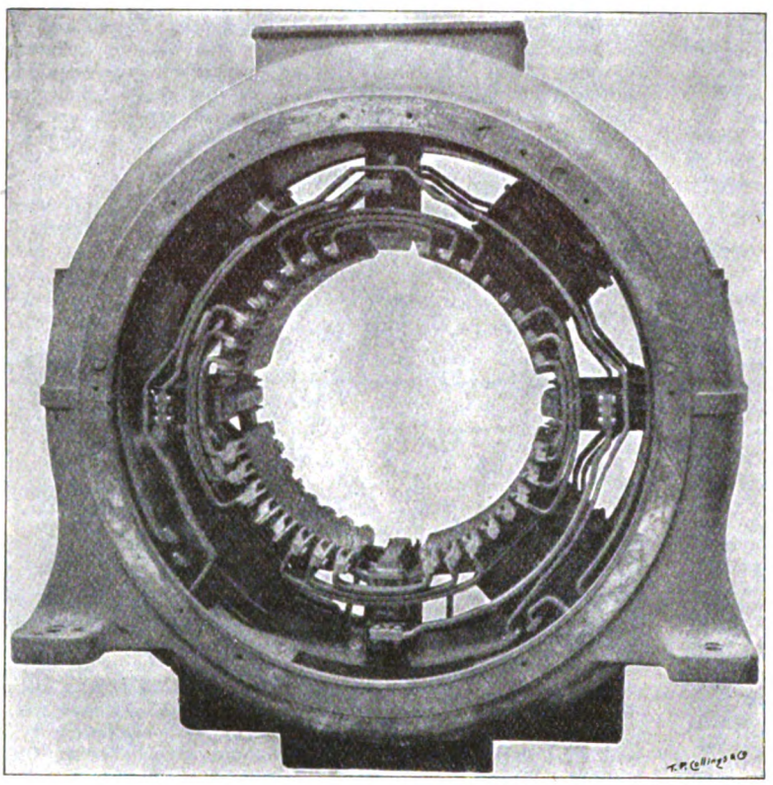


FIG. 5.—FIELD SYSTEM OF SIEMENS 750-KW. TURBO-GENERATOR.

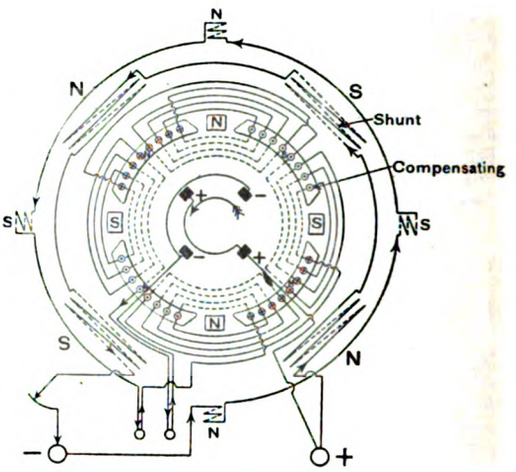


FIG. 6.—DIAGRAM OF CONNECTIONS FOR AN INTERPOLE MACHINE WITH COMPENSATING WINDINGS.

be placed round an iron core with an adjustable air-gap, the air-gap being altered to suit the number of turns through which the current is flowing so that the time constant of the diverter circuit equals that of the commutation system. The diverter can also be arranged so that a larger current than the normal will flow momentarily through the commutation coils so as to hurry up the magnetisation of the commutation poles.

If, instead of having the brushes in the neutral position, they are moved backward, a compounding effect is produced. In Fig. 1 curve B_1 shows the flux distribution due to the current in the armature when the brush is moved backward from its neutral position, so that the armature current has now a compounding effect, the amount (f) being the difference between the ordinates of curves B and B_1, which is shown in curve E. The field under the main pole is then increased from F to $F+f$. The smaller the air-gap the greater will be the compounding effect obtained. In the same way, by assuming the brush position to be moved forward, it can be seen that an under-compounding effect is produced. If the generator is to work on a circuit by itself a compounding effect is an advantage, but if, as is most usual, it has to work in parallel with other machines, it would take the peaks on a fluctuating load. Difficulties have also been experienced with compensated machines working in parallel on traction loads, and Messrs. Parsons brought out a patent in 1900 "to improve the stability" by bringing the equalising connection to tappings on the compensated winding instead of the junction of the compensating winding and the compound winding.

Up to about the last two years all direct-current turbo-generators have been fitted with either metal or a combination of metal and carbon brushes. It has, in fact, often been stated that it was a practical impossibility for high-speed generators to run with carbon brushes alone, but it is now becoming generally recognised that they will supersede the metal brushes in the same way as they have done on slow-speed machines.

turbo-generators. This type of brush is usually made by compressing the graphite in moulds, thus forming a series of layers which easily break away at the leaving edge. In the author's opinion, the only graphite brush of that type capable of being used on a high-speed machine is one in which the layers are in the direction of the running of the commutator, and consequently having the cross resistance in an axial direction instead of tangential. The brushes then do not break away so easily, the commutating qualities are about as good, and advantage of the low friction coefficient is still obtained. Other graphite brushes that were tried, although of a soft nature, ground fine particles of copper from off the commutator that were quite perceptible to the eye.

Endrueit brushes with carbon brushes slightly in advance of them are used to a considerable extent on turbo-generators. These brushes are made by wrapping layers of copper foil and paper together, the whole being then baked so as to form the paper into carbon.

The Boudreaux brush, which is made of a special metal, has very good commutating qualities, but even with a very light pressure it tends to cut the commutator.

Parsons use a brush made of brass wire which usually works on a corrugated commutator. The corrugations increase the area for radiation and decrease the current density at the surface of the brush. Some of their machines are fitted with all the positive brushes in one cell and all the negative in the other.

The author then described the Siemens type of commutator (see ELECTRICAL ENGINEERING, Vol. II., page 882) for large high-speed machines fitted with carbon brushes, and which is constructed as follows:—The commutator bars are provided with tunnels along their entire length, through which the air is drawn axially from each end by the action of a radial fan placed between the two commutator units. The blades of this fan also form the electrical connection between the two com-

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mutators. The inner unit is cooled by air which passes through channels in the spider close to the shaft. The sides of the shrink rings are protected by specially treated wood plates, which are held in position by a wedge-shaped metal ring, thus ensuring that no connection can be made from the commutator to the shrink rings by dust on the commutator or by flashes from the brushes.

Fig. 7 is a photograph of an armature of a Westinghouse machine having an output of 250 kw. at 3,000 revs. per minute at a pressure of 500 volts. The armature is provided with a radial type commutator, on which it is claimed that carbon brushes can be used at a speed of 3,000 revs. per minute without trouble from chattering, that there are no exposed shrink rings to increase liability to flash over, and that the commutator is kept very cool owing to the large radiating surface. (See also Electrical Engineering, Vol. II., p. 883).

The great advantage of carbon brushes is that when once adjusted they require no attention when the machine is running, and very seldom require attention when the machine is stopped. They also are not sensitive as regards commutation, so that if the commutation poles of the machine are not on the straight part of the saturation curve on overloads, sparkless commutation can still be obtained. It would appear that owing to the much lower current density at which carbon brushes can be worked, that the commutator would require to be proportionately longer, but as the arc of contact can be much greater, owing to the higher surface contact resistance and cross resistance of the brush, the commutator does not of necessity become excessively long.

The drawback to metal brushes and combinations of metal and carbon brushes is, that although perfect commutation can be obtained, they require attention when on load. They may even run for three days without much attention, but although no sparking can be seen by the attendant, considerable sparking takes place under the brush owing to the arc which was originally covered being increased, and this sparking often damages the surface of the commutator. Also owing to their low resistance large currents circulate through the short-circuited coil, especially if the brushes, owing to their adjustments, are not in their correct position. These currents work either with or against the main field and the commutation field, giving a magnetising or demagnetising effect so that if the brushes chatter at all, parallel working with other machines can become very difficult unless the generator has a separate excitation.

Messrs. Brown Boveri, in their turbo-dynamos, have departed from the ordinary construction of magnet frames, the field system of their machines being built up of a number of soft iron core plates in the slots of which the windings are fitted. This gives a continuous inner cylindrical surface, which has the advantage of decreasing windage resistance and allowing silent running.

A striking feature of their machines is that they are fitted, except when a steady source of supply is available, with a direct-coupled exciter, for the purpose of preventing the machine reversing its polarity. On sudden overloads, owing to the turbine dropping in speed, the voltage of the exciter is lessened proportionately, and consequently the generator has not such a tendency to take up all the load if running in parallel with other machines. A separate exciter is of considerable advantage with this type of machine as their fields have not the same tendency to "build" as those with solid field magnets.

As regards the construction of direct-current turbo-generators. Special care must be taken to have all the materials homogeneous and the windings and insulation kept perfectly rigid so that there may be no possibility of their moving either from centrifugal force or variations of temperature. Shafts are usually made of mild steel and run in white metal bearings, which have a spherical seating so that they can follow any whipping of the shaft. Most firms now use former wound armature coils fixed in open slots and held in position by strong fibre wedges, driven into grooves in the armature teeth, so that the pressure is evenly distributed over the entire length, the end windings being held by manganese bronze shrouds. All parts of the armature must be accurately balanced piece by piece as manufactured, and when assembled must be balanced both statically and dynamically as perfectly as possible. Usually arrangements are made so that balance weights can be added at each end of the commutator and at the turbine end of the armature. To obtain the static balance the armature is laid on two well-levelled steel rails with hardened surfaces. When the armature is lying across the rails there are several forces acting. First of all there may be an out-of-balance weight at a certain radius producing a certain torque. The friction between the shaft and the rails causes a torque in opposition to this. The deformation of the shaft causes another torque which is also in opposition. Both the friction torque and the deformation torque can be regarded as constant. The armature will not revolve so long as the torque due to the weight is equal or less than the sum of the friction and deformation torques, so that there is a limit of the angle within which the armature never starts moving of its own accord, even when having an out-of-balance weight. The armature is then revolved until it just reverses of itself. This gives the limit on one side. This position is then marked by a line through the centre which marks the limit. The armature is then revolved in the other direction, and the other limit determined in the same way. By dividing into halves the angle between these two, the position of the out-of-balance weight is found so that the weights to balance this are placed diametrically opposite. The armature is then put so that the line dividing this angle is horizontal. To obtain the weight a thin string attached at the top by a wooden plug is hung over and weights are added until the armature starts to revolve clockwise. The weight is then determined, at which the armature just starts revolving counter-clockwise. The mean of these two weights is then the amount required to balance the armature.

After having been balanced statically, the armature still requires to be balanced dynamically, for if the out-of-balance weight and the balance weights which were put in are not in the same plane perpendicular to the axis, they will act as a couple of forces. This couple must be overcome without altering the static balance, which is done by taking off some of the balance weights, and putting them on the corresponding place at the other end of the armature. If on running the armature up to speed a good balance cannot be obtained by this method, it shows that there is another couple acting in another axial plane. To get rid of this couple equal weights should be put in a diametrically opposite position at the two ends. The two weights are then moved round, always keeping them in opposite

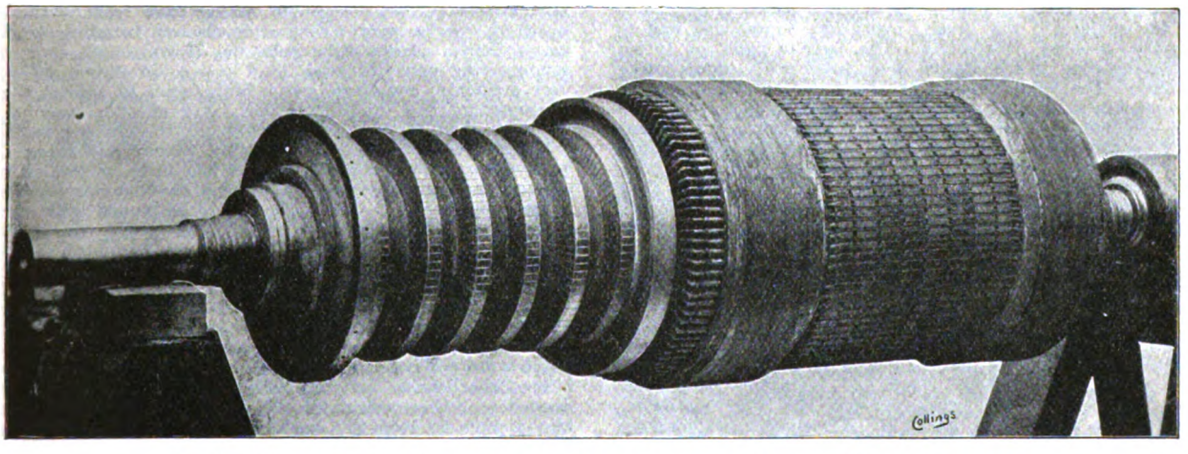


Fig. 7.—Westinghouse Armature and Commutator with Radial Working Surfaces.

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positions to each other until the place is found where the balancing is best. Then the weights are altered until the vibration disappears. Although the armature may be balanced so that there is no vibration near the machine, it sometimes happens that vibrations appear in another part of the building some distance away. This trouble, however, usually only appears on running up the machine when it may have to pass through its critical speed.

DISCUSSION.

Mr. G. J. STONEY (Messrs. C. A. Parsons & Co.) said that commutation poles had not always proved satisfactory in practice, and that the combination of compensating winding and commutation poles seemed much more satisfactory. It still had its defects, however, and he believed the real solution was to have compensating windings only, and to put on sufficient compensating winding to give a commutation field. In 1885, he said, his firm had tried the compensating winding, but it did not work, because they had only the same number of ampere turns on the compensating field as on the armature. A few years ago they had returned to the same subject, and increased the number to between 2 and 2¼ times the ampere turns on the armature, and immediately got exceedingly good results. The great advantage of having compensating winding only without interpoles is that the lagging of these interpoles with sudden changes of load is avoided. Also, it is not necessary to actually make the compensating winding of any certain amount, so that diverters are not necessary. With compensating winding only, there is a very smooth field in the air-gap, and as a result it is possible to shift the brushes considerably. They had found that metallic brushes were perfectly satisfactory, and there was no trouble whatsoever due to sparking under the brush, and there is no movement of the brushes from no-load to 25 per cent. overload. Carbon brushes require careful treatment, and the number of brushes was much larger than is necessary with brass wire. A great deal has been said about surface-wound armatures as against slotted. They had experimented on the latter, and found that they did not give nearly as good commutation as surface-wound. He did not think the surface-wound were any more likely to break down. Another point about having compensating winding only without commutating poles was that there was no trouble in parallel running. Mr. Stoney then referred to his firm's preference for two-pole as against four-pole designs, and said in conclusion that in his opinion, one advantage of the adoption of compensating winding and surface-wound armatures was that dynamos could be built for much higher speeds than with the ordinary slotted armatures and a mixture of compensating and commutation poles.

Mr. S. L. PEARCE (Chief Electrical Engineer, Manchester Corporation), referred to experiences as to the addition of compensating windings to the old machines installed some six years ago in Dickinson Street, which greatly diminished the brush movement required. They found, however, that the brushes wore away at pretty much the same rate as they did before, a considerable amount of wear and tear going on underneath the surface of the brush; every 336 hours they had to renew the brushes completely. The second type of turbo-machines installed in his station were fitted with commutating poles only. The chief trouble has been due to flashing over. These machines, unlike the Parsons corrugated type, had smooth commutators fitted with carbon brushes. To prevent flashing to earth they had the inside faces of the shrink rings lined with wood. As to the type of brushes, they had tried nearly every brush that was procurable. At the present time they found a successful combination in three "Endruit" brushes, and one hard carbon brush. They had tried the use of external blowers, and these were certainly able to effect a very considerable reduction in the temperature of the commutator bars. His chief criticism was with regard to the mechanical construction of the machine.

Mr. V. A. H. M'COWEN (Chief Electrical Engineer, Salford Corporation) spoke of having ordered Brown Boveri machines for Belfast, and later he has had a 1,000-kw. Brown Boveri machine running in Salford. They had been free from commutator troubles, but the brush expense was very excessive, working out to about ·005d. per unit. These machines were arranged with separate exciters, and as far as parallel running is concerned they had had no trouble at all.

Mr. J. S. PECK (British Westinghouse Co.) thought that, as had been the case with moderate speed machinery, the slotted armature and carbon brush would come to stay. Regarding the ventilation of the commutator, the ventilating duct through the commutating core must certainly reduce the wearing depth very much.

Dr. E. ROSENBERG (British Westinghouse Co.) agreed with Mr. Hoult that carbon brushes were possible, and worked well if the commutator were ventilated. With carbon brushes, good mechanical construction is more important than the composition of the brushes with layers that give a high resistance in the direction of movement of the commutator, although the latter will be preferable from a scientific point of view. With regard to balancing, the operation was very much shortened if arrangements were made to have resonance at a low speed by supporting the bearings by means of springs.

Mr. W. PARKER (Messrs. Siemens Brothers Dynamo Works) outlined some of the considerations which had led to the supercession of the metal brush in ordinary machines, and pointed out how history was repeating itself. An impression got abroad at one time that carbon brushes could not be got to run on commutators at high peripheral speeds without excessive vibration. This, at all events, was the reason why the first turbos designed by the firm which he represented were designed to run with metal brushes. They had now, however, several machines running successfully with carbon brushes. When the question of constructing D.C. turbos with carbon brushes was seriously taken in hand, it was found that the vibration difficulties could be overcome with a suitable brush-holder, and that the real difficulty was the excessive heating of the commutator. In order to overcome this it is absolutely necessary to cool the commutator artificially. With the method of cooling the commutator described in the paper it is possible to keep the temperature rise on the commutator down to about 40° F., with a density in the brushes of about 45 amps. per sq. in. Mr. Hoult in his paper gave the impression that the commutator would be considerably longer with carbon brushes. This, however, is not the case, as the following comparison shows:—With metal brushes the density is kept down to about 130 amps. per sq. in., and the arc of contact to about one-third in., hence the current collected per in. axially of commutator is 43 amps., about. Now with carbon brushes it is possible to increase the arc of contact to 1 in. or more, and the current collected per in. axially is therefore 45, hence the commutator, when fitted with carbon brushes and artificial cooling, is no longer than when fitted with metal brushes.

Mr. G. D. SEATON (Messrs. Willans & Robinson) made a few remarks on the difficulties of mechanical design, and said that, with reference to Mr. M'Cowen's figure of 0·005d. per unit for brush renewals, he understood that in Mr. Pearce's case this amount was about doubled.

Mr. J. D. BAILIE said that failures of binding were almost unknown. Regarding the use of metal brushes, it was quite a common thing with the Parsons commutator for the temperature rise, after long tests of say six to twelve hours' duration, to not exceed 50 to 60 degrees Fahr., frequently 40° F. only, and he did not think that in a well-designed machine the heating of the commutator was in itself quite such a difficulty as was inferred. The heating of the commutator was, in his opinion, caused by the use of the carbon brushes.

Mr. MILES WALKER (British Westinghouse Co.) made a few remarks from the chair. There was one point he would like to bring out, and that was that manufacturers in the future in this matter would not be controlled so much by what they themselves think as by what the users think. However much they might be convinced that a smooth core armature will stand, he was rather afraid they would never be able to convince the user. The same applied to the metal brush. Another point that had not been touched upon was the question of volts per segment. The user in the future would find by experience that machines of high voltage per segment in the commutator were not so satisfactory under difficult conditions of load. Mr. Stoney was perfectly right in saying that from a theoretical point of view a very strong compensating winding was much better than a commutating pole, but if you could show that a commutating pole did work, and you could put it off and on very suddenly, and there was a high factor of safety, then the commutating pole machine would be a cheaper machine than the other, and the user again would buy the cheaper machine.

Mr. HOULT, in reply, said that Mr. Stoney had inferred that with commutation poles the brushes had to be set almost microscopically. He had always found that there was a considerable range through which the brushes could be moved with sparkless commutation, the only difference being that with the brushes in advance of the neutral position, the shunt regulator switch had to be moved further for the same increase of load, owing to the demagnetisation of the main field. Mr. M'Cowen referred to the amount of attention required with the metal brushes in his station and their excessive cost in renewals. The speaker had had machines to run absolutely sparkless with them, but as a brush wore down it, of course, needed to be fed forward, which altered the bearing surface, so that the back of it only was in contact with the commutator. It usually then took the attendant all his time to keep the machine satisfactory. As regards Mr. Peck's reference to the Siemens ventilated commutator, the amount that can be safely turned down is about ⅛ in. so that it will be very many years before a new commutator would be required.

Wireless Communication with Lightships.—A letter has been received by the Margate Corporation from the Board of Trade in reference to the resolution recently passed favouring a system of wireless telegraphy between the Longsand lightship and the shore. The letter from the Board of Trade pointed out that already the establishment of wireless telegraphy had been sanctioned between six lightships and the shore as an experiment, and they were not prepared at present to extend it to the Longsand lightship, as from the short time it had been in operation the Board had been unable to form an opinion as to the success or otherwise of the experiment.

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TESTS OF A LIVE STEAM FEED-WATER HEATER

A DESCRIPTION of a series of tests undertaken by Prof. Goodman and Mr. D. R. Maclachlan, of Leeds, with the object of determining the gain in boiler efficiency obtainable by the use of live steam feed-water heaters, is contained in a Paper read by these authors at last Friday's meeting of the Institution of Mechanical Engineers. The tests were made upon a boiler of the "dry back" type manufactured by Messrs. Davey, Paxman & Co., of Chelmsford, 8 ft. in diameter, 14 ft. in length, with 60 tubes, each 3 in. in diameter. In the installation in question the feed-water is supplied by means of a force-pump driven from the cross-head of the main engine; on its way to the boiler it passes through a filter for removing oil, and thence (when in use) through a live steam feed-water heater. The feed-water enters at the top of the heater, and is sprayed into a chamber supplied with live steam from the boiler. The water, falling in a spray through the live steam, attains a temperature nearly equal to that of the live steam, and, collecting at the bottom of the heater, flows by gravity through a non-return valve into the boiler. Cocks are fitted to the heater for the discharge of air which collects in the heater. A small quantity of steam escapes with the discharge of the air, but this quantity was not measured, being practically negligible. The boiler is fitted with an induced-draught fan of the ordinary type, placed at the base of the chimney.

The water was measured in two standard tanks, each holding 1,250 lb., fitted with floats and accurately engraved brass scales. The level in the boiler gauge-glass was taken with the other observations, and care was taken to see that it was the same at the beginning and end of each trial. There was a slight leakage from the blow-off cock, which was allowed for. The drippings from the feed-pump gland were caught and returned to the feed-tank.

In order to ensure the greatest possible accuracy in the coal-measurements and to be absolutely certain that the coal was of the same quality on both days, the whole of the coal required for both tests was previously weighed up in 1-cwt. bags, and a numbered brass tag was tied to each. On the day of the first test, bags bearing "even" numbers were taken for the first six hours, and those bearing "odd" numbers for the second six hours; the remaining bags were used up on the second day. In order to eliminate errors due in estimating the quantity of fuel on the grate at the beginning and end of the trial, in the one the fire and ashes were cleaned out one hour before the test commenced, and the weight of fuel required during that hour was measured and the times of firing noted on the log sheet. The same fire was similarly treated one hour before the end of the trial. The second fire was treated in an exactly similar manner, but half-an-hour before the beginning and end of the test. The working of the fires before the trial, as regards quantity of fuel fired and the times of firing, being exactly the same as that before the end of the trial ensured that the fires were as nearly as possible the same at the end and at the beginning of the trials, both with regard to thickness and composition. The same stoker was employed throughout both trials, and samples of the coal taken periodically were tested.

The results of the two tests show that the boiler evaporated almost exactly the same quantity of water per pound of coal both when the heater was in use and when not in use, the results being even slightly better when the boiler was working without the heater; the actual increase in efficiency was 0·6 per cent. It would be useless to pretend to this degree of accuracy in any boiler trial, and the difference might easily be accounted for by errors of observation, notwithstanding the great care taken to eliminate all errors, but at the same time the authors would point out that with the heater in use the actual heat radiation surface was increased by that of the heater, and if this be taken into account the two tests agree even more closely. They are therefore forced to the conclusion that the heater has no material effect on the economy of the boiler, but from all appearances the deposit in the boiler is materially less when the heater is in use than when the feed-water passes direct to the boiler. The authors have assumed that the steam was dry and saturated throughout the tests, and from the fact that the boiler was not forced and the steam was taken off quite steadily and at practically the same rate on both days, they do not see any reason for believing that it was other than dry, but whether so or not, it was the same on both occasions, and therefore the results are strictly comparable.

CATALOGUES AND PAMPHLETS RECEIVED

FACTORY LIGHTING.—A neat little booklet from the Union Electric Co. points out the economic advantages of good lighting in factories, and putting forward the claim of the various types of "Union" arc lamps for this class of work.

TESTING LABORATORY.—We have received from the Westminster Electrical Testing Laboratory a booklet giving the scale of fees for all conditions of testing work. Lamps, instruments, transformers, and small machines can be tested at the laboratory. Special fees are quoted for outside work, and a list of instruments kept for hire is appended.

ARC LAMPS.—A new leaflet from the Union Electric Co. is devoted to alternating-current arc lamps. The types dealt with comprise a differentially-wound enclosed lamp for 45 burning hours, in sizes from 8 to 12 amperes, and the "Kohinoor" series-wound semi-enclosed lamp for 4 to 6 amperes, giving 20 burning hours. Each type is listed with several patterns of cover, and a full series of accessories is included.

GAS AND WATER-TIGHT TREMBLING BELL.—We have received from the Sterling Telephone & Electric Co. a description and a full-size drawing of their trembling bell for use on mines, railways, and ships. The entire mechanism, exclusive of hammer and gong, is in a hermetically-sealed chamber, the motion being transmitted to the hammer by means of a german-silver diaphragm. A pamphlet, issued by the same company, describes water-tight telephones for use under similar conditions.

INSULATING MATERIALS.—A new list issued by Messrs. A. Cort & Co., of Camberwell, contains full particulars of their various qualities of vulcanised fibre for electrical and other engineering purposes. The uses of fibre and its advantages over rubber and leather for many purposes are pointed out. Particulars of the ebonite, gutta-percha, and vulcanite sheets, rods, &c., manufactured by the company, and a list of their balata, gutta-percha, and cotton driving belts are included.

STORAGE BATTERIES.—An illustrated pamphlet issued by the Chloride Electrical Storage Co., of Manchester, describes the battery-booster plant installed at the North Wall Electricity Works of the Dublin Port and Docks Board. The load on the station will ultimately include a number of crane and capstan motors, and will consequently be very variable. The battery consists of 240 "chloride" cells, with a capacity of 840 ampere-hours at the 9-hour rate, and is in series with a Highfield reversible booster.

INSTALLATION RULES.—The Royal Insurance Company have issued a booklet in which are reprinted the wiring rules of the Institution of Electrical Engineers. The importance of contractors making themselves acquainted with these rules is emphasised in an introduction where the principal ways in which fires are liable to be produced in imperfect electrical installations are summarised. Extracts are also given from the 1905 Board of Trade medium pressure regulations, and the Home Office special rules for mines.

Wireless Telegraphy.—Mr. G. Marconi delivered a lecture on wireless telegraphy before the Liverpool Chamber of Commerce on Monday. He stated that 90,000 words of "commercial" messages had been transmitted between the Company's stations in Canada and Ireland, and that it was now possible to transmit at the rate of 100 words per minute, but a speed of 20 words per minute was that regularly maintained. A 2,000-word wireless telegram from New York had been printed in that day's *Times*.

Flour Bleaching Processes.—On Saturday Mr. Justice Parker delivered judgment in an action taken by the Flour Oxidisation Co., against Messrs. Carr & Co., for infringement of patent in respect of processes for improving the quality of recently ground flour, and for the revocation of Andrews' patent No. 1661 of 1901. The infringement alleged is the use by the defendants of the Alsop process as described in Alsop's patent No. 14006 of 1903, and it was further alleged that the system adopted by Andrews was anticipated by two previous patents taken out, one in 1897, and the other in 1898. After carefully weighing the evidence, Mr. Justice Parker stated that he had come to the conclusion that the only point for him to take into consideration was want of novelty in Andrews' patent. Carefully considering the alleged anticipation, he had come to the conclusion that these did not specify the use of ozone, but nitrogen oxides, although the patent hinted at the possibility of ozone being used in this connection; in other words, Andrews had put into effect what had been previously suggested, but not acted upon. He failed to see that this could be claimed as an anticipation, and had come to the conclusion that neither of the patents relied upon could be regarded as prior publication of Andrews' invention. He therefore found for the defendants, and granted a stay for a month to give the plaintiffs an opportunity of appealing. It may be pointed out that the action for the revocation of patent No. 14006 of 1903, granted to J. C. Alsop, and which has been declared invalid by the Courts (ELECTRICAL ENGINEERING, Vol. II., pp. 206 and 782), will shortly come before the House of Lords, when, if the appeal is successful, the judgment above given will not hold good.

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DISCUSSION ON DYNAMO DESIGN AT BIRMINGHAM

THE Paper by Messrs. F. T. Wall and S. P. Smith on the eddy-current losses in the pole-shoes of dynamo-electric machines, which was read and discussed at Newcastle on February 3rd (see ELECTRICAL ENGINEERING, February 13th, p. 241), was re-read and discussed at Birmingham on February 12th. Mr. Wall's Paper on the reluctance of the air-gap (see ELECTRICAL ENGINEERING, Vol. II., p. 965) was also read and discussed. In the former Paper the authors described an experimental method of measuring the eddy-current losses in pole-shoes, and curves showing how these losses depended on speed, flux-density, and the relation of the air-gap to the slot opening. In the latter paper Mr. Wall described some experiments made to determine the flux distribution with toothed armatures.

Dr. W. E. SUMPNER (Municipal Technical School, Birmingham), in opening the discussion to the first Paper, said that the curves of experimental results would be found valuable, but the empirical formula given was far too complicated for ordinary use, and had no theoretical justification.

Mr. J. D. COALES (Birmingham) thought that the method of varying the air-gap, adopted by the authors, would not keep the reluctance of the circuit quite constant owing to the changes produced in the distribution of the lines in the neighbourhood of the teeth.

Prof. G. KAPP (Birmingham University) asked why the authors considered it necessary to use for electric heating, coils which had very little self-induction. Did the authors use alternating current for heating?

Mr. T. F. WALL (in reply) agreed with Dr. Sumpner that the use of such a formula as that deduced from the experiments is not desirable for practical purposes. The object in putting the results in that form was to compare them with the values as deduced from theoretical considerations. With reference to Prof. Kapp's remarks as to the winding of the auxiliary heating coils, these were wound two in one slot, so that they could be connected up non-inductively, the object being to get rid as far as possible of the flux due to the currents in the coils, which were heated by direct current. Another method by which these losses could be measured was by "running down" curves. All that is necessary is in the first place to have a machine in which the air-gap under one pole could be varied. Then by choosing a gap so large that there would be no appreciable loss due to flux pulsations a "running down" curve would be taken and the power dissipated by all the losses in the machine deduced in the usual way from this curve. The air-gap under the experimental pole would then be reduced to a value which would allow of eddy current losses in the pole-shoe, and, keeping the flux density constant, another "running down" curve would be taken. The power deduced from this latter curve would then give all the losses occurring in the first case, plus the losses due to eddy currents in the pole-shoes, and by simply subtracting the results the losses could be at once deduced.

The CHAIRMAN (Prof. Kapp) then called for a discussion on Mr. Wall's Paper on "The Reluctance of the Air-Gap in Dynamo Machines."

Mr. H. B. MATTHEWS (Birmingham) described some experiments which he had made on a machine with semi-enclosed slots. The flux distribution curves which he had obtained were sinusoidal.

MR. J. D. COALES (Birmingham) pointed out that the flux densities in the teeth used by the author were rather low, and asked if this was because the research was undertaken mainly with reference to induction motors. A comparison of Figs. 9 and 13 (ELECTRICAL ENGINEERING, Vol. II., p. 966), for which the air-gap lengths were equal, showed that the general distribution of flux was the same in each case, although the flux density of Fig. 13 was twice that of Fig. 9. This would seem to show that the variation of the permeability of the teeth with flux density had not yet begun to make itself felt.

Dr. W. E. SUMPNER said that he would like to know the exact meaning of the curves in Figs. 9 and 13. He presumed that the ordinates represented the density of the lines of force on the surface of the iron. Mr. Wall's curves did not give the density in the actual air-gap, where the irregularities due to the slots, although appreciable, would be much less than those indicated in the curves. Moreover, these curves did not indicate the wave form of the electromotive force induced in the conductors, especially if these conductors were imbedded in slots. The induced electromotive force was the product of the flux density at the conductor into the speed at which the lines crossed the conductor. It must be remembered that for conductors in slots, while the flux density may be low, the relative speed of the flux and conductor is much greater than the relative speed of conductor and pole. Hence the static distribution of the flux afforded little indication of the wave form of the electromotive force.

Mr. T. F. WALL (in reply) said that the curves given by Mr. Matthews afforded a useful comparison of results, although, of course, since mean values are dealt with in this case, the peaks shown in Figs. 7, 9, 11, and 13 could not be determined. In reply to Mr. Coales, he thought that if the flux density were increased to such an extent that the permeability would be appreciably affected, the peaks shown in Figs. 7, 9, &c., would be correspondingly smoothed out. As Dr. Sumpner remarked, the curves of Figs. 9, 13, &c., show the flux density at the surface of the iron and not in the actual air-gap.

NATIONAL TELEPHONE CO.

THE ordinary general meeting was held on Thursday, Mr. G. Franklin, president, presiding, when the report and accounts given in our issue for February 13th were adopted. The chairman said he thought the result of the working for the year ended December 31st, 1907, would be perfectly satisfactory to the shareholders. The income had increased by £145,346 during the December half-year over the corresponding period of 1906; Post Office royalties had increased by £14,121, and the working expenses had increased by £69,840. Dealing with various items of the working expenditure, he made reference to the increase of £9,637 in rent, rates and taxes, and insurance, which, he said, was largely due to the liabilities imposed upon the company under the Workmen's Compensation Act. For the complete year 1907, there had been an increase of £265,223 in the income, working expenses had increased by £127,863, and Post Office royalties had increased by £26,071. The net result was an increase of £111,299. Working expenses were 63·59 per cent. of the income, compared with 62·60 per cent. He thought the large increase in revenue was entirely due to the large capital expenditure of recent years, and he gave the following figures of capital expenditure during the past three years: 1905, £975,119; 1906, £1,129,671; 1907, £1,129,511. The capital cost per station was now £30 5s. 11d., compared with £30 9s. 1d. twelve months ago. The total capital expenditure to date, including land and buildings, was £14,198,072, against share and debenture capital subscribed of £11,113,174, leaving £3,084,898 provided from revenue sources. It had been asked where was this reserve, and how was it represented, and his reply was that it was invested in the business, and to the extent of over £650,000 in freehold and leasehold properties. The number of stations had increased during the year by 39,372, which was ample evidence of the vitality of the company's business. Most of these stations were upon the measured rate, which was coming into universal use as a consequence of the evils which experience had shown to result from the unlimited service rate. In the course of his reply to the deputation which recently waited upon him in this connection, the Postmaster-General said:—"I have had a certain number of cases taken out—a considerable number—and it appears that on the average five years ago, when they first began their flat rate, they were using 3,000 calls in the course of the year. In five years these same subscribers on the average have increased their calls from 3,000 to 11,000. In no single case have they taken a second line; they are using the same line. They are paying no more now for their 11,000 calls than they were five years ago when they were paying on the average of their 3,000 calls." The company had many cases of flat-rate lines used to excess, and to such an extent was this so that 24 per cent. of the total calls had become ineffective owing to the lines being engaged. Some subscribers thought nothing of sending 250 or 300 calls per day along a line, with the result that nobody else could get into communication with them, a state of affairs which was bad both for the subscriber and for other subscribers. It was generally imagined that the cost of a telephone in capital and maintenance was the same, whether the calls were few or many, but the direct contrary was the fact. Moreover, it was peculiar to the telephone business that the larger the number of subscribers, the greater the capital cost per subscriber. For instance, if they had an exchange with 1,000 subscribers, the capital outlay on switchboards and junctions would be £4 per subscriber, but if there were 10,000 subscribers, the capital cost would be £13 per subscriber. For these reasons the directors had felt bound to co-operate with the Postmaster-General to bring into force throughout the provinces a measured service rate system which, he thought, would be justified both

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to the shareholders and to the subscribers. This system had been adopted, as the result of careful study, in the United States, Austria, Germany, and other European countries, and also in Australia. To attempt the retention of the flat rate was to fly in the face of experience. The critics of the company and its policy were pleased to picture the company as a very prosperous concern, and they were described as an undertaking with watered capital, inferior plant, &c. The fact was that the interest and dividends paid upon the capital had never reached 4¾ per cent. per annum. He wondered how many of those members of Chambers of Commerce who waited upon the Postmaster-General recently were, in their own business, satisfied with such a modest return on their capital as 4¾ per cent. Even taking into account the large reserve, the profits had never exceeded 6¾ per cent., whilst the dividends upon the deferred stock had never exceeded 6 per cent. per annum, a by no means too large return upon a business which, though licensed, was not protected, and which was generally full of difficulties and technicalities. As indicating the growth of the business, he stated that the number of the staff had increased during the year from 6,310 to 7,911, and the number of shareholders from 11,647 to 12,648. The average holding of the shareholders was £593. In reply to questions by shareholders, the chairman stated that the capital cost of the Post Office stations was apparently about £50 per station, but as this referred to London only, it must not be compared with the figure of £30 which he had mentioned. The cost of the Post Office system in London had been increased on account of it being entirely underground. The capital expenditure in Germany was equivalent to about £27 to £28 per station. With regard to new capital, there was a balance in hand of about £560,000. The Board had been legally advised that it would not be possible to attempt at the present moment to settle the legal rights of the various class of shareholders and debenture holders because in 1910 or 1911 the circumstances might be different. At the same time, the directors recognised the difficulties and steps were to be taken to settle the matter at the cost of the company.

ELECTROCHEMISTRY AND ELECTROMETALLURGY

A. SCHLEICHER and G. Schultz describe experiments which they have made upon the rusting of iron, in order to ascertain whether it is a chemical or an electrochemical process (*Stahl und Eisen*, 1908, **28**, 50). The experiments mainly consisted in potential measurements, which they obtained by immersing rusty and clean wrought-iron and cast-iron plates in water and connecting them together. The authors find that if the potential is zero, or if it remains at a constant value, then both the plates employed are affected in the same manner—in other words, they are oxidised to the same extent. A change in the E.M.F. takes place when one plate is more attacked than the other. The greatest E.M.F. which was obtained between two plates of wrought-iron was 0·36 volt, the current measurement being about 0·00018 ampere. When a rusty plate was connected with a clean one, it was found that the clean iron plate acted as cathode, iron being dissolved from the anode plate, and the E.M.F. falling rapidly. Taking a clean wrought-iron plate and connecting it with a clean cast-iron plate, it was found that the cast-iron plate functioned as cathode. The initial E.M.F. fell nearly to zero, but after a time rose again and finally remained constant; in this case both plates became oxidised. Experiments made with wrought-iron turnings and also with cast-iron turnings showed that the metal rusted more rapidly in water containing carbon dioxide than in water from which most of the carbon dioxide had been expelled.

Two Papers were read before the Faraday Society on Tuesday, both being of a highly physical and mathematical nature. The first was by Dr. Veley upon "Hydrolysis as Illustrated by Heats of Neutralisation." The author tried to correlate, so far as data permitted, hydrolysis values with those of heats of neutralisation, as formulæ proposed to calculate out the latter from determinations of the former have raised interesting and important issues. Unfortunately, important lacunæ occur, either the heats of neutralisation have not been determined, or the dilution and initial temperature have been omitted in many hydrolysis values available, or the former have been determined but not the latter. The author hopes that these lacunæ may be filled in by attention being directed to these omissions. In the experimental part of the Paper numbers are given for hydrochlorides of bases not containing carbon, such as ammonia and hydroxylamine. As bases containing carbon, the chloroanilines, phenylhydrazine, and piperidine have been studied.

The other Paper was by Dr. T. Knox, "A Study of the Sulphur Anion and of Complex Sulphur Anions," the substances studied being the red and black modifications of mercuric sulphide. The conclusions arrived at are that the black modification is the less stable owing to its greater solubility in sodium sulphide solution. This is only what one would expect, since when the black sulphide is left in contact with an alkali-sulphide, it spontaneously passes over into the red modification. The influence of temperature upon the solubility was found to be very small. The solubility of the mercuric sulphide in sodium sulphide has been found to depend on the formation of the complex anion HgS_2''. The constant for the formation of the complex from the ions $Hg^{\cdot\cdot}$ and S'' is :—

$$k_2 = \frac{[HgS_2'']}{[Hg^{\cdot\cdot}]\,[S'']^2} = 5{\cdot}1 \times 10^{54}.$$

From this the free energy of the reaction, Q, may be calculated, on the assumption that it does not vary with temperature. The solubility of HgS in Na_2S_2 was found to be about half that in the corresponding Na_2S solutions. The hydrolysis of Na_2S in dilute solutions has been shown to be practically complete. From the hydrolysis constant of Na_2S, the second dissociation constant of H_2S has been calculated. With the aid of the various constants obtained in this investigation, the concentrations of the S'' and other ions in the various sulphide solutions have been calculated.

ELECTRICAL SCIENCE

British and American

The Ether of Space.—On Friday last, at the Royal Institution, the evening discourse was given by Sir Oliver Lodge, who took as his subject "The Ether of Space." Physical action at a distance, the lecturer stated, was impossible; if matter acted upon matter, it was only by means of a connecting medium. When a spring was distorted, the particles of matter of which the spring was composed were merely displaced, it was the connecting medium between the particles that was strained. The ultimate particles of matter could never come in contact with one another. Newton, in order to explain gravitation, had found it necessary to conceive a connecting medium, which, he supposed, filled the interstellar space. This elastic connecting medium, which was universal and omnipresent, was called the Ether, and according to the theory of Prof. Larmor, the ultimate particle of matter, which was called an electron, was merely a point of strain, or a knot in this medium. Round this point of strain there was a slight tendency to rarefaction, a minute stress in the ether. This was an explanation of gravitation; and when a large number of electrons were massed together, the stress in the surrounding ether became enormous. For instance, to hold the moon in its orbit, a steel rod of over 3,000 miles in diameter (one and a half times the diameter of the moon itself) would be necessary. Clerk Maxwell had calculated that this hypothetical stress was, at the surface of the earth, of the nature of 3,000 times the ultimate strength of steel. The ultimate strength of the ether was probably of the nature of 10^{33} dynes per sq. cm., and if all the matter in the universe were in one piece, this value would certainly be exceeded. The essential difference between ether and matter was as follows :—The ether was, as a whole, at rest, was, in fact, our standard of rest; it had the property of elasticity, could be strained, and exhibited the phenomenon of recoil. All potential energy was due to a state of stress in the ether. Matter, on the other hand, could be moved, could effect impact, but could not be strained. Sir Oliver then showed by experiments how fluids in motion possessed the property of rigidity; the water-jet of a Pelton wheel was impenetrable and could be hammered; a chain or a rubber tyre became rigid when in quick motion, and a paper disc acquired solidity when in motion, sufficient to cut through a piece of cardboard. The fluid matter, represented by the air particles of a smoke vortex-ring, was rigid on account of the rotational motion. Not only rigidity, but elasticity, could be imitated by matter in motion. This was shown by Lord Kelvin's model, in which the axes of four rotating rigid bodies were connected together in the form of a square; and the property of elasticity was present along either diagonal. Thus the electron, which possessed the property of rigidity, might be a point of vortex motion in the ether, and elasticity could also be explained by motion. The lecturer said that he looked forward to the time when we could state definitely that ether in motion was the fundamental and unique thing in the material universe. There was no friction between ether and matter; to test this, he had passed a beam of light several times between two discs, which were rotating at

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an enormous speed, but this had not the slightest effect on the light waves. The lecturer then showed two experiments to illustrate the theory that the ether spins round the line joining an electric charge to a magnetic pole.

A downward force was applied to one extremity of the axis of spin of a gyroscope; the axis was slightly depressed, but rotated in a plane at right angles to the plane of spin. This precessional motion was, therefore, a test for spin. The apparatus to show the electrical analogy consisted of a vertical current-carrying wire, at a short distance from which was a magnetic pole free to rotate. The current, which could be looked upon as an electric charge flowing down the wire, corresponded to the downward force, and a magnetic line of force between pole and wire corresponded to the axis of spin of the gyroscope. When the charge flowed downwards, the magnetic lines of force, and with them the magnet pole, revolved round the wire; if the charge flowed upwards, the pole revolved in the opposite direction. This seemed to indicate that there was an ethereal spin in a direction at right angles to the spin of the magnet round the wire. These three vectors: the direction of flow of the electric charge, and the direction of the magnetic flux, at right-angles to one another, in one plane; and the direction of motion in a plane at right-angles to this, could be said to be the three uniting vectors of the universe. Sir O. Lodge concluded the discourse with some words on inertia, and on the density of the ether. The electron had a mass only one-thousandth of the mass of the hydrogen atom, but the ether itself had a density of about 10^{12} grams per cu. cm., or fifty thousand million times the density of platinum. If the elasticity of the ether was kinetic, *i.e.*, due to motion, the velocity of the vortex spin must be comparable with the translational velocity of ether waves, that is, with the velocity of light; and the consequent amount of kinetic energy stored up in every cu. mm. of space must be about 3×10^{17} kw. hours, or an amount of energy represented by the total output of a million kilowatt power-station working for thirty million years. (See also ELECTRICAL ENGINEERING, Vol. I., p. 655.)

Self-Inductance Calculations.—There are two papers in the January *Bulletin* of the Washington Bureau of Standards, dealing with the accurate calculation of solenoid coils of any number of layers. The one, by L. Cohen, is an improvement of the well-known formula for long solenoids of more than one layer given by Maxwell. Maxwell's formula was developed on the assumption of a uniform field within the coil, which means that the end effects were neglected; but as the author shows, this formula may lead to an error in the inductance as large as 12 per cent., even when the solenoid has a length ten times its radius. In the present Paper, the author proceeds by writing down the self-inductance of each layer separately, and the mutual inductances of all the layers among one another, and then summing these terms with as great accuracy as practicable. The final formula, which is too long for reproduction here, possesses an accuracy of the order one part in five hundred. It ought to be mentioned, however, that the formula is derived on the usual current-sheet assumption, and thus takes no account of the shape of the cross-section of the wire or the thickness of the insulation. In another Paper in the same number of the *Bulletin*, E. B. Rosa indicates a method to calculate very accurately the self-inductance of a coil of any length and any number of layers, wound with insulated round wire, taking account of the shape of the section as well as the thickness of the insulation of the wire. His method rests upon the use of numerical tables of correction, which he has compiled. He starts with the ordinary current-sheet formula of Rayleigh, then by reference to his tables applies the correction for the finite thickness of the winding. At this stage the computed value is the self-inductance of a solenoid wound with square wire of infinitesimal insulation. Three other corrections have now to be applied to allow for the fact that the wire is circular and not square, and that the insulation is of thickness not negligeable. For examples of the actual calculation and for tables of correction, the original Paper must be consulted.

Phosphorescence produced by Canal and Cathode Rays.—In a well-known experiment due to J. J. Thomson, a distinction between the cathode rays and the canal rays produced during the passage of a discharge through a rarefied gas, is well shown by causing each in turn to bombard a sample of lithium chloride contained in the discharge tube. The heavy positive rays (the "canal" rays) produce a bright red light where they strike the salt, while the negative or cathode rays cause a steely-blue phosphorescence. E. Trowbridge has now succeeded in causing cathode rays to produce a red light by their bombardment of lithium chloride, thus abolishing this particular distinction between the two kinds of rays. His experiments are described in the February number of the *American Journal of Science*. The cathode in the tube used was a concave aluminium disc which projected the cathode rays along the tube through the central circular hole in a ring anode. The part of the tube behind the anode was surrounded by a coaxial solenoid carrying a current and producing a longitudinal magnetic field. By adjustment of the position of the solenoid the cathode beam can be concentrated into a sharp focus on a screen bearing lithium chloride, placed at the end of the tube. The solenoid's field acts, in fact, as a sort of magnetic lens, the rays seeking the weakest part of the field. Under the intense bombardment, the screen shows a red spot surrounded by the usual blue phosphorescence. It would seem that the colour difference is, therefore, an effect dependent on the energy delivered per unit area.

Continental

Electrodynamics and the Ether Problem.—W. Ritz, who recently became known as a somewhat successful theoriser on spectrum lines, breaks some very new ground in the February number of the *Annales de Chimie et Physique*. The Paper, which extends over 150 pages, is nothing less than a frontal attack upon the conception of the ether, and an attempt to substitute a modernised emanation theory for the wave-theory of light and electromagnetic radiation. Briefly, he argues that the ether, from being a very rarefied kind of gas, has evaporated into a mere conception of physical space with no assignable properties. Nobody has succeeded in demonstrating the existence of the ether. The aberration of light from extra-terrestrial sources does not decide as between emission and undulation, and there is no known means of bringing the transmissive properties of the ether into evidence except by the intermediary of matter, a procedure which simply begs the question. The finite rate of propagation of radiant energy involves in reality nothing but a time-lag or retardation, and may be introduced into electromagnetic equations as a retardation of potential. As regards the wave-motion of light, there is nothing to prove the existence of wave-trains. All we know is that there are stationary waves at the source, and periodic effects at the receiving end or in intermediate matter, and these are amply covered by postulating a finite rate of propagation across empty space. For those to whom an action at a distance is inconceivable, the author suggests the emission of ultra-mundane particles by electrically charged bodies. He puts forward a system of electromagnetic equations from which the conceptions of "force" are eliminated. They are entirely kinematical, but represent, as he claims, all that we know, and no more. Gravitation falls into line as a second-order effect, and the secular displacement of the perihelion of Mercury finds a complete and satisfactory explanation in the fact that gravitation is propagated with the velocity of light. Michelson's experiment, the stumbling-block to the ether theory, becomes also quite comprehensible. Apart from the stationary ether, the electron theory, as developed by Lorentz, is retained in its entirety.

Mechanism of Band Spectra.—A determined attempt to explain the genesis of band spectra is made in the *Physikalische Zeitschrift* for February 1st by Johannes Stark, the discoverer of the Doppler effect in canal rays. He makes the very natural assumption that the bands are due to the detachable "valency electrons," whereas the lines are due to the internal "ring electrons." The valency electrons revolve about the positive nucleus in orbits having the shape of elongated ellipses, and as they rapidly radiate energy, the ellipse becomes steadily smaller. The stopping and starting at each end of the major axis generates an electromagnetic wave, and the waves so generated coalesce into two bands, one in the red, corresponding to the waves generated at "aphelion," and one in the ultra-violet, generated at "perihelion. These bands taper towards each other. As a rule, we only see the aphelion bands, and this explains why most spectrum bands are sharp on the red side and fade off towards the blue. The author calculates the minimum wave-length of the bands of water, carbonic acid, benzol, and other compounds from Planck's radiation law, and obtains some interesting confirmations of his theory, followed by daring predictions.

Discharge from Metallic Oxides.—Some interesting figures concerning the discharge from metallic oxides are given by F. Deininger in No. 2 of the *Annalen der Physik*. Platinum, tantalum, carbon, nickel, and other substances emit negative electrons at a red heat, and the current so generated attains saturation when they are kept at a negative potential of 20 to 25 volts. Richardson's formula, which, to a first approximation, makes the current density proportional to the square root of the absolute temperature, is found to apply very closely. Covering the metal with an oxide of calcium, strontium, or barium, exerts a very pronounced effect upon the emission of electrons. Not only is the emission enormously increased, but the individual properties of the metal are practically obliterated. Thus, on covering the metals with quicklime, the author obtained saturation current densities of 730, 810, 710, and 750 micro-amperes per square centimetre from platinum, carbon, tantalum, and nickel respectively at 1,150° C., whereas without the oxide the current densities were 0·04, 3, 0·2, and less than 0·01 respectively, even at 1,300° C. It is evident that in the former case the nature of the metal is irrelevant.

Electric Lighting at Mecca.—According to the *Daily Graphic*, an American consular report on the Mecca pilgrimage states that an English firm has been granted the contract for lighting the prophet's sanctuary at Medina with electricity.

Metropolitan Association of Electric Tramway Managers.—The quarterly meeting of the above association was held at the Municipal and County Club, Whitehall, S.W., on Friday, February 14th. A number of subjects of interest to managers in the Metropolitan area were discussed at the meeting.

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LOCAL NOTES

ABERDEEN: *Deeside Electricity Works.*—The Electricity Committee last week paid an official inspection to the generating station of the Deeside Electricity Supply Co., which it has recently acquired.

ACTON: *Electricity Statistics.*—The accounts for the nine months ended December 31st, 1907, showed a deficiency of £2,781 compared with an estimated deficiency of £1,887.

BAILDON (YORKS.): *Electric Lighting Scheme.*—A scheme for giving a supply of electricity in this district has been submitted by a Baildon firm of electrical engineers, and is now under consideration.

BELFAST: *Automatic Point Controllers.*—At the weekly meeting of the Electrical and Tramway Committee on Monday the tramways manager, Mr. Andrew Nance, recommended the purchase of three sets of Tierney's automatic controllers at £80 each as an experiment. If successful they will be applied to all the points, the total cost being about £3,500. The present system by which the points are moved by boys costs £1,750 per annum.

BERMUDA: *Electric Supply.*—The Bermuda Electric Light, Power and Traction Co. will soon commence to supply current in Hamilton, the capital of the island. This company, an American concern, secured the necessary powers by an Act in 1904, but owing to delay in commencing work, the Hamilton Corporation declared that the rights acquired had been forfeited, and refused the company permission to erect poles, &c. The Government, however, sided with the company, and accorded the necessary permission. To protect existing lines at crossings, two parallel guard wires are used, instead of the network of guard wires, the mesh of which was not to exceed six inches, at first stipulated for in the regulations.

BIRMINGHAM: *Progress of Electrical Undertaking.*—Mr. R. A. Chattock, City Electrical Engineer and Manager, delivered a lecture at the Midland Institute last week, in which he dealt with the Corporation electrical undertaking. He stated that a very small plant was installed in the year 1882, but in a very few years this became overloaded, and in 1889 the Birmingham Electricity Supply Company was formed. In 1900, the Corporation purchased the undertaking from the company, and three years later decided to municipalise the tramways and to work them by electricity. In connection with the new arrangements for supply in the city, the supply of current to large power users was being taken up in a very gratifying manner, especially for rolling mill work, large motors having a capacity of 200 h.p. or 300 h.p. being installed in many instances for this purpose. During the year 1900, when the Corporation purchased the undertaking from the company, the plant capacity was 2,700 kw., but at the present time the capacity of the three generating stations at Dale End, Water Street, and Summer Lane is 16,476 kw., and whereas during 1900 the units sold were 3,040,822, it was anticipated that during the year ending March 31st, 1908, the units sold would reach 21,000,000. The horse-power of motors connected to the mains in 1900 was 550, but at the present moment this amounts to 6,000.

Tramway System.—At the suggestion of the Board of Trade, side gates have been placed to all the new cars to lessen the risk of accidents. The brake invented by Mr. A. W. Maley, of the Leeds Tramway Department, described in ELECTRICAL ENGINEERING, Vol. II., p. 851, has been fitted to three new cars by consent of the Board of Trade for a period of three months, but the manager has been authorised to endeavour to secure the consent of the Board of Trade to their use on all the 30 new cars recently ordered.

The committee report that the Electric Supply Committee, under powers given to the Corporation in their Tramway Acts of 1903 and 1905, request that a sum of £12,293, expended in cables, and £1,021, the cost of laying cables for the Aston route within the city, should be assigned to the electric lighting undertaking. Already a sum of £67,300, expended on feeder cables in connection with the tramways, has been assigned to the electricity undertaking.

The following terms have been arranged for the temporary working of the tramways in the Handsworth district:—(1) Birmingham will provide sufficient cars, for which Handsworth will pay £1 10s. per car per week as hire. (2) Handsworth Council will pay to Birmingham working expenses at the rate of 5½d. per car mile. (3) Handsworth Council will provide electrical energy, car-shed accommodation, and maintain the permanent way. (4) Birmingham will maintain overhead equipment, the cost of which is included in the working expenses of 5½d. (5) Birmingham will hand over to Handsworth all receipts from the traffic. This arrangement is subject to reconsideration immediately the outstanding questions between the Handsworth Council and the company, who have control of the Aston tramways, are settled, so that through services can be arranged.

BOLTON: *Power Supply.*—Messrs. H. Bessemer & Co., Ltd., of the Bolton Iron and Steel Works, have asked for a reduction in the charges for electricity supplied by the Corporation to their works, and if no concession is made they propose erecting their own power station.

BO'NESS: *Electricity Works Assessment.*—The National Electrical Construction Co., the owners of the electricity works at Bo'ness, appealed against the decision of the Valuation Committee of the County Council of Linlithgow, in connection with the valuation of the electricity works and mains. The Committee's valuation was £650 upon the works and £650 upon the mains, whereas the company contend that the total valuation should be £400, which was the sum at which the valuation stood for the year 1906-7. The Valuation Committee, on the other hand, consider that £400 was an arbitrary sum and was not a fair valuation of the undertaking, the capital expenditure upon which amounted to £25,946, and on account of which an annual payment of £1,650 was made to the town council. Taking into account, however, that the works had only been in existence for three years, they were willing now to fix the annual value at 3 per cent. on the cost, or £720. The Appeal Court has upheld this decision.

BRENTFORD: *Tramway Track Repair.*—At the last meeting of the District Council the Special Committee appointed to consider the condition of the tramway track reported that the repairs were being carried out in a most unsatisfactory manner by the Tramway Co.'s men, and that the present condition of the track was dangerous to traffic, due to the track being so much worn and in a bad state of repair. The Council was recommended to serve notices on the company under the Tramways Act of 1870, and the London United Tramways Act of 1898, to take up the existing wood block paving, to take out and replace with new all worn points and rails, to readjust rails where they are sunk, so as to obtain a cross fall of 1¼ in. at least on to the near side rails in every case throughout the street. In the event of the notice not being complied with within seven days, as mentioned by the Tramways Act, the Council—(which agreed to the above recommendation)—will make representations to the Board of Trade and request that authority to direct inspection by an officer, and if the default complained of is proved to his satisfaction, his report is to be adduced as evidence, and proceedings be taken against the company for legal penalties, viz., not exceeding £5 per day for every day the non-compliance continues, until the entire track has been thoroughly repaired to the satisfaction of the Council.

BRIGHTON: *Tramway Undertaking.*—At the meeting of the Brighton and Preston Ratepayers' Association, a suggestion was made, with the hope of bringing the tramway undertaking into a more flourishing position, that lighter trams should be purchased for working on the hills, it being stated that the outlay would be more than repaid by the saving of 50 per cent. in current. It was also suggested that electric motor-omnibuses should also be taken up in connection with the tramways. Councillor Ashby, a member of the Tramways Committee, assured the members of the Ratepayers' Association that if they only understood the inner working of the undertaking, they would realise the difficulty in the way of running the system successfully. A great drawback was the interference of the Council with the recommendations of the manager, a state of affairs which would not exist in the case of a company. An objection to lighter cars was the liability of accidents. With regard to electric motor omnibuses, the Council had already received applications for permission to run these, and he agreed that this permission should be allowed. During the course of the discussion, it was suggested that the tramway system could only be made to pay by placing the control in the hands of the traffic manager, who would fit the service to the public requirements, instead of having hard and fast time tables fixed by a committee.

The Southwick Electricity Works.—At the meeting of the Corporation on Thursday, Councillor Griffiths asked that the report as to the first year's working of the Southwick electricity works should be presented as soon as possible after March 31st, and in the course of a speech went into some detail concerning the finance of the undertaking. There appears to be some misunderstanding on this matter between Mr. Councillor Griffith and the Chairman of the Electricity Committee, Mr. Alderman Carden. The transfer to the Southwick works was only made in February of last year, and it is consequently impossible to give any reliable data until a year's working has been completed under the new conditions. On the previous year's working a loss of £10,233 was made, due to the necessity for having to run two stations fully staffed and under steam for about ten months out of the year in question. This entailed a very great expenditure, but was unavoidable, as the risk of shut-downs in the event of Southwick plant failing during the period of testing would otherwise have been too great. So far as can be judged from the current year's working, there is every prospect of reducing the £10,000 loss of last year to something about £2,000, and the accounts would have been on the right side this year had it not been for the exceptionally high price of coal during the last six months. The average price has increased by well over 3s. per ton for the year's working, and this represents a total sum of over £3,000. The £10,000 deficit of last year was paid out of the reserve fund, and there is still a balance of some £10,000 or £12,000 from which this year's deficit will in all probability be paid. It may be pointed out that the rates have never been called on for anything so far by the Electrical Department, and, in

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fact, in past years of prosperity the undertaking has contributed no less than £14,000 to the rates, and in view of the present position it would have been very much better had this sum been kept in the reserve fund.

CANADA: *Toronto Electric Light Co.*—In connection with the purchase of electrical plant of the Toronto Electric Light Co. by the Corporation, an independent valuation has been made which sets the value of the plant to the Corporation at $4,000,000. The company intended to ask $6,000,000, but the Corporation Consulting Engineer recommends that in this event a separate plant should be erected. The basis suggested by the Corporation adviser is one year's revenue in addition to the value of the plant.

CHEADLE AND GATLEY: *Revocation of Electric Lighting Order.*—The Board of Trade have revoked the Cheadle and Gatley Electric Lighting Provisional Order, 1900.

CHISWICK: *Smoke Nuisance from Tramway Station.*—The engineer to the London United Tramways Co. has written to the Council in reply to complaints which have been made by that body with reference to the emission of black smoke from the generating station. The engineer states that the apparatus which was installed some months ago, and which it was claimed would entirely prevent the emission of smoke, had been a complete failure, and was about to be removed from the power station. It appeared to be impossible to operate the company's station without the emission at times of a quantity of light smoke. Every precaution, however, was taken to reduce this to a minimum, and, in his opinion, there was not a chimney-shaft in London dealing with so much boiler capacity which was more free of smoke than the company's. It was stated by the Chairman of the Council that the Sanitary Inspector was dealing with the matter.

CLECKHEATON: *Proposed Abandonment of Tramways.*—With reference to the proposal of the Yorkshire (Woollen) District Electric Tramway Co. to abandon certain authorised tramways, the company has written to the Board of Trade offering to assign their powers to the local authority for a purely nominal consideration, and stating their willingness to enter into an agreement to work the tramways. The company takes this position for the reason that the local authorities of Cleckheaton and Liversidge are of opinion that the tramways would be profitable. The company further states that as the lines already constructed only yield on the average a return of 2 per cent. per annum on the capital outlay, they consider they would be ill-advised in raising further capital for the construction of the lines above referred to. At the meeting of the local Chamber of Commerce on Thursday, it was decided to again protest against the company being allowed to abandon this part of their original scheme.

New Telephone Charges.—At the meeting of the Chamber of Commerce on Thursday, it was decided to ask Sir T. P. Whittaker, the Member for the division, to do his utmost towards securing the appointment of a Select Committee to inquire into the question of telephone work and charges.

DOUGLAS (ISLE OF MAN): *Electricity Supply.*—A proposal has been before the Town Council to engage a consulting engineer to report upon the cost and feasibility of utilising water from the reservoir in connection with the generation of electricity for lighting the town and working the tramways. Rough estimates go to show that the conversion of the trams on the Douglas Promenade and in the upper town would cost between £70,000 and £80,000. At present there is a profit of £6,000 per annum made upon the existing trams, and the Council hesitate to face the risk of reducing three-fourths of the present system, which cost £59,000, to the scrap heap. Consequently it has been decided not to go further with the scheme, but to leave it open for private enterprise.

DUNDEE: *Electrical Contractors' Dinner.*—The annual dinner of the Dundee branch of the Electrical Contractors' Association, was held on the 19th inst.

DUNFERMLINE: *Electricity Supply.*—Following upon the decision of the Town Council to appoint an engineer to submit estimates as to the cost of erecting a generating station, and alternatively of taking a supply of electrical energy in bulk from the Fife Electric Power Co., Sir Alexander Kennedy has been appointed to do this.

EAST HAM: *Arc Lamp Hiring Scheme.*—The Borough Electrical Engineer is to circulate a pamphlet in connection with the hire of arc lamps at an inclusive charge per quarter, together with a draft form of application and agreement to be entered into by consumers who wish to avail themselves of an installation under this system.

EDINBURGH: *Electric Pressure Testing.*—It has been decided to instal an apparatus for testing electrical pressure in the City Chambers, and that the apparatus be placed under the direction of the gas inspector, who already has similar powers of control in relation to the gas supply.

FARNHAM: *Overhead Wires.*—A special meeting of the Urban District Council was held last week to further discuss the application of the Farnham and District Electric Supply Co. to be allowed to adopt overhead wires as part of their scheme for supplying electricity in the district. Inquiries have been made of a number of other places similarly situated to Farnham, and extracts from the return show that at Burgess Hill no complaint has been made with regard to overhead wires; Felixstowe and Walton are quite satisfied, provided light steel poles are used; the Chelmsford Borough Surveyor states that all lines should be underground, and Walton-on-Naze has agreed to overhead wires to facilitate the operation of the company. At the end of the discussion, a resolution was moved suggesting that the company might endeavour to evolve a scheme to carry the wire at the backs of houses instead of on poles in the public streets. An amendment to this was moved, giving the consent of the Council to use all overhead wires provided the poles be placed at the backs of houses. The amendment was carried by five votes to four.

HANDSWORTH: *The Tramway Question.*—At the last meeting of the District Council, it was reported that the chairman of the Council and the chairman of the Tramways Committee had at last been able to interview Mr. Emile Garcke and the secretary of the Tramways Company in London, with reference to the Handsworth tramways. As a result, a letter from the secretary of the company had been received, expressing the company's willingness to enter into negotiations with Handsworth for the sale of their section of the cable tramways, if Birmingham will join Handsworth in the matter. A suggestion was made that the price should be fixed by arbitration if they could not agree, leaving it to the respective local authorities to settle their liabilities between themselves.

HANLEY: *"Free" Wiring.*—Mr. C. H. Yeaman has presented a report dealing with the question of how far it would be possible to extend the efforts now being made to encourage the use of electric lighting in small houses and cottages. He states that most schemes of this sort have been worked in conjunction with a hire-purchase or deferred-payment wiring scheme. From inquiries made, he has ascertained that, out of 200 electrical undertakings, 162 have not entered upon any such scheme, 12 have tried and abandoned it, and only 26, of which Hanley is one, continue to work a system of deferred payment in connection with electric wiring. Of the 26 undertakings providing wiring, four did the work themselves, six handed it over entirely to private firms, and 16 employed a contractor under their own management. After very carefully investigating the evidence he has been able to collect, Mr. Yeaman has come to the conclusion that little more can be done in Hanley than has been done up to the present.

HEANOR: *Electric Lighting Scheme.*—An electric lighting scheme is under consideration by the Town Council.

HESTON & ISLEWORTH: *Refuse Destructor.*—It has been decided to place the management of all matters relating to the refuse destructor under the Electric Lighting Committee.

HUDDERSFIELD: *Electricity Accounts.*—The gross receipts of the electricity undertaking for the past year were £30,555, whilst the expenditure amounted to £19,569. After meeting capital charges, there remains a balance of £985, which has been placed to depreciation and contingencies fund. This latter fund now stands at £11,874.

IPSWICH: *Free Wiring.*—The Electricity Department is now prepared to instal wiring, lamps, and plain fittings, upon the basis of a quarterly rental per lamp installed. The consumer is asked to sign an agreement undertaking to pay the rental for at least three years, should he occupy the house for that period. The whole installation will remain the property of the Corporation, and the consumer will be required to get his landlord's signature to an agreement confirming this. The consumer may, at any time, arrange to purchase the installation for cash, or by paying an increased rental for a period. The supply will be measured through a meter in the usual way, and charged at 4d. per unit, with a discount of 5 per cent. for prompt payment. If desired, a prepayment or slot meter can be installed, ½d. per unit extra being charged in lieu of meter rent.

KINGSTOWN (DUBLIN): *Condition of Tramway Track.*—At the meeting of the Council last week, a resolution was proposed that, as the tramway company had failed to fulfil its statutory obligation to keep the tramway track in Kingstown in a safe condition, the District Surveyor be authorised to rail off for public traffic such parts of the tram road referred to. After some discussion it was decided that the Surveyor be instructed to make out a list of the dangerous places, and to forward it to the tramway company, with a request that they should at once be put in order.

LONDON: *London County Council: Electric Light Loan.*—At the meeting of the L.C.C. on Tuesday, the Woolwich Borough Council applied for sanction to borrow £5,000 to cover expenditure (£1,762) incurred up to September 30th, 1907, and to be incurred, in the purchase of electrical apparatus for letting on hire and for wiring consumers' premises on the hire-rental system. The amount applied for is made up as follows:—Arc lamps, £1,000; motors, £1,150; radiators, £350, and wiring work, £500.

Tramway Matters.—On the recommendation of the Highways Committee the Council decided, in connection with the electrification of the Beresford Square to Abbey Wood tramways, to purchase 150 yards of tramway in High Street, Plumstead, from the Bexley Urban District Council. The price, fixed at the cost of construction, less depreciation, is £1,169 15s. 9d. Certain

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modifications will be required in the track work of the purchased tramway in order that through running may be arranged.

MR. Sharp asked the Chairman of the Highways Committee what progress was being made with the construction of the tramway from Hammersmith to Harlesden, and whether it would be opened in time for the Franco-British Exhibition. Mr. Whitaker Thompson replied that difficulties have arisen with Hammersmith Borough Council in regard to paving works, and the dispute might have to be taken to the Board of Trade for arbitration. These delays might prevent the completion of the whole of the route before the Exhibition, but the Council had the permission of the Board of Trade to complete the tramway as far as Uxbridge Road, and that would be done as soon as possible, but the rapidity of completion of the portion north of Uxbridge Road must depend on the reasonableness of Hammersmith Borough Council.

Camberwell: London Power Bills.—From March 31st, 1900, up to the present time, the sum of £1,568 has been spent in opposing electric power bills.

Finsbury: Tramway Speed.—The Borough Council have decided to ask the Board of Trade to restrict the speed to twelve miles an hour upon the L.C.C. tramways along Goswell Road.

Hammersmith: Reserve Fund.—In June, 1903, the Borough Council resolved to provide a reserve fund in connection with the electric light undertaking, and at that time the sum of £2,500 was carried to the credit of the fund. Nothing has since been added, but £7,000 has been transferred from the funds of the undertaking to the relief of the rates. At the last meeting of the Council, the Finance Committee reported that it was most desirable that the reserve fund should be placed on a more satisfactory basis before any further contributions in aid of the rates were made. The Council adopted the committee's recommendation that the further sum of £2,500, being part of the accumulated surplus of £5,500 not yet appropriated, be carried to the credit of the reserve fund.

Islington: London Power Bills.—Mr. Vorley, chairman of the Lighting Committee, reported to the Council last week having attended an important conference between the Law and Parliamentary Committee of the L.C.C., and representatives of Borough Councils possessing electricity undertakings. Unanimously the Borough Council representatives said that the Electricity Supply Bills ought to be opposed in Parliament. Resulting from the meeting an informal conference was afterwards held of the same Borough Council representatives, and some important resolutions were passed; so important were they that he had every confidence that they would affect the whole question of bulk supply in London in the future. Before he mentioned the matters publicly, however, he desired to bring the resolutions before the Lighting Committee, and no doubt a full report would be presented to the Council. By 18 votes to 3 the Council agreed to a resolution empowering the Lighting Committee, should they deem it desirable to modify the scale of charges to large consumers of electricity possessing high load factors, provided always that such modification apply to all consumers taking current under the same conditions, and that every such modification be reported to the Finance Committee for their sanction.

LUTON: *Opening of Tramway System.*—The system of electric tramways which have been constructed by Messrs. J. G. White & Co. were opened on Friday. The contractors some time ago submitted a proposal, which was accepted, to construct, equip, and lease the tramways for a period of years, the Corporation to provide the capital, which amounted to £62,000, and the company to pay rent equivalent to interest and sinking fund charges during the term of the lease. The system adopted is overhead trolley, and the distance at present covered is about six miles. Already there are thoughts of extending the system and linking up with the neighbouring town of Dunstable.

MANCHESTER: *Progress of Tramways.*—In an address by Alderman E. R. Wilson at the Longsight Public Hall, on Thursday, it was stated that the capital expenditure upon the Corporation tramway system now amounts to £1,750,000. Last year no less than 145,264,000 passengers were carried, 69 per cent. of whom paid a fare of one penny. The average fare received was 1·19d., and, whereas the old tramway company paid £8,000 in rates, the Tramways Committee now pays £25,000 per annum. The average cost per mile of track has been £5,270, with an additional £1,090 per mile for overhead equipment.

STOCKTON (RURAL): *Revocation of Electric Lighting Order.*—The Board of Trade have revoked the Stockton (Rural) Electric Lighting Order, 1902.

TAUNTON: *Electric Tramway Agreement.*—The Taunton Electric Traction Company has made an application for a renewal of the agreement which expires in August, under which the British Electric Traction Co. guarantees to the Corporation a minimum payment for the supply of electricity in connection with the tramways. The company intimates that if satisfactory terms can be arranged, including a reduction in the price paid for current, the extension of the trams to Rowbarton will be put in hand. The question of negotiating with the company is in the hands of the Electric Tramway Committee, and a report will be presented at the meeting in March.

YORK: *Light Railway Inquiry.*—The Light Railway Commissioners heard an application on Tuesday by the Corporation for powers under the Light Railway Act to convert the existing horse tramways to electric traction, and for the construction of additional lines. Mr. Tyldesley Jones, who represented the Corporation, said that there was a difference of opinion, both on the Council and in the city, as to whether the Corporation should work the lines themselves or lease them to a company or some other firm. A pledge was therefore given that before any decision should be come to on that point the ratepayers should be consulted, and a special clause had been introduced into the Order to enable the ratepayers to vote as to three alternatives:—(*a*) Shall the light railways be constructed and worked by the Corporation? (*b*) Shall the light railways be constructed by the Corporation and then leased to a company, firm, or person to work them? (*c*) Shall the undertaking be leased to a company to construct and work? The cost of the tramways on the surface-contact system was estimated at £128,000, and the Corporation owned the electric lighting station, which contained quite sufficient plant to deal with these tramways. The North-Eastern Railway Co. contended that certain bridges should be rebuilt, but after hearing the evidence the Commissioners decided to grant the application, and expressed the opinion that the bridges were safeguarded in the order.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ACCRINGTON.—New baths, with electrical installation, are to be erected at Accrington at a cost of £9,500.

ACTON.—Tenders are invited for the annual supply of meters, prepayment meters, carbons, house fuse-boxes, meter boards, and cables. Particulars from Mr. J. M. Blair, the Electrical Engineer, 130 Churchfield Road, Acton, and tenders to the Clerk by February 29th.

AUSTRALIA.—The Commonwealth Government calls for tenders by April 14th for the construction and laying of two cables between Victoria and Tasmania. £1,000 deposit is required, and full particulars and specifications may be inspected at the Commonwealth Government office, 72 Victoria Street, Westminster.

BELFAST.—Extensions of cables have been authorised at a cost of about £250 in connection with the Campbell College.

BRADFORD.—The Tramways Committee has decided to spend £21,000 on the renewal of the track in various parts of the city.

BURY.—The Corporation invite tenders for the supply, delivery, and erection of two 2,000-kw. turbo-alternators with exciters and condensers. Specifications and general conditions may be obtained from Mr. S. J. Watson, Electricity Works, Bury (fee £2 2s., returnable), and tenders to the Town Clerk by March 16th.

DUNDEE.—Tenders are invited for E.H.T. three-phase and direct-current switchboards and substation generating machinery. Full particulars from Mr. H. Richardson, the Chief Electrical Engineer (fee £3 3s., returnable), and tenders to the Clerk by March 2nd.

FINCHLEY.—The Council invites tenders for the supply and erection of one 700-kw. high-speed engine and dynamo combined. Specifications, &c., from the Electrical Engineer, Mr. E. Calvert, Electricity Works, Squire's Lane, Finchley, N. (Fee, £2 2s., returnable.) Tenders to the Town Clerk by March 2nd.

GLASGOW.—The Tramways Department invite tenders for the supply and erection of two movable bridges over the Forth and Clyde Canal at Dalmuir and Kilbowie. Full particulars from the General Manager, 46 Bath Street, Glasgow, and tenders to the Town Clerk by April 15th.

HANDSWORTH.—Tenders are invited for (*a*): 315 kw. generating set, (*b*) feed-pump economiser and pipe work, (*c*) switchgear for 315 kw. generating set. Full particulars from Messrs. Kennedy & Jenkin, 17 Victoria Street, fee £3 3s., returnable, and tenders to the Town Clerk by March 4th.

HANLEY.—On the 18th inst., Mr. H. R. Hooper held a Local Government Board inquiry into the application of the Corporation to borrow £18,000 for electricity extensions. Included in this were a new 500 kw. steam generator, £5,000; mains, transformers, meters, instruments, and tools, including overdraft mains at December, 1904, and expenditure under all these heads to December, 1906, amounting to £5,358; and future extensions from that date of £12,642. Owing to the new requirements of the Local Government Board, that the expenditure under each head should be given separately and in detail, the Inspector was furnished with full particulars of the expenditure from the commencement, and he decided to deal with the application as at the 12th inst., at which date the expenditure in excess of previous sanctions amounted to £9,431, while to avoid the necessity for a further sanction at an early date he

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also allowed prospective sums to be included for new plant, £5,000; new mains, £4,000; new transformers and substations, £3,000; and instruments, boosters, &c., of £538; making a total of £21,969, or nearly £4,000 on suspense account for the next two years, beyond the amount applied for. The Inspector emphasised the point made in several recent inquiries that meters and testing instruments, having short life, should be provided out of revenue. Also that independent ledger accounts must be kept of the expenditure against each sanction, and the Electrical Engineer gave such particulars for the period since he took office in the spring of 1905. The Electrical Engineer pointed out that while he entirely agreed with the principle of paying out of revenue for all small items, these made a large annual sum in the aggregate, and an undertaking adopting this virtuous policy suffered in its cost sheet in comparison with one not doing so, unless such charges were made upon a depreciation and reserve fund into which surplus balances or profits were paid annually.

HASLINGDEN.—At a meeting of the Haslingden Town Council on February 20th, it was reported that the Local Government Board had sanctioned a loan of £8,400 for the erection of a refuse destructor at Lincoln Place, which will be worked in connection with the electricity undertaking.

HEYWOOD.—The report by the Electricity Committee with regard to extensions at the electricity works, involving an expenditure of £10,000, has been approved.

HORNSEY.—The Finance Committee recommend the adoption of the recommendation by the Electricity Committee that a new feeder for the supply of electricity to the Muswell Hill district should be laid, and that application be made to the Local Government Board in this connection with regard to a loan of £10,000.

ILFORD.—The Council invites tenders for the supply of the following, required during the year ending March 31st, 1909, for the electricity department:—Meters, cables, incandescent lamps (carbon and metallic filament), arc lamp carbons, house service fuse boxes, joint boxes, coal. Full particulars from Mr. A. H. Shaw, Electricity Works, Ley Street, Ilford, Essex, and tenders to the Clerk by March 10th.

LEEK.—The resident engineer is to undertake the duties of consulting engineer in connection with the proposed extensions at the electricity works.

LLANDUDNO.—The Council has authorised the extension of the plant at the generating station, which has been rendered necessary in connection with the supply of electrical energy to the tramways.

LONDON: *London County Council.*—Tenders are invited for the supply and delivery of about 525 tons of steel girder tramway track rails and fastenings required for the reconstruction on the overhead trolley system of electric traction, of the existing tramways from Brixton Road to near Camberwell Green. A statement must be made as to where the rails will be manufactured. Specifications, &c. (fee, two guineas, returnable), from the Chief Engineer to the Council, and tenders to the Clerk by March 3rd.

MANCHESTER.—The Electricity Committee invites tenders for the supply, delivery, and erection at the Stuart Street station of natural draught cooling towers. Particulars from Mr. F. E. Hughes, secretary to the electricity department, Town Hall (fee, two guineas, returnable), and tenders to the chairman of the Electricity Committee by March 10th.

RICHMOND (*Ireland*).—A sub-committee of the Richmond Asylum has been appointed to consider the installation of electric light.

ROCHDALE.—Major Stewart, R.E., on Tuesday held a Local Government Board inquiry into an application by the Corporation for sanction to borrow £22,175 for the purposes of electric lighting. It was explained that in the first few years there was a loss of £5,543 on the electricity undertaking, which had to be paid for out of the rates, but £5,350 of this was repaid, and there was now a reserve fund of £4,000. The net profit had increased from £1,195 in March, 1905, to £4,135 last year. The Inspector expressed satisfaction with the accounts.

SPAIN.—The *Gaceta de Madrid* of February 7th notifies that the Compañia del Ferrocarril de Sarriá á Barcelona have applied for a concession for an electric tramway in Barcelona, and that a period of one month from the date of publication has been appointed for the presentation of more favourable proposals.

The *Gaceta* of February 11th notifies the approval of the transfer of an electric tramway concession granted to the Seville Tramways Co., Ltd., to the Compañia Sevillana de Electricidad.

The *Gaceta* of February 11th also announces that tenders will be opened at noon on March 16th, at the Junta de Obras del puerto de la Coruña, for the supply of three three-ton electric cranes, at a maximum cost of 133,919 pesetas (about £4,618). Local representation is necessary.

WREXHAM.—Tenders are invited for stores. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by March 6th.

WEST HAM.—With regard to the estimate of the cost of plant required for the Council's electricity undertaking up to March 31st, 1910, the consideration of which stands adjourned pending the decision of the Finance Committee of the Council on the question of applying to the Local Government Board for sanction to a loan for the sums of £7,045 and £64,880, a further report has been made by the Electrical Engineer giving an explanation of the necessity for the new plant, and also particulars as to the periods during which the amounts will be required. It is estimated that for the year ending March 31st next £12,300 will be wanted for generation, and £4,500 for distribution. For the year to end March 31st, 1909, £18,005 is put down for generation, and £9,750 for distribution, and for the following year £6,325 for generation, and £14,000 for distribution. The Electric Lighting and Tramways Committee have approved this allocation of the estimated cost, and have instructed the Electrical Engineer to submit the same to the Finance Committee.

WIGAN.—Tenders are to be invited by the Board of Guardians for an electrical installation at the new Workhouse Infirmary, Billinge.

TENDERS RECEIVED AND ACCEPTED

BELFAST.—Quotations have been received for scrap copper and wire, and the tender of Messrs. Pearce, Brown, Smith & Co., 7 Wilson Street, Finsbury, London, has been accepted.

BIRMINGHAM.—An order has been placed with Messrs. Dick, Kerr & Co. for 30 electric tramcars, similar to those already in use.

BIRMINGHAM.—The Birmingham Tame & Rea Drainage Board have accepted the tender of Messrs. Johnson & Phillips, Ltd., for the complete erection and equipment of a 6,600-volt transmission line in connection with the new storm water pumping plant which is being installed.

CHISWICK.—The Council has accepted the tender of E. Evans, Hounslow, for the annual maintenance of fire-alarms and telephones in the Council's offices.

KIRKCALDY.—The tender of Mr. R. Bryson, of Kirkcaldy, has been accepted for wiring the new sanatorium at £29 15s.

LEEK.—An agreement has been entered into with the D.P. Battery Co. to put the batteries at the generating station into good order and maintain them for ten years at a premium of £65 8s. per annum. An offer by the Vulcan Boiler & General Insurance Co. for insurance of the engines and dynamos at £52 3s. has also been accepted.

LOCHGELLY.—The Lochgelly Coal & Iron Co. have placed an order with Messrs. Johnson & Phillips, Ltd., for the complete erection of a 3,000-volt overhead transmission line for their Lochgelly works.

LONDON: *London County Council.*—The tender of P. & W. Maclellan, Ltd., amounting to £1,072 18s. 9d., for the supply of 136 tons of flat-bottomed rails, &c., required for the tramway car-sheds at Bow, Hammersmith, and Hackney, has been extended to include about 115 tons of two kinds of flat-bottomed rails with bolts and fish-plates, for the first portion of the central car repair depôt in Woolwich Road. For the rails the price quoted is 2s. 6d., less than the original figure of £7 8s. 9d. per ton. The total cost of the 115 tons is estimated at £956.

The tender of the Electric Construction Co., Ltd., for the supply of 500 kw. machines is to be extended to include a 150 kw. machine required for starting the larger machines, now being installed at Hammersmith temporary substation. The price of the machine is £541 10s.

The Council has accepted the tender of the India Rubber, Gutta Percha, & Telegraph Works Co., Ltd., for the supply of 300 plough bases at 54s. each, and 600 leads at 4s. each, required in the tramways department.

The Council have accepted the tender of Messrs. Johnson & Phillips, Ltd., for supplying and laying cables in connection with the extension of tramways in Seven Sisters and Caledonian Roads.

Lambeth.—The Borough Council has accepted the tender of the General Electric Co. at £3 2s. 8d., for the supply of additional electric light fittings for the new Town Hall.

Stepney.—An order has been placed with the Tudor Accumulator Co., Ltd., for a battery of nine cells (in connection with the meter testing switchboard at the generating station) at £64.

MUMBLES.—Mr. A. H. Gibbings, of Liverpool, has offered to undertake to convert the present 200 public lamps from gas to electricity at a cost varying from a minimum of £2 15s. to £3 10s. per lamp per annum, according to the number of hours of lighting. The present cost of public lighting is about £2 3s. per lamp. During the discussion which took place upon this offer, it was stated that some time ago Mr. Gibbings had told the Council that electric light would prove cheaper than gas, but from this offer it appeared that it would cost about £150 per annum more than they paid for gas. In reply to this, it

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was pointed out that there would be considerably more light. It was decided, however, to inquire of Mr. Gibbings if he could give better terms.

WEST HAM.—The Electric Lighting and Tramways Committee has accepted the offer of the Bell Punch and Printing Co., Ltd., to extend the contract for ticket punches for a period of three years, at the rate of 12s. per punch per annum, instead of 15s., as per the present contract. This will effect an annual saving of about £52 10s. The Committee has approved the acceptance of the offer of the present contractors, the Cryselco Co., for the annual supply of carbon lamps at present contract prices, less 10 per cent., and also the purchase from Wm. Cory & Sons, Ltd., of 12,000 tons of North Country coal at 10s. (a considerably more favourable price, points out the Engineer, than obtained during the past year), and 12,000 tons at 9s. 8d., of North Country coal, slightly lower calorific value accounting for the difference in price.

WILLESDEN.—The Urban District Council has accepted the tender of G. & H. Turner for the annual maintenance of the telephone system.

COMPANIES' MEETINGS AND REPORTS

ABERDEEN SUBURBAN TRAMWAYS.—The accounts for the half-year ended January 31st, 1908, show a profit of £887, making, with the sum brought forward, a balance of £1,587 at the credit of profit and loss account.

BRUCE PEEBLES.—An extraordinary general meeting was held in Edinburgh on Monday to consider a resolution for the voluntary winding up of the company. Mr. W. Peebles, who presided, said that the conditions which had led to the present crisis were: (1) the need of further working capital, accompanied by extreme stringencies of the money market. (2) The stoppage of practically all new contract work for this reason. (3) High price of raw materials. (4) The low prices obtained through undue competition. When the company was formed the prices obtainable for its ordinary manufactures were nearly double those of to-day, but there had been a constant decline brought about, first by various competition, and latterly by the continued competition of home firms. With regard to the Moscow tramway contract, option had been obtained which it was hoped would be of benefit. The chairman impressed upon the shareholders that the business was a valuable one, and that if they agreed to a scheme of reconstruction the company might emerge from the crisis stronger than ever. The combined holding of his family in the company was £78,000. A resolution requesting the joint liquidator to consider whether a scheme of reconstruction was feasible was carried.

Mr. A. W. Tait, one of the liquidators, has prepared a statement in regard to the financial position of the company, giving comparative figures for 1906 and 1907. Dealing first with the assets, the buildings and works at East Pilton are stated for 1907 at £49,000, and for 1906 at £49,647. The other assets are:—Working plant, machinery, tools, office furniture, trade marks, patent rights, &c., £104,248, as against £110,091 (in the 1907 figures the amount of goodwill was about £23,000); stock, stores, work in progress, and finished work, £82,565, as against £109,593; book debts, £123,669, as against £301,572; cash in hand and bank, £3,124, as against £2,886; shares in power and traction companies, £115,777, as against £51,920; and special reserve fund investments, £11,937, as against £7,718. The liabilities were—Preference share capital, £150,000 as against £150,000; ordinary share capital, £141,905 as against £141,905; debentures, together with interest accrued, £75,890 as against £75,890; debts due by the company, £183,909 as against £208,907. There is an addition this year of overdraft on the Royal Bank at December 31st of £32,589, and there is a reserve account—special reserve £11,556, and general reserve £27,000. The net loss after making provision for the clearing up of the contracts still on hand carried into this balance-sheet was £151,228, and if deducting the general reserve fund and special reserve fund there was a loss of £92,671.

A committee of shareholders has been appointed to confer with the liquidators.

An application has been made in the Edinburgh Court of Session on behalf of Mr. C. J. Shields, a preference shareholder, objecting to the appointment of Mr. A. W. Tait as official liquidator, on the grounds that he is not subject to the jurisdiction of the Court, that it is inexpedient that a director should be appointed liquidator, and that the expense attendant on the appointment of a London accountant is undesirable in the interests of economy.

BUENOS AIRES & BELGRANO ELECTRIC TRAMWAYS.—At the annual meeting on Thursday, Mr. J. B. Concanon, the Chairman of the company, who presided, stated that the accounts comprised the working for the six months to June 30th, 1907, as well as the half-yearly instalment received in accordance with the agreement for the sale of the property. The actual net profits for the six months to June 30th, after deducting London office expenses, amounted to £32,668, and in view of the sale, this sum was higher than it would have been, as no provision had had to be made for depreciation and renewals. The report and accounts were adopted. Dealing with a complaint as to there being no dividend declared upon the ordinary shares, the chairman stated that it was not proposed to pay this dividend owing to the fact that before it could be made, an application to the Courts for a reduction of capital would be necessary. This would involve expense, but even if this were deducted, the directors hope to make a very large distribution to the ordinary shareholders.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY: *West End Undertaking.*—The report shows gross earnings for the year ended December 31st, 1907, amounting to £151,920, compared with £126,145, and expenses, including depreciation, £80,114, compared with £84,088. After bringing in the balance of £4,574 from last year, and paying interest on the debenture stock, there is a balance of £42,023, out of which the dividend for the year on the preference shares, and an interim dividend for the first half-year at the rate of 5 per cent. per annum on the ordinary shares has been paid, amounting to £28,000, leaving a balance to be dealt with of £14,023. The directors propose a final dividend for the second half-year at the rate of 5 per cent. per annum, making 5 per cent. for the whole year, absorbing £10,000, and to carry forward £4,023. The company has now connected to its West End mains the total equivalent of 538,964 8-c.p. (or 30 watt) lamps, which is an increase of 28,375 upon last year's figures. The total is made up as follows:—391,201 in lighting, 10,238 in heating, and 137,525 (5,501 h.p.—4,129 kilowatts) in motors.

City Undertaking.—The gross earnings of this undertaking were £118,543, compared with £105,502, the expenses being £63,748, compared with £57,324. Interest on debenture bonds and loans, and dividend on preference shares absorbed £48,133. From this is deducted the deficiency on preference shares' dividend, 1902-1905, £4,406, leaving £2,256. The City undertaking has, therefore, been able out of its revenue for the year 1907 to pay the interest on its debenture bonds and dividend on its preference shares, to repay the balance of £4,406 to the West End undertakings, and to carry forward the sum of £2,256 2s. 3d. The company has now connected to its City mains the total equivalent of 454,757 8-c.p. (or 30 watt) lamps, which is an increase of 42,073 upon last year's figures. The total includes 287,787 in lighting, 26,770 in heating, and 140,200 (5,608 h.p.—4,209 kilowatts) in motors.

The report further states that no progress was made in the last session of Parliament towards settling the question of the bulk supply of power in the metropolitan area. The question has again been carefully considered by the Board, in conjunction with the Boards of other electric lighting companies, and they are still of opinion that the most practical way of dealing with the question is to entrust the bulk supply to an undertaking composed either of all or some of the London electric supply companies. With this end in view a Bill is being promoted in the present session of Parliament to constitute a joint committee representing eight of the London electric supply companies. The chief object of this joint committee will be the rendering of mutual assistance and the giving of a supply of energy in bulk. A special resolution approving this Bill will be submitted at an extraordinary general meeting of the shareholders to be held immediately after the annual meeting on March 3rd.

CHELSEA ELECTRICITY SUPPLY.—The report for the year ended December 31st, 1907, shows a profit of £33,099, which with £1,092 brought forward and £451 balance of interest, makes a total of £34,642. After deducting interest on debenture stock, interim dividend of 6 per cent. on preference shares, and interim dividend on ordinary shares at the rate of 4 per cent. per annum, there remains a balance of £20,924, which the directors recommend shall be appropriated as follows:—Renewals and depreciation fund, £11,619; debenture stock premium redemption fund, £519; amount written off cost of extinction of founders' shares, £802; final dividend on the 6 per cent. preference shares, £900; final dividend on the ordinary shares at the rate of 5 per cent. per annum, making 4½ per cent. for the year, £6,179; leaving a balance to be carried to the next account of £904. The number of 8 c.p. lamp equivalents connected on December 31st, 1907, was 240,735, an addition of 7,430 during the year, and the total number of units sold was 3,548,628, being 240,914 more than the previous year. At the close of the meeting on March 11th a special meeting will be held for the purpose of confirming the promotion of the London Electric Supply (Joint Committee) Bill in Parliament.

GROSSE BERLINER STRASSENBAHN.—The report for the year 1907 shows a net profit of £490,000, which allows of a dividend of 8 per cent. on the capital of £5,000,000. The unfavourable effect of the cold winter of 1906-7, and the following wet spring and summer months, had been offset by the very favourable conditions during the autumn months. Owing to the increased cost of material, the maintenance expenses had increased. The net receipts per car-mile had been 8·1 pence.

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the same as the previous year. The total number of car-miles had increased from 51·5 million in 1906 to 53·2 million in 1907, the number of passengers carried from 364 million to 378 million, and the receipts from £1,700,000 to £1,770,000. The working expenses were for the past year 55·3 per cent. of the receipts, against 53·9 per cent. for the previous year. The cost of the energy supplied was 22·5 per cent. of the total working expenses, amounting to some £214,000. The company now owns some 325 miles of single track, and 2,494 cars. The number of employees amounts to 10,400. Of the smaller companies, the West Berlin suburban tramways shows a net profit of £45,000, and pays a dividend of 5½ per cent. The Berlin-Charlottenburg tramways show no net profit.

LANARKSHIRE TRAMWAYS.—The result of the December half-year's working show revenue amounting to £34,929 and expenses to £20,732. Deducting interest on debentures, interest on loans, contributions payable to local authorities, and amounts written off, a total of £4,124, there remains £10,070, and adding balance brought forward from the last accounts, viz., £5,182, the sum of £15,252 is available for distribution; £5,500 has been placed to reserve for depreciation; a dividend is recommended at the rate of 6 per cent. per annum on the issued share capital for the half-year; £240 is absorbed in directors' fees; and £895 is carried forward. Part of the original single line in Clyde Street has been taken up and double track substituted, the cost of the original line being written off in the attached accounts. During the half-year £5,000 has been paid off the loan from the company's bankers. The time allowed for the construction of the extensions authorised by the company's order of 1903 expires next August, and application is now being made to Parliament to extend the time for a further period. The directors, however, propose to proceed at once with the construction of two short extensions, one to the Hamilton Burgh boundary in the Bothwell Road, and the other from Motherwell Cross to the Motherwell Burgh boundary beyond Coursington Bridge. To meet the immediate requirements for capital expenditure for these extensions and seven additional cars, the shareholders are now invited to subscribe for £20,770 additional share capital at par, which is the balance the company is now authorised to issue without further sanction from the shareholders. The shareholders will be asked at an extraordinary general meeting, to be held immediately before the general meeting on the 20th inst. to grant authority to issue the remaining share capital authorised by the company's order of 1903 as and when required.

At the meeting on Thursday, the report and accounts were adopted. Mr. A. R. Monks, who presided, stated that the Cambuslang extension of 3¼ miles which had been opened during the year, and which had been linked up with the Glasgow tramways, had fully realised expectations.

LANCASHIRE UNITED TRAMWAYS.—The accounts for the year 1907 show a profit of £12,789, and there is a balance of £289 after payment of the prior lien debenture stock interest.

MATHER & PLATT.—The report to December 31st last shows a net profit for the year, after charging depreciation and making provision for directors' remuneration and expenses, of £125,677, to which is added the balance brought forward from last year, viz., £15,380, showing an available total of £141,057. The preference dividend, and the interim dividend on the ordinary shares paid on September 1st last, for the half-year to June 30th, 1907, absorbed £22,000, leaving for disposal £119,057. The directors recommend a dividend of 5 per cent. per annum on the preference shares for the half-year to December 31st last; a dividend at the rate of 10 per cent. per annum on the ordinary shares for the year to December 31st last (less interim dividend paid in September); a bonus of 5 per cent. on the ordinary shares; transfer of £40,000 to reserve account (bringing up the amount to £340,000); transfer to "Employees' Benefit Fund" of £5,000, carrying forward £16,057. The meeting will be held in Manchester to-day.

NATIONAL ELECTRIC SUPPLY.—The annual general meeting was held at Preston last week, Mr. J. Booth presiding. The sum of £3,745 has been expended upon capital account during the year ended December 31st, 1907, principally in mains and additions to the pumping plant at the station. The receipts have increased by £1,650, the company having sold £104,000 units more during the year than during the previous year. The net revenue account shows an increase of £1,200, and a dividend has been declared upon the ordinary shares of 8s. per share. £600 have been added to the reserve and depreciation account, and the remainder is carried forward. In the course of a few remarks upon the future position of the electric supply industry in Preston, the Chairman stated that although the increasing use of metallic filament lamps might, on the surface, be against the interests of electric supply companies, he had no fears of this nature, because he thought that consumers would go in for greater illumination with the satisfaction of not having to pay more for it. The demand for electricity for power purposes was also steadily growing, and there was also a small demand for electricity for cooking and heating purposes, improved appliances for which were being put upon the market.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING.—The report for the year ended December 31st, 1907, states that the number of units sold was 9,282,370, as against 8,076,770 in 1906, an increase of 14·92 per cent. The increase has not been in proportion to the estimate which was formed in the beginning of 1907, due to the falling off in the demand for electrical energy for power and other purposes in the engineering and other trades, owing to lessened work, and this combined with the increased cost of coal has had a depreciatory effect upon the anticipated profits for the year. The gross profits for the year for Newcastle amount to £18,501, and for Newburn to £856, which, together with the sum of £9 received for transfer fees, and £2,248 brought forward from last year, makes the total £21,615. After deducting directors' and trustees' fees, income tax, &c., and making provision for leasehold redemption fund, there remains a net balance of £19,922. The directors, after providing for interest on debenture stock, &c., recommend a dividend at the rate of 4 per cent. per annum for the half-year ended December 31st (less income tax), which, together with the interim dividend paid in August last makes 4 per cent. for the year. To accomplish this it will be necessary to draw upon the reserve fund to the amount of £1,222. The directors, however, feel justified in recommending this in view of the abnormal price of coal and the other circumstances mentioned above. An arrangement has recently been made with Messrs. John Spencer & Sons, Ltd., for a term of years to utilise their exhaust steam at the Newburn station and thus energy will be produced at a very low rate, which will assist the profits of the station considerably.

NORTHALLERTON ELECTRIC LIGHT & POWER.—The result of the year's working to December 31st, 1907, is a net profit of £142, which, with the balance brought forward from last account, makes a total of £214. A dividend of 5 per cent. is recommended.

NORTHAMPTON ELECTRIC LIGHT & POWER.—The report for the year ended December 31st, 1907, shows that the equivalent of 3,222 eight c.p. lamps have been added to the lighting load, and 33 h.p. to the motor load. The number of consumers has increased by 108, and the output by 837,161 units, an increase of 11½ per cent. The maximum load on the plant during the year was 645 kw., an increase of 10½ per cent., whilst the load factor was 12·7. The report refers to the considerable increase in the cost of coal, but points out that the apparent increase in rates and taxes is due to overload between two years in respect of income tax on the bonus paid in 1906. In all other items of working costs, there has been substantial decrease in power units generated. Owing to the continued extension of business, further plant is needed, and additional capital outlay will have to be incurred during the current year. The directors propose to add £2,000 to the depreciation fund, to write £100 off motors, and to apply the balance of £1,186 in payment of a half-year's dividend of 5 per cent. on the preference shares, and 6 per cent. (making 5 per cent. for the year) upon the ordinary shares, carrying forward £162.

NORTH LONDON RAILWAY.—At the half-yearly meeting on Thursday, Lord Rathmore, the Chairman, in moving the adoption of the report, which shows a very heavy fall in receipts from passenger traffic, namely, £18,180, stated that the cause of this formidable decline was the great increase in the number and efficiency of their competitors. Electric tube railways and electric tramways were most dangerous competitors, the London County Council electric tramcars being equipped apparently regardless of expense. However convenient these luxurious conveyances might be for the persons to be carried, as ratepayers the railway companies felt they had a grievance.

NOTTING HILL ELECTRIC LIGHTING.—At the ordinary general meeting on Tuesday, Sir William Crookes presiding, the report and accounts given in our last issue were adopted. In the course of his speech the Chairman referred to the fact that the company now paid rates to an amount equal to 2½ per cent. per annum on their share capital, but the Board had been taking advice with a view to appealing against the assessment. The manner in which the assessment arrived at was actually a tax upon their goodwill. The price of coal had increased very considerably during the past half-year, and was 33 per cent. more than in the previous year. Everything pointed to increasing prosperity in the future, a very important contract having been entered into in connection with the Franco-British Exhibition, by which the Hammersmith Borough Council would take from the company not less than one million units between April and November. At the conclusion of the general meeting, a special meeting was held for approving the Bill promoted by the Kensington and Knightsbridge, Notting Hill, St. James and Pall Mall, Westminster and the Central Company, which has been deposited in Parliament to enable the companies to link up their supply, and generally assist each other. Referring to the other Bills relating to electric power in London, the Chairman stated that it was thought advisable to oppose both in order to get clauses inserted to protect their interest.

OXFORD ELECTRIC.—The report for the year ending December 31st, 1907, states that the revenue account shows a profit (including £895 brought forward from last year) of £15,848. After providing £2,000 for debenture interest and writing off £2,329 on account of hire-purchase and college installations, the balance available for dividend is £11,519. The directors recommend a dividend of 7 per cent. per annum on the ordinary shares, a 5 per cent. dividend on the preference shares, and a 5 per cent. dividend on the preference share capital issued in

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1907, placing to reserve and renewal of plant account, £2,500, and carrying forward £977. It is estimated that at December 31st last there was the equivalent of over 91,000 8-c.p. lamps connected to the mains. The number of Board of Trade units sold during 1907 was 12 per cent. larger than in the previous year. A considerable portion of this increase is due to current supplied for motive power purposes. The meeting is on March 6th.

SCARBOROUGH ELECTRIC SUPPLY.—The report for 1907 shows that although there has been an increase in the amount of energy supplied during the year, the receipts have continued to be adversely affected by the depression of trade in the town, while the expenses have risen owing to the higher price of coal. The capital outlay during 1907 was £1,330, as against £3,427 for 1906, the principal item of expenditure being for extension of mains. The accounts show that after placing the sum of £750 to depreciation account there is a balance on revenue account of £4,238. The directors recommend that a dividend be paid (free of income-tax) at the rate of 4 per cent. for the year, which will absorb £3,990, leaving to be carried forward £248. The meeting will be held to-day at Scarborough.

At the meeting on Thursday, the report and accounts were adopted. The Chairman stated that the Corporation had approached the company with regard to the erection of a refuse destructor, and had asked what price they would charge per ton for this. A price for this was very difficult to arrive at, for, from their investigations, they found that it averaged from 6d. to 3s. per ton in various parts of the country. The Electric Supply Company had asked 2s. 6d. per ton, but the Corporation, although they made no offer, evidently thought this too high. At the same time, he thought it would be a pity if the Corporation went to the expense of erecting works themselves without endeavouring to come to terms with the company.

SIMPLEX CONDUITS.—The second annual general meeting of the above company was held last week at Birmingham. The chair was occupied by Mr. Henry Huggins (chairman). The profits of the year, after providing for bad and doubtful debts, amount, with interest on investments and transfer fees, to £13,894, and after charging directors' fee, depreciation, and income tax, £2,340, and adding the amount brought forward from last year £1,379, there remains for disposal £12,933. The Chairman congratulated the shareholders upon the result of the year, pointing out that after paying a dividend of 6 per cent. on the preference shares, amounting to £2,280 and 10 per cent. on the ordinary shares, absorbing £4,000, they had carried £4,000 to reserve, and £2,653 forward to next year.

SMITHFIELD MARKET ELECTRIC SUPPLY.—At the meeting on Friday, the report and accounts, given in our issue for February 15th, were adopted. Mr. H. S. Leon stated that the position of the company, so far as the Corporation of the City of London was concerned, remained unaltered, and, as stated in the report, this was the reason for the directors' hesitation in declaring any dividends for the year 1907.

YORKSHIRE ELECTRIC POWER.—Mr. A. G. Lupton presided at the half-yearly meeting on Wednesday last week, when the report and accounts, given in our issue for February 5th, page 191, were adopted. He pointed out that in the revenue account under the heading of Management and General Expenses, no amount had been charged to the item "Auditor appointed under provisions of the Act." He stated that the Board of Trade would in future probably appoint the same auditors to represent them as those now representing the shareholders, with the result that unnecessary trouble would be saved and a definite saving to the finances of the company made. The extra cost of coal shown by the balance sheet he said was largely due to the fact that the sale of current had been greater than in the preceding half-year, but also in part to the abnormal rise in the price of coal. The revenue account showed a 40 per cent. increase. One of the most significant changes which had taken place during the year was with regard to the application of electricity in the textile industry. Four years ago the use of electricity for textile purposes was so small as to be practically negligible, but to-day in their power area, there were districts where entire mills were run electrically. One great satisfactory feature was that nearly all the consumers had connected, or arranged to connect, more motors than they had originally intended. A determined effort was also being made to attract new consumers into the district, the power mains being laid in districts pre-eminently suitable for electric power factories. He was glad to say that the feeling of opposition on the part of the local authorities was largely passing away, and the revenue which the company was deriving from the supply of electricity was growing fast. During the half-year under review, agreements for 3,252 h.p. had been made, which was nearly four times the increase of the preceding six months. Terms had been arranged with the Brighouse Corporation, under which the municipal generating station was closed and power taken in bulk from the company. A considerable revenue was also hoped for from tramways in this borough. In conclusion, Mr. Lupton stated that the time of waiting for many of them had been very tedious, and the directors had had very anxious moments, but it was felt that the company was now fairly started on its way towards success, and the districts served by the company were appreciating the facilities offered them.

PARLIAMENTARY INTELLIGENCE

LONDON ELECTRIC POWER BILLS.—The London (Westminster & Kensington) Electric Supply Bill was read a second time in the House of Lords on Tuesday. The London Electric Supply Bill was read a second time in the House of Lords on Thursday.

THE SUPPLY OF ELECTRICITY BILL.—In reply to a question in the House of Commons last week Mr. Lloyd George stated that he hoped to introduce a Bill amending the Electric Lighting Acts as soon as there seemed to be a reasonable prospect of time available for its discussion.

LONDON & WINDSOR MOTOR ROADS, TRAM ROADS, & TRAMWAY BILL.—This Bill, which has been under consideration by Mr. Campion, one of the Examiners of Proofs for Private Bills, with the Standing Orders of the House of Commons for several days, has been referred to the Standing Orders Committee upon a number of points in connection with notices, &c.

PETITIONS AGAINST BILLS.—The period for lodging petitions against Bills in the House of Lords has now expired, and since our last issue 42 petitions have been deposited against the London & District Electricity Supply Bill, 28 against the London Electric Supply (Joint Committee) Bill, 17 against the London & Windsor Motor Roads Bill, 13 against the West London, Barnes & Richmond Tramways Bill, whilst several petitions have been presented against the Highgate Hill Tramways Bill, London County Council Tramways Bill, London (Westminster & Kensington) Electricity Supply Co.'s Bill, and the Croydon & Southern District Tramways.

PROGRESS OF ELECTRIC BILLS.—The Metropolitan District Railway Bill and the Great Northern, Piccadilly & Brompton Railway Bill were read a second time in the House of Lords on Thursday. The South Wales Electric Power Distribution Co.'s Bill was read a second time in the House of Lords on Wednesday last week.

STANDING ORDERS COMPLIANCES.—The West London, Barnes & Richmond Tramways Bill has been referred to the Standing Orders Committee, owing to the promoters being unable to secure the consents of the London County Council, Surrey County Council, Hammersmith Borough Council, Wandsworth Borough Council, and the Barnes Urban District Council. The Croydon & Southern District Tramways Bill has been referred to the Standing Orders Committee owing to the consent of the Croydon Corporation and the Croydon Rural District Council not having been obtained. The London United Tramways Bill, the promoters of which are unable to obtain the consents of the Brentford Corporation and the Middlesex and Surrey County Council, has been referred to the Standing Orders Committee.

NEW COMPANIES

J. BONN & CO.—This company was registered on February 19th, with a capital of £1,500 in £1 shares, to take over the business of engineers, mechanical and electrical instrument and appliance manufacturers and model-makers, carried on by J. Bonn at 97 New Oxford-street, and 9 Lawrence Street, High Street, Bloomsbury, W.C., as "J. Bonn & Co." The subscribers are:—J. Bonn, A. E. Jones, Mrs. B. Bonn, Mrs. S. Jones, F. Mayer, W. H. Woodall, J. P. Whitehorne. No initial public issue. Registered without articles of association. The first directors are J. Bonn and A. E. Jones. Registered office, 97 New Oxford Street, W.C.

BRITISH MAGNETO CO.—This company has just been registered, with a capital of £1,000 in £1 shares, to carry on the business of electricians, manufacturers of, dealers in, and agents for the sale of all kinds of electrical apparatus for motor-cars or otherwise, motor ignition devices and electrical accumulators, motor-cars and boats, &c. No initial public issue.

Telegraph Traffic.—The cable between Trinidad and Demerara was restored to working order on the 21st instant. The via Hanekin land line route was restored on the 20th instant. We are further advised that the cable between Cayenne and Salinas (Brazil), belonging to the Compagnie Française des Cables Télégraphiques, which ceased working on January 27th, was repaired on the 24th instant, having thus been down for 28 days. This company's route via Haytî is therefore again open for traffic to South America. The storm which recently passed over Great Britain caused derangement of telegraphic wires, communication with Bolton, Blackburn, York, Middlesbrough, Darlington, Sunderland, and West Hartlepool being interrupted. Continental wires also suffered, some of the daily papers being without their market reports. Now that the French company's repairing steamer has completed the Brazilian repair, she will proceed to re-establish the Paramaribo-Cayenne cable. The following new telegraph offices have been opened in the United Kingdom, viz., at Carlton (Bedale), Easebourne (Midhurst), Hales (Market Drayton), King's Sanatorium (Midhurst), Llandefeilog (Llanelly), Portland, Flagship (Weymouth), Salsburgh (Motherwell), Station Road (Wescliff-on-Sea), and Tedburn St. Mary (Exeter).

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APPOINTMENTS AND PERSONAL NOTES

The West Ham Electricity Committee have appointed Mr. Whitney, of the Midland Electric Corporation for Power Distribution, mains assistant.

Dr. William Mansergh Varley, assistant professor of physics and electrical engineering at the Heriot-Watt College, Edinburgh, and examiner in physics for the Central Welsh Board, has been appointed headmaster of the Devonport Technical School.

A recommendation by the Electric Light Committee of the Bray Urban District Council that the salary of Mr. McDonnell, assistant electrical engineer, be increased by £10 per annum, has been adopted.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night, was £59 10s. to £60 per ton (last week, £58 10s. to £59 per ton).

HARRIS, LEE & CO.—In reference to the statement of affairs given in our last issue, a meeting of creditors was held on Wednesday last week, when Mr. Brown, of the Electrical Ordnance Co., occupied the chair. A cable was received from South Africa stating that the firm were unable to obtain an offer for the whole of the stock locally, and it was said to be understood that an offer would be made to continue the business on behalf of the creditors. In the result, however, it was decided that the liquidation of the company be proceeded with as quickly as possible with a view to an immediate winding up.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—In the bankruptcy of H. B. Budd, Ruminantly, East Grinstead, Sussex, the accounts show unsecured liabilities amounting to £1,022 12s. 5½d., and net assets estimated to realise £36 5s. 9d., or a deficiency of £986 7s. 0½d. The debtor for the last 12 months has had a business known as the Hastings & St. Leonards Electric Installation Co., at 37c Robertson Street, Hastings. A composition of 7s. 6d. in the £ has been approved.

Wireless Telegraphy.—The *Manchester Courier* states that the Council of the Liverpool Chamber of Commerce has adopted a resolution urging the Government to introduce wireless telegraphy installation in British possessions abroad. The president, Sir Alfred Jones, states that it was hoped the Colonial Office would establish the system in the West Africa, but they had urged it was not feasible, though Signor Marconi had expressed his confidence that there would not be the slightest difficulty in working it. Inquiries showed the cost of laying a cable for Southern Nigeria and Lagos would be about £20,000, and that the cable companies wanted a guaranteed income of £4,000 a year before they would lay the cable. As against this, the cost of installing wireless apparatus would be only about £2,000, and the cost of working about the same.

MISCELLANEOUS CITY NOTES

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO.—The directors recommend a final dividend on the preference shares at the rate of 7 per cent. per annum, and on the ordinary shares at the rate of 11 per cent., making 10 per cent. for the year. After crediting depreciation account with £8,000 and transferring to reserve £4,000 the sum of £10,156 is carried forward.

CHELSEA ELECTRICITY SUPPLY CO.—The directors recommend dividends for the half-year to December 31st, 1907, at the rate of 6 per cent. per annum on the preference share capital, and 5 per cent. per annum on the ordinary share capital of the company, making 6 per cent. and 4½ per cent. respectively for the year 1907, after paying debenture interest and placing £11,619 to depreciation fund, £519 to debenture premium redemption fund, and writing off £802 from the cost of extinction of founders' shares; carrying forward £904 as against £1,092 in the previous year. The dividends will be payable on and after March 16th, 1908.

COUNTY OF LONDON ELECTRIC SUPPLY CO.—The directors recommend a final dividend on the ordinary shares of 6 per cent. per annum for the half-year to December 31st, 1907, making 5 per cent. for the year. The sum of £25,000 has been transferred to reserve for depreciation, and £4,381 carried forward.

METROPOLITAN ELECTRIC TRAMWAYS.—It is stated that underwriting arrangements have been completed for an issue of £173,800 4½ per cent. debentures at 96 by this company. This issue will range *pari passu* with the existing £350,000 4½ per cent.

TELEGRAPH CONSTRUCTION AND MAINTENANCE CO.—The transfer books will be closed until March 3rd.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.—It is stated that Messrs. Edwin Waterhouse, J. S. Phillips, J. B. Ackroyd, Thomas Skinner, and M. Prior, who, together with Mr. Lynden Macassey as secretary, agreed to act as an advisory committee to examine the scheme proposed by the Underground Electric Railways Co. of London, Ltd., and Messrs. Speyer Brothers for dealing with the profit-sharing notes issued by the Underground Electric Railways Co. of London in 1903, which mature in June, have held a number of meetings to consider the scheme in conjunction with the corresponding committees in Amsterdam and New York, and will complete almost immediately their investigation.

W. T. HENLEY'S TELEGRAPH WORKS CO.—A dividend of 15 per cent., less tax (including an interim dividend of 5 per cent. paid in December), has been declared upon the ordinary shares.

New Telephone Charges.—The Postmaster-General has sent a letter to Lord Joicey inviting the various Chambers of Commerce, which comprised the recent deputation concerning the telephone charges, to select a few of their number, say five or six, to discuss personally with him the questions in dispute. He states that for the discussion to be useful and complete, the smaller user should be represented as well as the large user. The Secretary of the Newcastle Chamber of Commerce has stated his intention of arranging the suggested conference.

OFFICIAL ANNOUNCEMENTS AND SMALL ADVERTISEMENTS.

Official Advertisements are charged at the rate of **1/-** per line (column width).

Small Prepaid Advertisements of Situations Vacant and Wanted, Plant for Sale or Wanted, &c., are inserted at the rate of **1/-** for the first 12 words and 1d. per word afterwards. Three insertions for the price of two. Advertisements can be received up till Wednesday morning first post.

Letters should be addressed to THE KILOWATT PUBLISHING CO., LTD., 203–6, Temple Chambers, London, E.C.

SITUATION VACANT.

ASSISTANT DISTRIBUTING ENGINEER wanted near London. Previous experience with H.T. and D.C. mains, arc lamps, and meters essential. Preference given to a man suitable for interviewing consumers. Salary £78.

Apply, stating experience, age, and enclosing testimonials, to Box A55, ELECTRICAL ENGINEERING, 203, Temple Chambers, London, E.C.

APPOINTMENTS VACANT.

THE NATIONAL PHYSICAL LABORATORY.

VACANCIES OCCUR FOR TWO JUNIOR ASSISTANTS IN THE ELECTRICAL AND ELECTROTECHNICAL DEPARTMENTS. The stipends of Junior Assistants range from £100 to £150 a year. Commencing stipend according to qualifications. Apply before March 8 to the Director, National Physical Laboratory, Teddington, stating age, and giving details of experience and references. Applicants should have general workshop and practical electrical testing experience in addition to a good theoretical training. It is desirable that only copies of testimonials should be sent.

FOR SALE.

CITY OF BIRMINGHAM.

THE ELECTRIC SUPPLY DEPARTMENT have for disposal, at their Dale End Station, Eleven High Speed Engines and Dynamos; Six Lancashire Boilers; Four Babcock Boilers; Spare Armatures; Balancers; Boosters; Direct Current Motor-Transformers; Steam and Feed Piping; Fittings, &c.

The detailed list of the apparatus may be had by applying to the undersigned.

R. A. CHATTOCK,
City Electrical Engineer and Manager.

14, Dale End,
Birmingham.
27th February, 1908.

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"ELECTRICAL ENGINEERING" PATENT RECORD

(This Patent Record is compiled by our own Editorial Staff and is Strictly Copyright.)

Specifications Published Feb. 20th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from abroad.

1906 Patents

24,232. BRITISH THOMSON-HOUSTON CO. (*Allgemeine Elektricitäts-Ges.*). The preparation of filaments for electric lamps. A metallic tungsten filament is heated to a temperature of approximately 500° C. in a chamber with a limited supply of oxygen. This filament is reheated to a high temperature in a vacuum. The filament then consists entirely of tungstous oxide, WO_2, and it is claimed to have a longer life than the ordinary metallic filament. Four claims, no figures.

24,253. BRITISH THOMSON-HOUSTON CO. (*Allgemeine Elektricitäts-Ges.*). Holders or supports for lamp filaments incandescing at high temperatures, composed wholly of, or having a surface coating only of pure thorium or magnesium oxide. The holder is moulded, heated to a temperature of at least 2,000° C., and then dipped in a mixture of hydrofluoric and sulphuric acid. The melting point of the final product is very high, so that there should be no danger of the filament becoming fused to the holder. Two claims, no figures.

1907 Patents

2,416. W. E. SUMPNER. The use of an auxiliary winding on the electromagnet or transformer portion of alternating-current instruments for the purpose of eliminating errors due to phase differences. The ends of the auxiliary winding are connected to the opposite plates of a condenser of such a capacity that the ampere-turns of the auxiliary winding are equal to the magnetisation ampere-turns of the primary winding. Four claims, five figures.

3,739. LANCASHIRE DYNAMO & MOTOR CO., WARBURTON, & KELSALL. A method of automatic control for motors driving punching and shearing or similar machines. When the period of heavy load comes on, and the motor slows down, the field is automatically increased, thus compelling the fly-wheel coupled to the motor to give up a large amount of energy and at the same time preventing the motor from taking too much power from the supply mains. When the load is taken off the motor accelerates and the field is automatically decreased, thus causing the motor to accelerate at a quicker rate and to take more power from the supply mains. A particular case of a series motor is described in the specification, in which the series winding is provided with a diverter rheostat controlled by shunt and series coils. Three claims, one figure.

4,364, BRITISH THOMSON-HOUSTON (*General Electric Co.*). An improved method for treating carbon filaments. The filaments are heated with a silicon-bearing substance, such as quartz, to a temperature of about 1,500° C. for about one hour. After this treatment the filaments are reheated in a vacuum furnace to a temperature of about 2,000° C. to drive out any volatile matter. These filaments give out a white light and have a high efficiency. Six claims, no figures.

4,706. HOWARTH (*Akt.-Ges., Brown, Boveri & Cie.*). The exciting windings of the interpoles of a single-phase motor are supplied by an alternating-current, generated by transformer action, in an auxiliary winding on one or both of the main poles. The interpole field consequently follows all the irregularities of the main field, and any electromotive forces induced by transformer action in the short circuited armature coils by the main field are exactly neutralised by electromotive forces induced by rotation in the interpole field. Inductive and non-inductive resistances are placed in the excitation circuit to adjust the magnitude and phase of the interpole exciting current. One claim, six figures.

4,742. BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). A single-phase motor without a commutator, but possessing the characteristics of a direct-current series motor. The motor is of the repulsion type, as the field winding only is connected to the supply. The rotating member is a ring on which is wound a ring winding and also a drum winding, both divided into sections, a section of the ring winding being in series with a corresponding section of the drum winding. Inside the ring is a stationary iron core set at about 45° to the axis of the main field, thus shunting part or all of the main field. Electromotive forces, induced by transformer action in portions of the ring winding, send currents through the corresponding portions of the drum winding, which set up a field at right angles to the primary field. A reaction between the stationary and rotary members is produced in consequence, which causes the ring to rotate. No E.M.F.s due to rotation are induced in the ring winding, but E.M.F.'s are induced in the sections of the drum winding, which oppose the E.M.F.'s induced by transformer action in the ring winding. The current and torque are thus reduced as the rotor speeds up. Two claims, two figures.

14,725, SIEMENS BROS.' DYNAMO WORKS (*Siemens Schuckertwerk-Ges.*). A quick-acting voltage regulator of the type in which a resistance in the field circuit of the exciting machine is periodically or intermittently short circuited and put in circuit in order to vary the exciting current in accordance with the load. The improvement consists of controlling the movable lever and contact by the differential action of two electromagnets with different time constants. Six claims, seven figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Summaries of the more important of these patents will appear in our next issue.

1906 Patent

24,923, RAWORTH. Electric traction control systems.

1907 Patents

440, BRITISH THOMSON-HOUSTON CO. (*Allgemeine Elektricitäts Ges.*) Regulating A.C. commutator motors.
2,652, JOEL. Electric batteries.
2,675, CONNOLLY. Insulating electric conductors.
2,720, PATTERSON. Miners' electric safety lamps.
2,750, VON ZWEIGBERGK. Motor starting switches.
2,751, VON ZWEIGBERGK. Controllers for cranes, &c.
2,930, SUGDEN & RODWAY. Circuit breakers.
2,963, WELLINGTON & DANIELL. Arc lamps.
2,964, WELLINGTON & DANIELL. Arc lamps.
3,000 and 3,000A, BOULT (*Elektrizitäts Akt.-Ges. vorm. Schuckert & Co.*). Electrolytic apparatus.
3,060, JONES. Arc lamps.
3,693. HEPKE & DIENER. Fuses.
3,881, TORDA. Variable-speed motors.
6,455, LEA. Tumbler switch.
6,751, RAVENSHAW, MIDDLETON, & TOWNSEND. Magnetic clutches or brakes.
6,925, ATKINSON. Electric controllers or switches.
7,449, THORPE. Electricity meters.
8,642, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Mounting incandescent lamp filaments.
8,706, SCHMIDT. Interrupters for electric circuits.
9,294, HOLDEN & ELPHINSTONE. Automatic switches.
9,345, ELLIOTT. Electric pendant lamps.
11,071, ALLGEMEINE ELEKTRICITÄTS GES. Electrically-operated winding gear.
11,873, SIEMENS BROS. DYNAMO WORKS LTD., & POYNDER. Method of altering the working speed of polyphase motors.
14,100, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Lightning arresters, &c.
16,574, LUNDBERG, LUNDBERG, & LUNDBERG. Switches.
17,308, WAPPLER & FAYER. Interrupters.
17,410, SIEMENS SHUCKERTWERKE GES. Switches.
17,717, COWPER-COLES. Electroplating.
19,794, GES. FÜR DRAHTLOSE TELEGRAPHIE. Detectors.
19,856, SIEMENS BROS. DYNAMO WORKS, LTD. (*Siemens Shuckertwerke Akt.-Ges.*). Couplings for A.C. Generators.
20,185, AKTIEBOLAGET ALADDIN. Starting devices for vapour lamps.
20,676, CONRAD. Electrically-operated switches, &c.
21,035, YATES & LUM. Motor control.
21,119, VON PEEZ. Electric indicators.
22,746, SIEMENS & HALSKE AKT.-GES. Filaments for incandescent lamps.
24,706, JOHNSON & PHILLIPS, LTD., & TURBS. Arc lamps.
24,862, ARCIONI. Integrating train for double tariff meters.
27,933, UNTERBERG & HELMLE. Testing aparatus for magneto-electric ignition apparatus.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patents

21,584, BURKE. Dynamo-electric machines.
28,647, FESSENDEN. Production of high frequency oscillations.

1908 Patents

549, TRÜMPLER. Electrical heating apparatus.
1,159, THOMPSON. Regulation of alternating current circuits.
2,206, AMALGAMATED RADIO-TELEGRAPH CO. Radio-telegraphy.
2,375, HOWARD. A.C. relays.

Expiring Patents

No patents of electrical interest expire during the current week.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. * = Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ltd.	10	7	5/-*	10¼—11¼	
Do. 4½% Cum. Pref.	10	4½	4½	10—11 xd	
Do. 6% Cum. Second Pref.	10	6	6	10—10¼ xd	
Do. 4½% Debenture, Red.	Stock	4½	4½	100—103	
Bromley (Kent) E.L.& Power Co., Ltd.	5	5½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	95—98	
Brompton & Kensington E. S. Co., Ltd.	5	10	4½%*	7⅛—8⅛	+⅛
Do 7% Cum. Pref.	5	7	7%*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	97—100	
Ch. Cross, W. E. & City E. S. Co.	5	5	5%*	4⅜—4⅞	
Do. 4½% Cum. Pref.	5	4½	2½%	4⅜—4⅛ xd	
Do. 4% Deb. Red	Stock	4	4%	97—100	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	4⅜—4⅞	
Chelsea Electric Supply Co., Ltd.	5	4½	2/-*	3⅜—4⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	5%*	10—11	
Do. 6% Cum. Pref.	10	6	6%*	11⅛—12½	
Do. 5% Deb. Red	Stock	5	5%	122—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	99—102	
City of Durham E. P. Dis. Co.	5	4	2/1½*	3—3¼	-¼
Do. 5% Pref.	5	5	5%*	4⅜—4⅞	
County of London Elect. Sup. Co. Ltd.	10	5	4%*	7⅛—8	+¼
Do. 6% Cum. Pref.	10	6	6%*	11—11½	-⅛
Do. 4½% Deb. Red	Stock	4½	4½	105—108	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	96—99	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	¼—¾	
Do. 6% Cum. Pref.	5	3½	—	¾—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	70—80	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4⅜—5⅛	
Do. 5% Cum. Pref.	5	5	2/6*	5—5⅛	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6⅛—6⅜	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%	95—98	
Kens. & N'tng Hill E.L. Cos. Db. Rd.	Stock	4	4%*	99—103	
London Electric Supply Corporation	3	4	2/4½d*	1¼—1⅜	
Do. 6% Pref.	5	6	6%*	4⅜—5⅛	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	91—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	5⅜—6⅛	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅝—5⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	+1
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D.	100 & 500	4½	4½%	98—101	
Newcastle & Dist. E. L. Co., £9 paid	10	5	3/7½d.*	9¼—10¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6½—6¾	
Do. £2 Pm.	5	8	1/4⅜d*	6¼—6⅜	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5½	
Do. 10/- Pm.	5	5	1/4⅜d	5—5½	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	6%*	11½—12½	
Oxford Electric Co., Ltd.	5	7	2/6*	5⅜—6½	
Do. 4% Deb. Red	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ltd.	5	10	5/-*	7⅞—8⅜	
Do. 7% Non-Cum. Pref.	5	7	3/6*	6½—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	½—1½	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2½—3	
South Metropolitan E. L. & P. Co.	1	2½	6d*	½—¾	
Do. 7% Cum. Pref.	1	7	8⅞d.*	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	101—104	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1½—2⅜	
Do. 5% Cum. Pref.	5	5	2/6*	2—2⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	5%*	8—9	
Do. 4½% Cum. Pref.	5	4½	4½%	5—5½	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	88—90	
Central London	Stock	4	3%	64—67 xd	-1
Do. 4% Preferred	Stock	4	4%	82—84 xd	
Do. Deferred	Stock	4	2%	44—47 xd	
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	77—80	+1
City and South London Cons.	Stock	2½	4¼%	38—40 xd	-1
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	114—117 xd	
Do. 5% Perp. Pref. 1896	Stock	5	5%	112—115 xd	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113 xd	
Great Northern & City Pref. "A"	10	4	11½d.	1⅛—1⅜	
Gt. Northern, Piccadilly & Brompton	10	4	4/-*	5½—6½	+1
Do. 4% Perp. Deb.	Stock	4	4%	86—89	+1
Mersey Cons.	Stock	n l	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1%	37—38	-1
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½%	72—75	
Metropolitan District	Stock	nil	—	10½—11½	
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Deb.	Stock	4	4%	71—76	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pr. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	42—45	-2
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅝—¾	
Do. 5% Cum. Pref.	1	5	5%	1⅛—1⅜	
Do. 4½% Deb. Red.	Stock	4½	4½%	90—95	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1¾	
Do. 6% Cum. Pref.	10	6	6%*	4⅝—5⅛	-⅛
Do. 5% Perp. Deb.	Stock	5	5%	97—101	+1
Do. 4½% 2nd Deb.	Stock	4½	4½%	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4⅜—4⅞	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	98—101	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. * = Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%			
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½ xd	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅝—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7—8	-¼
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	92—95	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—1/8	
Do. 5% Cum. Pref.	1	5	5%	1⅛—1⅜ xd	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	98—100	
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—½	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅜—1⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅛—⅜	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9½d*	¼—½	
Do. 5% Cum. Pref.	1	5	5%	⅜—½ xd	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4⅛—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	1/1½	⅞—1⅛	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	60—70	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1⅛	
Do. 6% Cum. Pref.	5	nil	—	3½—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	3½%	55—58 xd	-1
Do. 6% Pref. Ord.	Stock	6	6%	99—101 xd	-½
Do. Def. Ord.	Stock	1⅜	1%	13⅜—14½ xd	-½
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	87—90	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3½	
Do. 10% Cum. Pref.	5	10	5/-*	8½—9½	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4½	4⅝%	13⅜—14⅝	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12⅞—13½	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5⅜	5%	131—136	
Do. 3½% Pref.	Stock	3½	1¾%	84—87	
Do. 4% Mort. Deb.	Stock	4	4%	100—103	
G. N. Tel. Co. (Copenhagen)	10	20	5%	32—34	-1
Indo-European Telegraph Co. Ltd.	25	13	65/-	54—57	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	
National Telephone Co., Ltd., Pref.	Stock	6	6%*	111—113	
Do. Deferred	Stock	5½	6%*	111½—113½	
Do. 6% Cum. 1st Pref.	10	6	6%*	11—13	
Do. 6% Cum. 2nd Pref.	10	6	6%*	10½—12½	
Do. 5% 3rd Pref.	5	5	5%*	5⅞—5¼	
Do. 3½% Deb. Red	Stock	3½	3½%	97—99	
Do. 4% Deb. Red.	Stock	4	4%	100½—102½	
West African Telegraph Co. Ltd.	10	4	4/-	10—10¼	
Western Telegraph Co., Ltd.	10	7	6%	13½—13⅝	-⅛
Do. 4% Deb.	Stock	4	4%	98½—101½	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	¼—⅜	
Do. 6% Cum. Pref.	1	6	7½d	3⅜—3⅝	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅝—3⅞	+⅛
Do. 6% Pref.	1	6	7½d	1⅞—1⅞	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6⅝—7⅛	
Do. 6% Cum. Pref.	5	6	6%	5⅞—6	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	101—104	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%*	85—89	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—⅜	
Do. 4% Mort. Deb. Red.	Stock	4	4%	43—48	+1
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅜	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	79—82	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	11—12	
Do. 5% Cum. Pref.	5	5	5%	5⅜—5⅝	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106—108	
Consolidated Electrical Co., Ltd.	1	3	8⅞d*	⅞—1⅛	
Crompton & Co., Ltd.	3	5	5%	1⅞—2⅛	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1—1⅛	
Do. 6% Cum. Pref.	1	6	7½d	1—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	99—102	
Edison & Swan United "A." £3 paid	5	4½	2/6	⅜—1	
Do. do (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	⅝—1⅝	
Do. 7% Cum. Pref.	2	7	—	1⅜—1⅝	
Do. 4% 1st Mort. Deb.	Stock	4	4%	65—69	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅞—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	11⅜—12⅜	
Do. 4½% Cum. Pref.	5	4½	2/1*	5—5½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	+½
Do. 4% Deb. Red.	100	4	4%	99—101	
Tel. Const. & Maintenance Co.	12	15	5%*	33—35	
Do. 4% Deb. Bds. Red	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3¼—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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ELECTRICAL ENGINEERING

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SUMMARY

The inquiry into the objections to the draft Home Office regulations relating to the use of electricity issued last year was opened by Mr. James Swinburne on Tuesday. At the commencement, the opposition asked that the following four questions of principle be considered and decided first before details of the various regulations were gone into:—(a) The question of dual control; (b) whether the limiting voltage to which the regulations were to apply should not be 250 instead of 100; (c) whether existing apparatus should be affected, *i.e.*, should the regulations be retrospective; (d) whether there should be an appeal from the decision of an inspector in enforcing the regulations. The case for the Home Office was opened upon these points, and Mr. G. S. Ram, the Electrical Inspector of Factories, gave evidence. It was stated that, as the result of a conference between the Home Office and the Board of Trade, the latter department has decided to relinquish Nos. A 1, A 24, and A 28 of its Regulations in order to eliminate any question of dual control. These concessions, however, by no means satisfy the opposition. Yesterday Mr. Swinburne stated that he could not make a preliminary report on the four questions of principle submitted above, and decided that the inquiry should take its normal course, and that the evidence put forward in support of the regulations should be completed. (Page 341.)

Considerable progress has been made with the extension to the Kingsway tramway subway, which is to connect the embankment lines with the northern system; and it is hoped that traffic will be commenced by the end of March. Most of the new subway is double-track tunnel, but a short length is composed of separate tubes for each track. A simpler form of conduit construction is used than in the case of the L.C.C. surface lines. (Page 343.)

The report and accounts of the Charing Cross, West End, and City Electricity Supply Co. for the year ended December 31st, 1907, show a considerable increase in business over former years. The combined costs of West End and City undertakings work out at 1·55d. per unit, including allowance for depreciation. (Page 347.)

A detailed description of the instrument employed in the directive wireless telegraph system of E. Bellini and A. Tosi, in order to vary the direction of communication while using fixed aërial conductors, is given in an article by these authors, together with a theoretical discussion of its action. A similar arrangement is used for receiving as for sending, and it is claimed that when receiving signals the bearings of the sending station can be determined within one degree.

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By taking bearings of two known stations, a ship at sea can ascertain its position with considerable accuracy. (Page 348.)

A GREAT deal of attention is being paid to the manufacture of small transformers for reducing the supply voltage of alternating-current installations to a value suited to the most convenient forms of metallic filament lamp. A secondary voltage of 100 volts or thereabouts is sufficient in many cases, but in some installations where it is desired to use small units of light a voltage as low as 25 volts is sometimes used. In practically all cases auto-transformers with a single winding are used, as these are both simpler and more efficient than the type with separate primary and secondary windings; and advantage is obtained in cases where the secondary voltage is one-half or one-third of the primary by utilising all the sections of the transformers as a balancer, and dividing the load as equally as possible among them. By this means a smaller transformer may be employed, as the copper losses only correspond to the out-of-balance current. This arrangement entails very little alteration to the wiring of an existing installation. A form of transformer is also made for use with single lamps or groups of lamps which are switched on and off together. This can form a part of the fitting, and avoids no-load losses when the lamps are not in use. (Page 351.)

THE East Ham telephone exchange of the National Telephone Co., opened last January, is typical of the latest practice in small common battery exchanges. A multiple switchboard is employed with a present accommodation for 500 lines, and an ultimate capacity of 800 subscribers' lines. Electromagnetic calling signals are used instead of lamps, and these are restored by gravity when the current is cut off from the magnet coil by the insertion of the answering plug. The subscribers' operators' cord circuit is divided by condensers instead of by a repeating coil, and a 16-cell battery is employed instead of 11 cells. (Page 355.)

A NEW type of solenoid-operated controller for printing-press motors, which presents some new features, is described in an illustrated article. (Page 358.)

THE report of the Departmental Committee appointed to inquire into the working of the National Physical Laboratory recommends that the ordinary testing of materials to ascertain if they fulfil the requirements of contracts should, with certain exceptions, not be undertaken by the Laboratory, and should be left to private practitioners. On the other hand, the rule as to compulsory publication of the results is to be relaxed. In addition to publishing the contents of the report, we give several extracts from the evidence, the most interesting of which relates to a request by Sir JOSEPH SWAN, that could not be granted, that the Laboratory should undertake for him certain investigations with regard to the properties of certain refractory metals and metalloids, the results of which, Dr. GLAZEBROOK said, might have had a great influence on the metallic filament lamp industry in this country. (Page 359.)

THE bulk supply to the Middlesbrough Corporation from the Cleveland and Durham County Electric Power Company will be commenced in a few days. A substation has been constructed, which receives current at 11,000 volts, three-phase, and supplies continuous current from two 700 kw. rotary converters. (Page 362.)

AN illustration is given of a new pattern of electric kettle. (Page 362.)

AN article upon impressions produced by electric waves upon photographic plates is abstracted under "Electrochemistry and Electrometallurgy." JOSEF RIEDER finds that glass plates upon which an image has been impressed and then coated with aluminium powder will then reproduce that image when subjected to the action of electric impulses. The metallic image, in fact, behaves as a coherer. The German Government has recently erected an electrolytic plant capable of producing 600 cubic metres of hydrogen gas per 24 hours. The plant has been specially installed for the purpose of inflating army balloons. (Page 363.)

TANTALUM lamps in a number of sizes are now available for use on alternating-current circuits. (Page 363.)

UNDER "Electrical Science," in the British and American section, is a note of a Paper on the constant E.M.F. between mercury and certain electrolytes. P. WALDEN formulates a law connecting dissolving power with specific inductive capacity. Miss GLEDITSCH tests Ramsay's connection between radium, copper, and lithium by the spectroscopic analysis of radium minerals. (Page 364.)

AMONG the specifications published by the Patent Office on Thursday last is that by A. D. JONES, describing the composition used for filling the grooves of the positive carbon of the Jandus enclosed flame arc-lamp, which was described in our last week's issue. One by the BRITISH THOMSON-HOUSTON Co. covers a method for fusing metallic filaments to the leading-in wires in incandescent filament lamps; and SIEMENS & HALSKE have one relating to metallic filaments with coatings of another metal. SIEMENS BROS. DYNAMO WORKS and H. B. POYNDER have patented a modification of their method of speed control for polyphase motors. An abstract of the specification covering their method was published in ELECTRICAL ENGINEERING, February 20th, 1908, p. 285. (Page 365.)

AN inquest has been held at Birmingham with regard to the death of a tramway conductor caused by the overturning of a car. Sir ALEXANDER KENNEDY has declined to accept the appointment of consulting electrical engineer to the Burgh of Dunfermline, in consequence of the rejection of his recommendation that the Council's Provisional Order should be transferred to the Fife Electric Power Co. A large increase in the deficit of the Hastings Corporation Electricity Department is expected, which, it is alleged, is partly due to reduced income from private lighting owing to the increased use of metallic filament lamps. The Works Committee of the Paddington Borough Council have recommended that an offer by the Metropolitan Electric Supply Co. for lighting a portion of Harrow Road with 66 flame arc lamps in place of gas lamps be accepted; but the matter is still under discussion. (Page 367.)

IT will be moved in the House of Lords to-day that the London Electric Supply Bills be referred to a Joint Committee of both Houses. The second reading of the Cavehill and Whitewell Tramways Bill has been rejected. (Page 369.)

AN expenditure of £35,967 has been authorised in Hull by the Local Government Board, largely for the renewal of old cables and the laying of additional mains. The Napier (New Zealand) Municipality invites offers for the construction of tramways. Tenders for generating plant are invited at Heywood, Stoke-upon-Trent, and West Ham. (Page 370.)

THE Westminster City Council has accepted the tender of the Westminster Electric Supply Co. for the lighting required in connection with the Marble Arch Improvement Scheme, in preference to the tender of the Gas Light and Coke Co. The lamps will be flame arcs; the Gas Company tendered for high-pressure incandescent gas lamps. Subject to Parliamentary sanction, the Tramways Committee of the Ilford Urban District Council has recommended provisionally the adoption of the "Robrow" surface-contact system for a section of their tramways. The Walthamstow Urban District Council has accepted the Vulcan Boiler & General Insurance Co.'s tender for the insurance against breakdown of eleven armatures at the electricity works at a yearly premium of £90. (Page 371.)

THE question of underground telephone wires in

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London has been again before the London County Council. Although the Post Office can lay these without payment to the Council, and can rent them to the National Telephone Co., the Council still insists on a rental being paid by the company if they lay the wires themselves. (Page 372.)

A letter from the Jandus Arc Lamp and Electric Co., received as we go to press, makes clear the points of difference between the new Jandus enclosed flame arc lamp, described in our last issue, and the Blondel Lamp. (Page 373.)

The increased earnings of the South Metropolitan Electric Light and Power Co. for the past year have amounted to over 8 per cent. on the additional capital expenditure during the year. Meetings have been held during the week of the London Electric, Charing Cross and City, Kensington and Knightsbridge, and Westminster Supply Companies, at which the reports given in previous issues of Electrical Engineering were adopted. The report of the Metropolitan Electric Supply Co. shows an increase in the gross revenue of £3,048, and an increase of working expenses of £395. The further dividend of 3s. 6d. per share makes a total distribution for the year of 6½ per cent. The report of the Brompton and Kensington Electric Supply Co. shows a credit balance on the revenue account of £31,718. The dividend on the ordinary shares had been at the rate of 10 per cent. for the year. The accounts of the Cambridge Electric Supply Co. show a profit for the year of £8,292; the dividend for the whole year is 6 per cent. The final dividend of the Telegraph Construction and Maintenance Co. makes a total of 17½ per cent. for the year. Some objections have been lodged to the appointment of the liquidators of Messrs. Bruce Peebles & Co. (Page 374.)

The opposition against the imposition by the Home Office of new Regulations as to the employment of electrical energy in factories is very real. No less than 185 sets of objections had been lodged for consideration at the official inquiry by Mr. Swinburne which commenced on Tuesday. The need for additional official control has certainly not been made apparent in the statement made by Mr. Ram, and we maintain the opinion that in the case of premises supplied with electrical energy the present Board of Trade regulations are amply sufficient. They protect the public, it is argued, and not the workman, but since the means of protection are the same in both cases there is no need to make a change. It might have been expected that Mr. Ram would come provided with a long list of serious accidents due to causes not preventable if the Board of Trade Regulations were regarded, but preventable under his new code, but this course has evidently not been applicable, as the number of serious and fatal accidents due to the utilisation of electricity in works has been extremely low.

The question of suitable supply voltages for incandescent lighting, which, after an acute controversy between the interests of the lamp-maker and the supply authority, was practically settled in favour of standard pressures of about 200 volts, has been reopened by the introduction of metallic filament lamps, for these at the present time can only be made suitable for such circuits in sizes forming an inconveniently large light unit to substitute for the carbon filament lamps commonly used in existing installations. We will not attempt to predict what the future will bring forth in this respect, but what we desire to call attention to is that, in the present state of the art of lamp manufacture, the advantages of high-efficiency metallic filament lamps can in many cases only be made available where a much lower pressure than 200 volts is obtainable. A certain amount is, of course, done by running lamps in series, but the disadvantages of this method are obvious. On alternating-current circuits the best course is to adopt small transformers on consumers' premises; and an article on another page describes the results of the activities of a number of manufacturers in this direction. The transformers used are, in practically all cases, of the auto-transformer or single-winding type, as this gives advantages both as regards cost and efficiency; and wherever the conditions of the installation allow they should be connected up as balancers, and the circuits divided up into two or more sections as equally loaded as possible. This arrangement, especially in installations of fair size, entails less alteration to existing wiring than might be at first supposed, and results in a very considerable saving in the copper losses, as the transformer only has to carry the "out of balance" current, and indirectly in the iron losses, as a smaller apparatus can be used. Owing to the much higher efficiency of the metallic filament lamp as compared with its predecessor, the currents which the wiring and fuses will have to carry will, notwithstanding the lower voltage, not be increased above their value under the old conditions. In some installations groups of lamps always switched on and off together may have their own transformer, as then the open-circuit loss when the lamps are not in use can be avoided.

The report of the Departmental Committee with regard to the working of the National Physical Laboratory, and the Blue Book containing the evidence, affords interesting reading, and the result will be that a check will be put to some extent on the commercial testing of samples in competition with consulting engineers and private testing laboratories. Although the amount of work done so far in this direction by the Laboratory has not been great, it is evident that an extension of it was in contemplation by the long tariff of tests published in a pamphlet which has been circulated freely by the Laboratory, and by the fact that the fees for these tests were based practically on less than cost price. It appears that the charges were based on an estimate of the actual cost of labour and material, increased only by 15 per cent. The Laboratory has no rent to pay, and no allowance was made for this, nor for the fact that costly instruments have to be bought and maintained and an expensive organisation kept up, so that the subsidy given by the Government and private benefactors was actually being used to divert business from some of the best and most useful workers in the engineering professions. The statement that this competition at "cut" prices was unintentional must, of course, be accepted unreservedly, but that it existed and was capable of serious development is none the less certain. The Laboratory is in a position to do a vast amount of useful research work, and, in fact, it has already produced some valuable results, and this is the more reason that a policy should be followed which will enable it to proceed unhampered by jealousies and free from sordid business considerations which must be particularly unattractive to the distinguished scientific gentlemen who are responsible for the work and organisation of the institution.

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ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, MARCH 5TH.

Royal Society.

4.30 p.m. Meeting at Burlington House, Piccadilly. Among the Papers to be read are the following:—(1) "On the Electrical Resistance of Moving Matter," by Prof. F. T. Trouton, F.R.S., and A. O. Rankine; (2) "On the Nature of the Streamers in the Electric Spark," by Dr. S. R. Milner.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at 25 Great George Street, Westminster, S.W. Paper to be read: "Fuse phenomena," by Prof. A. Schwartz and W. H. N. James.

Röntgen Society.

8.15 p.m. Ordinary General Meeting at 20 Hanover Square, W., when Dr. Deane Butcher's Paper on "Recent Improvements in X-ray Apparatus," will be discussed.

SATURDAY, MARCH 6TH.

Royal Institution.

3 p.m. Afternoon Lecture I., by Prof. J. J. Thomson, F.R.S., on "Electric Discharges through Gases."

TUESDAY, MARCH 10TH.

Institution of Electrical Engineers: Manchester Students' Section.

7.30 p.m. Meeting at the Municipal School of Technology, Whitworth Street. Paper to be read:—"Electrical Testing," by A. E. Jepson.

Institution of Electrical Engineers: Manchester Local Section.

7.30 p.m. Special Meeting at the University, when Mr. W. Rosenhain will deliver a lecture on "The Internal Structure of Metals."

Institution of Electrical Engineers: Glasgow Local Section.

8 p.m. Meeting at 207 Bath Street, Glasgow.

WEDNESDAY, MARCH 11TH.

Institution of Electrical Engineers: Birmingham Local Section.

7.30 p.m. Meeting in the University. Paper to be read:—"Artificial Load for Testing Electrical Generators," by R. K. Morcom and D. K. Morris.

Association of Engineers-in-Charge.

7.30 p.m. Meeting at St. Bride's Institute, Fleet Street, London. Paper to be read:—"Notes on Electric Lifts," by H. D. Wilkinson.

Incorporated Institution of Automobile Engineers.

8 p.m. Annual General Meeting at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London. Paper to be read:—"Some Problems Peculiar to the Design of Automobiles," by F. W. Lanchester.

THE PROPOSED HOME OFFICE REGULATIONS

(Special Report. Strictly Copyright)

THE inquiry ordered to be held by the Home Office into the objections against the new draft regulations issued in August last year for the generation, transformation, distribution, and issue of electrical energy in premises under the Factory and Workshops Act, 1901, was commenced by Mr. James Swinburne, F.R.S., at Caxton Hall, Westminster, on Tuesday. The regulations in question, which were given at length in ELECTRICAL ENGINEERING, Vol. II., p. 282, apply to systems in which the normal working voltage is over 130 volts for continuous, or over 65 volts for alternating. The usual definitions of high and low pressure are employed, low pressure meaning a pressure not exceeding 250 volts, medium pressure meaning a pressure normally above 250 volts but not exceeding 650 volts, high pressure meaning a pressure normally above 650 volts but not exceeding 3,000 volts, and extra high pressure meaning a pressure normally exceeding 3,000 volts.

No less than 185 sets of objections have been lodged against the regulations, these representing supply authorities, both company and municipal, consumers, chambers of commerce, &c., throughout the kingdom. As many of these sets of objections represent the views of a number of authorities or persons, the actual number of objectors is very considerably greater than 185. The Home Office are represented at the inquiry by Mr. J. H. Gray and Mr. Raymond Asquith, and the official witnesses are Mr. J. Scott Ram, the Electrical Inspector of Factories to the Home Office, Mr. W. H. Patchell, and Mr. J. F. C. Snell.

At the commencement of the proceedings Lord ROBERT CECIL, K.C., M.P., who represents the London electric lighting companies and some others, suggested that as there were several questions of principle to be settled before the details of the regulations were discussed, the Commissioner should take these first and give a decision upon them. These points he defined as follows:—(*a*) The question of dual control; (*b*) whether the limiting voltage to which the regulations were to apply should not be 250 instead of 130 volts; (*c*) whether existing apparatus should be affected, *i.e.*, should the regulations be retrospective; (*d*) whether there should be an appeal from the decision of an inspector in enforcing the regulations.

This view was supported by many of the representatives of other objectors, and it was decided that Mr. Gray should open the case for the Home Office on these points first.

Mr. GRAY said he thought that one matter in connection with these regulations had been quite misapprehended, viz., the difference between the function of the Home Office in the administration of the Factory Acts, and the Board of Trade in the administration of the Electric Lighting Acts. The difference in the functions of these two authorities was responsible for a certain inconsistency in the objections to the regulations now under discussion, in that it did not seem to have been fully recognised that whereas the object of the Home Office was to protect the employees, the object of the Board of Trade in its regulations was to protect the public. The present code of regulations had been prepared by Mr. Ram, not as the result of consideration in his chair, but as the result of several years continuous examination and investigation into all the methods of electrical generation in the various installations throughout the country. That there should be two sets of regulations with the same object in view he agreed was unnecessary, and would be unwieldy. This ought to be avoided, and with this object in view a conference had taken place between the officials of the Home Office and the Board of Trade, the result of which was that the Board of Trade was prepared to relinquish certain of its regulations, which it was conceivable would clash with those now proposed by the Home Office. This he thought settled the question of dual control.

These regulations are Nos. A1, A24, and A28. We give them below:—

1. *Pressure of Supply to Consumers.*—The pressure of a supply delivered to any consumer shall not exceed the limit of low pressure, except for special purposes, for which a medium pressure supply may be given on the consumer undertaking to comply with the following conditions:—

(*a*) Where the supply is for power purposes:—

(1.) The frame of every electric motor shall be efficiently connected with earth.

(2.) The consumer's wires forming the connection to motors, or otherwise in connection with the supply, shall be, as far as practicable, completely enclosed in strong metal casing efficiently connected to earth, or they shall be fixed in such a manner that there shall be no danger of any shock.

(3.) The supply to every motor shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the motor, and connected so that by its means all pressure can be cut off from the motor itself, and from any regulating switch, resistance, or other device in connection therewith.

(4.) Switches, efficient fuses, or other automatic circuit-breakers, shall be provided so as to protect the circuits from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

(5.) A notice shall be fixed in a conspicuous position at every motor and switchboard in connection with the supply forbidding unauthorised persons to touch the motors or apparatus.

(*b*) Where the supply is for arc lamps in series:—

(1.) The consumer's wires forming the connection to the arc lamps, or otherwise in connection with the supply, shall be, as far as practicable, completely enclosed in strong metal casing efficiently connected with earth, or they shall be fixed in such a manner that there shall be no danger of any shock.

(2.) The supply to every arc lamp shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the arc lighting, and connected so that by its means all pressure can be cut off from the arc lamp itself, and from any regulating switch resistance or other device in connection therewith. Provided that where the arc lamps are connected in series across the outer conductors of a three-wire system, it shall be sufficient if one such switch be provided for each series of arc lamps.

(3.) Switches, efficient fuses, or other automatic cut-outs shall be provided so as to protect the circuit from excess of current, and all switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

(*c*) Where the supply is for incandescent lamps in series:—

(1.) The consumer's wires forming the connection to the incandescent lamps or otherwise in connection with the supply, shall be completely enclosed in strong metal casing, and this casing,

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together with the switches and lamp-holders, if metallic, shall be efficiently connected with earth.

(2.) Switches, efficient fuses, or other automatic cut-outs shall be provided so as to protect the circuits from excess of current, and all switches and cut-outs shall be so protected that there shall be no danger from the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

Where the supply is for any special purpose other than those above-mentioned, or where the pressure of the supply exceeds the limits of medium pressure, it shall be subject to such other regulations as the Board of Trade may from time to time prescribe.

24. *Responsibility of Undertakers for their Lines, &c., on Consumers' Premises.*—The undertakers shall be responsible for all electric lines, fittings, and apparatus, belonging to them, or under their control, which may be upon a consumer's premises, being maintained in a safe condition, and in all respects fit for supplying energy.

28. *Transformers and High-Pressure Apparatus to be Enclosed in Metal, &c.*—Where the general supply of energy is a high-pressure supply, and transforming apparatus is installed on a consumer's premises, the whole of the high-pressure service lines, conductors, and apparatus, including the transforming apparatus itself, so far as they are on the consumer's premises, shall be enclosed in solid walls or in strong metal casing efficiently connected with earth, and securely fastened throughout.

The next objection was as to whether the rules should be made retrospective. He agreed that it would be exceedingly hard if these rules, which were primarily intended to deal with the future, should be so drafted as, to a large extent, to make even a small proportion of the existing works impossible to be carried on, and it was with this object in view that the exemptions had been provided. The last exemption had been specifically drafted to protect existing undertakings. It reads as follows:—"If the occupier can show with regard to any requirement of these regulations, that the special conditions in his premises are such as to prevent danger not less adequately than if the said requirement were observed, that requirement shall be deemed to be satisfied." One great object of the Home Office had been to keep these rules in their shortest and simplest form, and to make them as little cumbersome as possible, and for this reason he would ask objectors to think twice before they suggested the addition of a large number of words or of additional rules. If the objects aimed at could be effected by the present rules or by a very small number of alterations, then he thought it should be done, but his instructions were that, rather than load up these rules with numerous specific exceptions or specific provisions, the Home Office would drop any particular rule. He thought the objectors in many cases would be well advised to leave the rules in their present form, because this would lead to a proper business-like working of their undertakings, far more than if many modifications were inserted.

The third point was as to the right of appeal. This question arose to some extent out of the exemption clause which he had just read. That there should be some form of appeal appeared to be fair, but the procedure was such that an appeal was always obtained in the very best possible form. Many of the objectors asked that there should be an appeal to some third party or that arbitration should be resorted to, or some other form of procedure, which would enable each occupier to raise the question before the matter became one for prosecution for breach of the rules, or failure to comply with them. In the application of these rules, the following would be the procedure. The Factory Inspector for any particular district would carry out his usual inspection to find out whether the rules had been complied with. It was his duty to point out to the owner when a breach was being made, or when an omission was made. If the owner did not make the breach good, if it could be made good, then, of course, the inspector would report to the Home Office. Reports of all electrical matters came before the electrical inspector, and unless the electrical inspector was satisfied with the report, one way or the other with regard to the complaint, he would visit the place, if he thought it necessary, and examine the matter for himself. He would allow the occupier a full hearing, and then consider the report of the inspector and any statement made by the occupier together. This, he submitted, was really a true solution of this objection, but at the same time he thought the Home Office would be prepared to go further. In addition to what he had just stated with regard to procedure, the owner should be given an opportunity of making a statement in writing to the electrical inspector, who would then be in a position to consider the report of the inspector on the one hand, and the statement of the occupier on the other. If after this any prosecution was instituted by the Home Office, obviously it was in the interests of those responsible for the prosecution being instituted to take the utmost care that they were not fighting for form, but for substance. The suggestion that an appeal should be made to another Government body, seemed to him impossible.

The next question of principle was that the regulations should not be enforced as regards any voltage under 250, whether alternating or continuous current. This provision had been subject to a good deal of criticism, and in reading the many objections, it was clearly seen that there had been a good deal of misconception due to a confusion of the functions of the two Government departments, namely, the Home Office and the Board of Trade. It was stated in the objections that the Board of Trade regulations stated that 250 volts was perfectly safe. He joined issue with this at once. What the Board of Trade regulations did say was that nothing beyond a certain voltage should be used, and all the Home Office regulations provided was that to any pressure below 65 volts alternating and 130 volts continuous their regulations would not apply. If the regulations were altered in this respect, it would not be with the consent of the Home Office. This particular point had been given the most careful consideration, and as a result of the investigations made by the electrical inspector, and the information he had received during his term at the Home Office, it had been decided that the voltages named in the regulations must remain. The reason for this attitude was that the advisers of the Home Office believed that 100 volts alternating current was dangerous to life, or in certain circumstances lower voltages were dangerous to health or limbs. He ventured to ask any electrical engineer whether he would be prepared to take into his hands two good metal terminals at 100 volts alternating current properly connected. Not only was it impossible for some people to hold 100 volts, but it was impossible for them to hold 25 volts alternating current, and this made it a very serious matter, for there were other dangers to be thought of. Suppose a workman on a platform, somewhat raised from the ground, accidentally brought some part of his body, unprotected, in contact with 25, 30, 40, or say 50 volts alternating or continuous current. The mere temporary contact with a bare conductor would be sufficient to startle him, and to make him fall from his position and consequently to suffer injury, although the supply was at such a low voltage. The officials of the Home Office had endeavoured so to draft these rules, and to specify the restrictions as to consider not only the safety of the workmen, but also that the electrical industry should not be unduly restricted by unnecessary regulations. On this account many things had been omitted from the draft which, in the opinion of the advisers of the Home Office, might very well have been included to bring them into conformity with the practice which had existed in the administration of the Factories Act in connection with matters other than electrical ones, as regards taking proper steps for the protection of the workmen. One or two objectors had raised the question that these regulations would cost a good deal of money, but he would say once and for all that the question of money was no answer in itself, and any objections on this ground alone appeared to him to have no substance. If to prevent the loss of human life it was necessary to have enormous expense, then this expense must be incurred of necessity.

Mr. G. SCOTT RAM, the Electrical Inspector of Factories, said he had been responsible for the investigations, upon which these regulations were drafted. Dealing with the question of dual control, he said the Board of Trade had agreed, so far as factories were concerned, to withdraw the regulations already mentioned dealing with the wiring of consumers' premises. The other points in the two sets of regulations which more or less overlapped had reference to the consumers' services where the supply was given from the public mains, and in some cases there was a high pressure supply which would also include transformers and the switching device on the consumers' service. He proposed to insert at the commencement of the third exemption the following addition: "Nothing in these regulations shall apply on the premises of an occupier being a consumer of an authorised electric supply undertaking, to any service cables, and apparatus on the supply side of the occupier's terminals belonging to, or under the control of, the authorised undertaking." This exemption would have some effect on the following rules in the present draft, viz., Nos. 1, 2, 5, 6, 7, 8, 9, 10, 21, 25, 26, 27, 28. With regard to the question of appeal, he proposed to add the following exemptions, making four in all: "In case any difference of opinion shall arise between an inspector and occupier under these regulations, the occupier shall be entitled to make a statement in writing for submission to the Electrical Inspector." He thought that the exemptions were sufficient to do away with the objections raised as to the application to existing works. With regard to the voltage, the Home Office was not prepared to accept anything higher than 65 volts alternating current, and 130 volts continuous current.

LORD ROBERT CECIL, K.C., M.P., cross-examined Mr. Ram on behalf of the London Electric Lighting and other companies. On the question of dual control, Mr. Ram agreed that it would not do to have two authorities controlling the application of electricity, and although the Home Office hoped that it had eliminated this dual control, if it could be shown that it still existed, they must find a way out of it. The witness's attention was drawn to regulation No. 1, which he agreed was somewhat widely drawn, and would allow the Home Office to have any alteration made it might think fit. He would not agree that the possibility existed of the Board of Trade requiring alterations one month and the Home Office coming along a month later and saying they were quite wrong. His opinion was that this contingency could not arise if regulation A 1 of the Board of Trade was withdrawn as proposed. Similarly, with regard to the construction of sub-stations, Mr. Ram refused to admit that there would be dual control, his view being that whereas the control of the Board of Trade related only to the construction of sub-stations from the point of view of the safety of the

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public, the Home Office wished to protect the workpeople in the sub-stations. These matters had been very carefully discussed between the Board of Trade and the Home Office, and it had been concluded that there would be no difficulties of the sort pointed out.

Lord Robert Cecil said that his clients wished it to be clearly understood that there was to be no sort of double control, and, to be frank, they preferred the Board of Trade to the Home Office.

After further cross-examination upon the points as to why it was proposed to exempt consumers' service lines from the regulations, to which Lord Robert Cecil stated that he could get no satisfactory reply, counsel suggested that the only way out of the difficulties which the electric supply companies, represented by him, felt themselves to be in with regard to these regulations, was to embody some such exemption as that proposed in the following clause :—"Nothing in these regulations shall apply to any generating station, sub-station, conductors' cables, or apparatus of, or belonging to, any company, body, or person authorised by Special Act, Licence, or Provisional Order, to supply electrical energy for any public or private purpose, and complying with the regulations made by the Board of Trade under any such Special Act, Licence, or Order for securing the safety of the public, or to any system connected therewith, and also complying with any such regulation."

The object of this, it was stated, was to exempt everybody who is under the control of the Board of Trade at present. Having pointed out further instances of dual control in connection with the Electric Lighting Clauses Act of 1899, Counsel put to Mr. Ram the question as to why the regulations under the Coal Mines Act were less stringent than those now proposed. Mr. Ram refused to admit this. Further instances were put to him of generating stations already existing in which a strict compliance with the proposed regulations would involve such enormous expense as to render the carrying on of their business impossible. The reply was made that there would always be some means of getting over such difficulties. On the question of the appeal to the electrical inspector against the requirements of an inspector of factories under these regulations, Lord Robert Cecil said he regarded this as little better than a farce; it merely called the attention of an occupier to the existence of the penny post in that he could write a letter.

LORD ROBERT CECIL.—We ask for some real reconsideration by an impartial person before we have to go to any very large expense.—I do not think this is required or necessary.

We are not satisfied with an appeal to a magistrate on such a technical matter; we want an appeal to an impartial arbitrator as provided in the Coal Mines Regulations Act. I do not think this is reasonable because you have anything you want as it is.

Lord Robert Cecil suggested that there should be added the words, "an appeal to a competent, fully qualified person not being an official nominated by the Home Office on the application of either party." Asked as to why the limit had been placed at 150 volts continuous and 65 volts alternating, Mr. Ram stated that it was not deemed necessary to go below this, as they would then be making regulations for such things as electric bells. As a matter of fact, he did not think these regulations were as stringent as the Board of Trade regulations in this respect.

Cross-examined by Mr. VESEY KNOX, K.C., on behalf of the Newcastle Electric Supply Company and the Cleveland and Durham County Electric Power Company, Mr. Ram agreed that the rules might be modified so that no action could be taken against an occupier for alleged breach of the rules without a certificate from the electrical inspector stating that there was a cause for prosecution. Counsel pointed out that as the rule stood at present he saw nothing to prevent, for instance, representatives of a workmen's union from taking action against an occupier in the interests of the men, on quite trivial points.

On the question of passage ways on switchboards, Mr. Ram stated that, some of the switchboards of the Newcastle Co. were very excellent, and he often quoted them as models to other people. He knew that the company owned about 200 boards, and that many of them did not comply with the proposed regulations that there should be a height of 7ft. and a width of 3ft. on passage ways. He did not, however, think it would be necessary to reconstruct all these, as he thought the owners could easily prove their claim to exemption. Generally he got over these difficulties by friendly discussion.

Mr. VESEY KNOX.—Why, then, if you have got on so well in the past, do you wish to have these regulations?—We must have the regulations to draw attention to the dangers. Merely pointing them out in a memorandum is not sufficient in many cases.

In answer to further questions, Mr. Ram stated he regarded the distance set out in the regulations for switchboards passage ways as being a useful standard. If, however, the boards could be made safe by other means, all well and good.

Questioned by Mr. W. B. Woodhouse, on behalf of the Yorkshire Electric Power Co., the Incorporated Association of Electric Power Companies' Officials, and the Leeds Chamber of Commerce, on the question of the voltages of 65 and 150 respectively, Mr. Ram refused to admit that whereas a power company supplying a sub-station at 10,000 volts would be exempt, so far as the sub-station was concerned, if they supplied at lower pressure, they were not exempt. Mr. Ram also refused to admit that the latest Board of Trade regulations were less stringent than those issued in 1906. On the point of all metal work having to be earthed, Mr. Woodhouse asked if Mr. Ram had considered the case of the Thury system; Mr. Ram's reply was that in this case it would be unnecessary, and, in fact, it would introduce a danger if this regulation were enforced.

In reply to questions on behalf of the Barry Railway Co., Mr. Ram stated that he saw no reason to produce particulars of the accidents which had induced the Secretary of State to certify that electrical generation was dangerous. Neither could he call to mind at the moment any accident upon the passage way less than 3ft. wide.

Mr. SYDNEY MORSE put several questions as to the exemption of the consumers' service lines, upon which a certain amount of doubt seemed to exist.

Mr. SWINBURNE stated that his difficulty on this point was that he understood an occupier could not be made to keep a fuse in proper order because it did not belong to him, and therefore there was a difficulty in enforcing the law against an occupier as regards his fuse, but it did not follow that the rules were not to be enforced against a supply company, and yet he did not see how this was to be done, because the place was not a generating station.

Mr. MORSE stated that he felt the occupier would be held to be the occupier of the premises in respect of such a fuse or switch.

Mr. GRAY, on behalf of the Home Office, said this exemption had been modified in order to prevent an occupier being held responsible for a switch, which he was under a penalty not to touch; therefore it had been decided to leave this matter under the control of the Board of Trade.

In reply to further questions by Mr. Morse, Mr. Ram stated that the proposal at present was that the Board of Trade regulation, A 1, would cease to exist if the Home Office regulations were passed. Further questions by Mr. Morse were directed to the points that the expense of complying with the regulations on the part of small existing undertakings would be prohibitive, and that for economical reasons the station would have to be closed. Mr. Ram repeated his previous answers that difficulties such as these could be got over by friendly discussion, but Mr. Morse pressed the question as to what would happen to supply companies which had had an accident whilst not complying with the Home Office regulations, and to which there could be no defence. No expression of opinion was made.

The next question was as to the use of switches in the holders of portable lamps. Considerable discussion took place between Mr. Morse and the witness as to particulars of accidents due to this cause. Mr. Ram stated that he could not remember any off-hand, although there had been several in small workrooms coming within the Factory Act. Mr. Morse's contention was that there had been none, and that if the Home Office regulations were carried out, very considerable expense would have to be incurred in fitting these lamps with switches.

The TOWN CLERK OF EDINBURGH asked if Mr. Ram would agree to the regulations only applying to new work and not to existing stations. Mr. Ram was unable to give a definite reply.

At the close of Mr. Ram's re-examination,

LORD ROBERT CECIL asked that the four main questions of principle referred to at the commencement of the proceedings should first be disposed of. If Mr. Swinburne's report was favourable this would dispose of a large number of objections to individual regulations, and thus shorten the proceedings very much.

After some further discussion, Mr. Swinburne stated that he would consult with the officials of the Home Office, and state the decision arrived at the next morning.

WEDNESDAY, MARCH 4TH.

Mr. SWINBURNE said that with regard to giving an interim report as suggested, the Home Office does not see their way to accede to this. But he did not wish to put the whole responsibility upon the Home Office. He himself felt that the course suggested would put him in the position of having to decide something before he had heard the whole question. He would have to decide, for instance, whether there was to be overlapping before it was really settled what the new rules were to be. He therefore thought it best to go on with the inquiry. Dealing with the question of expense, Mr. Swinburne stated that whilst they were all anxious to reduce this as much as possible, the electrical industry was still young, and the expense to be incurred must not be considered merely from the point of view of the importance of this inquiry. They were endeavouring to make rules which would have far-reaching importance, and therefore they should not shirk their responsibilities in any way. The inquiry will take the normal course, viz., that the Home Office shall put forward evidence in support of the regulations, after which speeches will be made on the questions of principle which have been raised with the object of ascertaining whether a decision can be given upon these as distinct from the detailed regulations.

Mr. G. SCOTT RAM then went through the regulations *seriatim*, giving the reasons for them, and indicating certain modifications to meet objections. We will give a full report in our next issue.

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THE ALDWYCH-EMBANKMENT L.C.C. TRAMWAY SUBWAY

SINCE the opening of the service of cars in the subway running from the southern end of Kingsway to Theobald's Road in February, 1906, and the

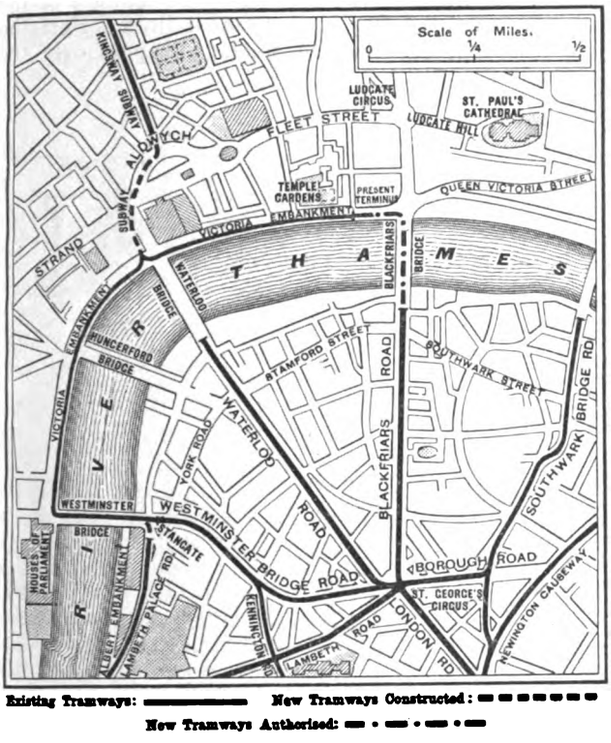


FIG. 1.—MAP OF ROUTE, SHOWING JUNCTIONS WITH EXISTING TRAMWAYS.

inauguration in the December of the same year of the tramways over Westminster Bridge and along the Embankment, the only link remaining uncompleted in the joining up of the northern and southern portions of the London County Council tramway system, apart from the alternative route over Blackfriars Bridge, has been the extension of the first portion of the subway from Aldwych to the point by the side of Waterloo Bridge, where the junction will be made with the Embankment lines. The work on this portion of the subway is, however, being rapidly pushed ahead, and every hope is entertained that traffic may be commenced by the end of March.

It will be remembered that powers were not obtained for the construction of the whole of the lines involved in the scheme of linking up the northern and southern systems until the passing of the L.C.C. Tramways Act of 1906, although the Act of 1902 authorised the construction of the portion of the subway under Kingsway. The map in Fig. 1 shows the position of the subway with reference to the other lines. Further details of the Aldwych-Embankment section of the subway are given in the plan in Fig. 2. The length of the curved tunnel under Aldwych was constructed at the same time as the Kingsway subway, and was used partly for the cross-over in connection with what has hitherto formed the terminal station. A further part of this tunnel was laid with a temporary single track, and used for the storage of cars, and here a plough pit and an inclined repair pit were provided. The permanent concrete work under the temporary tracks, however, was of a form arranged to take the double track and conduits which were eventually to be laid. As the repair pit was made in the centre of the tunnel, and partly by raising the track rails, the removal of the temporary work to permit of the new double track being laid on the permanent foundations is a comparatively simple matter. This part of the subway, following the curve of Aldwych, and sloping down at a moderate gradient to the Strand, is, generally speaking, of similar construction to the Kingsway portion with both tracks in the same tunnel, and, together with the pipe subways with which it is flanked like the Kingsway subway, formed a part

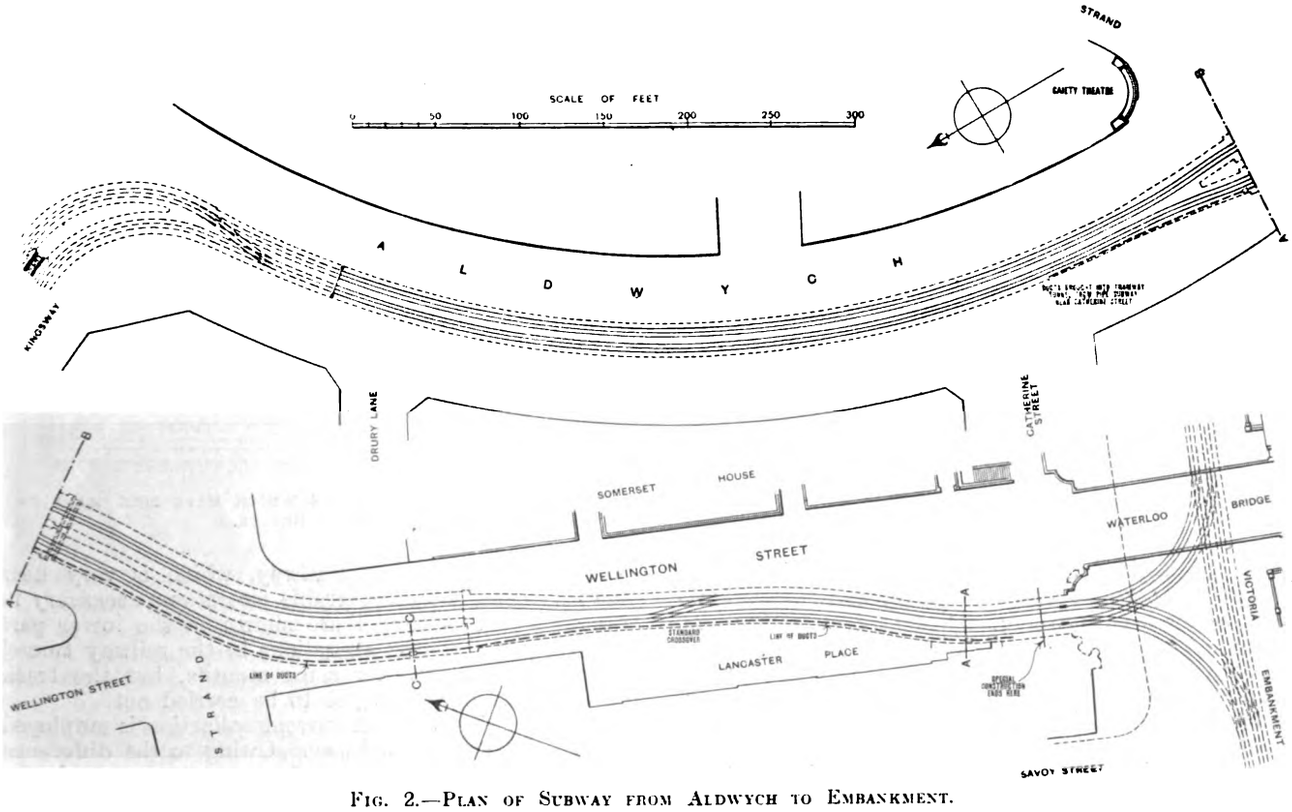


FIG. 2.—PLAN OF SUBWAY FROM ALDWYCH TO EMBANKMENT.

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of the construction of the new thoroughfare. The laying of the new double track is now in progress.

In the second portion of the subway, commencing at the junction of Aldwych and the Strand, the two tracks are placed in separate tunnels, and cast-iron circular tunnel construction similar to that of the "tube" railways has been employed. These tubes were driven with shields in the usual way, and no particular difficulties were encountered in their construction. They

supporting Wellington Street is being cut away. The accomplishment of this part of the work has offered some engineering difficulties, but good progress towards completion has now been made. The alterations to the stone pillars, &c., by the side of Waterloo Bridge for the formation of the entrance arch are indicated in plan in Fig. 3, which shows also the arrangement of the junction with existing Embankment lines. Here the tracks, as they cross the road, will pass over the

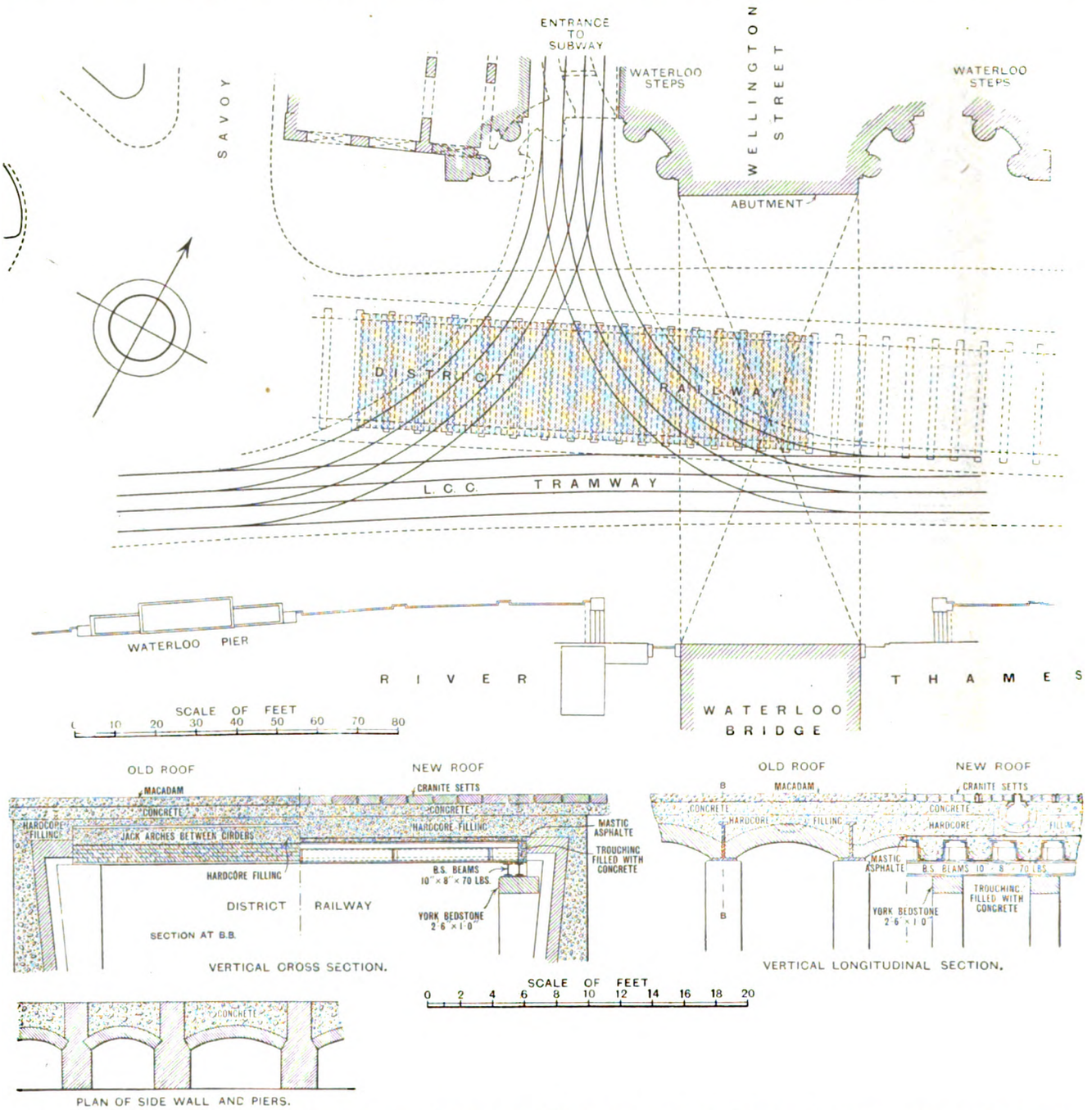


Fig. 3.—Plan and Sections at Junction with Embankment Tramways, showing Alterations which have been made in the District Railway Tunnel Roof and the Stonework by Waterloo Bridge.

are of 14 ft. 11 in. diameter from iron to iron, both on straight portions and on curves, and this is sufficient to allow everywhere a clearance of 2 ft. round the cars that will be employed. This form of tunnel is continued across the Strand and a short distance down Wellington Street, but the rest of the subway as far as the opening on to the Embankment is all double-track tunnel and steel-work construction with cross-girders is employed. For the insertion of these girders a good deal of the brick arch construction

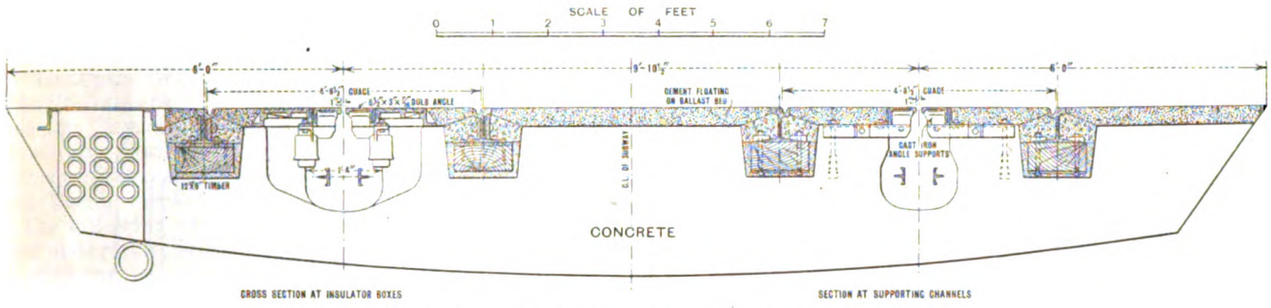
tunnel of the District Railway, which is very near the surface. The considerable alterations necessary in the roof of this tunnel are shown in the lower part of the figure. These alterations in the railway tunnel have been complete for some months, but the track and conduit work has yet to be carried out.

The conduit system of current collection is employed in the whole of the subway. Owing to the difference in the conditions in a tunnel reserved exclusively for tramways from those prevalent on a road where general

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vehicular traffic is also present, it has been possible to adopt a design of conduit somewhat different from the standard arrangement employed elsewhere on the London County Council tramway system. The standard road conduit construction as adopted on the Embankment was described at some length in Electrical Engineering, Vol. I., page 9, and it is unnecessary to repeat here the features of its design.

A good idea of the arrangement of the track and conduit in the double-track portions of the subway is obtained from Fig. 4. It will be noticed that, owing to the space between the track rails not being required to take the weight of ordinary traffic, not only have the heavy cast-iron yokes which are such a prominent feature of the standard construction been done away with, but the rigid slot rails are replaced by iron "bulb angle" sections, laid in short lengths, and easily removable, so that the whole conduit is a very great deal more accessible. These bulb angles at each side of the slot, and shown in section in Fig. 4, are laid in 7 ft. 6 in. lengths, and rest at each end on special shaped castings, carried by and bolted to short channel-iron cantilevers, embedded in the concrete, and held down by Lewis bolts. Additional anchoring of these cantilevers in a direction across the track is obtained by short angle iron anchor pieces rivetted to their sides. The positions of these and of the supporting cantilevers themselves are shown more clearly in Fig. 6, which is a plan of a portion of this type of track. The fixed angle bars at either side of the removable bulb angles are also carried on the cantilevers, and serve to hold the slot to gauge, and at the same time as curbs to the concrete. These are laid in 30-ft. lengths and jointed by means of fish-plates. Some further details of the arrangement of the castings which support the ends of the bulb angle sections are shown in Fig. 6, from which it will be noticed that they are cast with a ridge fitting between the ends of adjacent sections which prevents creeping or end-play. The ends of the bulb-angle sections are chamfered off to avoid any possibility of the plough fouling in its passage. The arrangement of the insulator boxes, which occur every 15 ft., is indicated in the left-hand part of Fig. 4, and in greater detail in Fig. 7. The insulators themselves are not quite of the standard pattern as employed on the surface lines, as they are bolted to the continuous-angle irons above them, instead of being attached by means of a bracket on the side of the insulator to the flange of the slot-rail. The covers of the insulator boxes are of a simpler and lighter form than in the standard construction for road work. The running rails are supported on 12 in. by 6 in. longitudinal timbers of pitch pine, to which they are bolted down by means of clips. Special anchor-plates are used under the joints.



CROSS SECTION SHOWING ARRANGEMENT OF TRACKS IN DOUBLE TUNNELS.
THROUGH A.A.

Fig. 4.—Section of Track and Conduit in Double Track Portion of Subway.

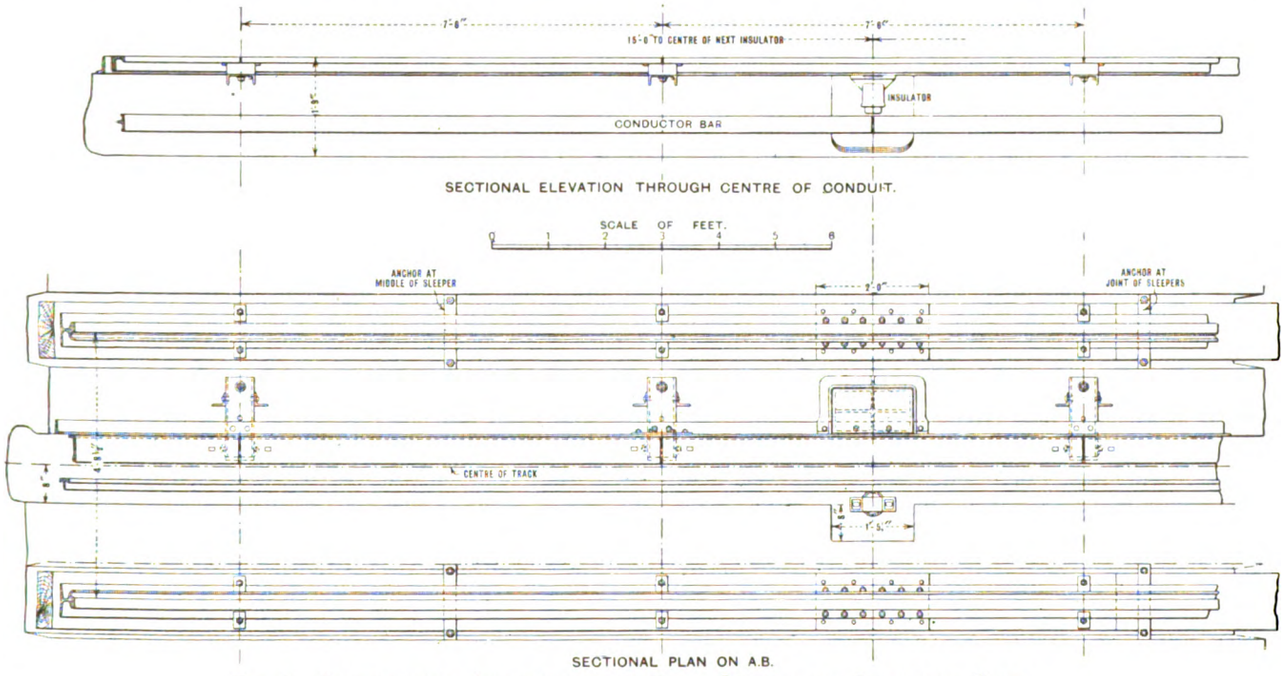
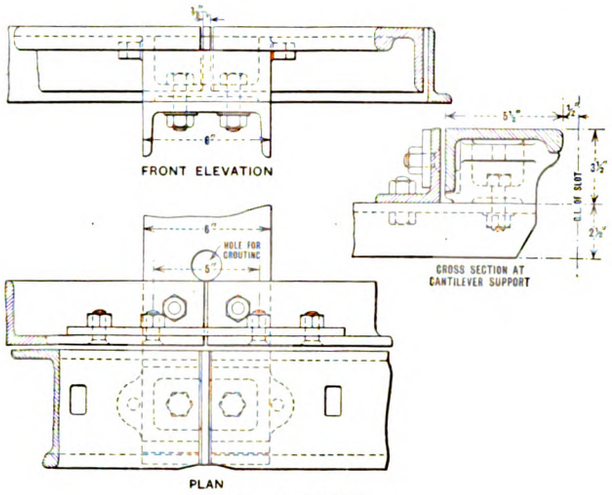


Fig. 5.—Plan showing Arrangement of Track Conduit and Insulation Boxes.

The tramway construction in the short sections of tube tunnel is shown in Fig. 8, and is similar to the

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construction in the double tunnel. The figure shows how the concrete work is brought up at each side, above the level of the track, to form continuous platforms, and the arrangement of the cable ducts on one side. Owing to the limited space in the tunnel, it is only practicable to find room for the cable ducts by raising the level of the platforms above the

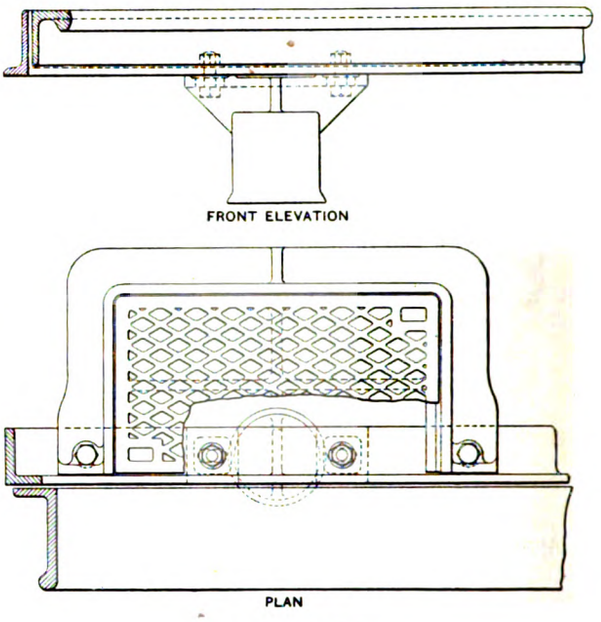


Scale—1/8th full size.

Fig. 6.—Details of Bulb-angle Supports.

track, but the additional advantage of having continuous platform upon which there was room to walk on both sides of the track led to the same arrangement being adopted on the opposite side. In part of the double-track tunnel the cables are carried in ducts at the side below the level of the track, as shown in Fig. 4, but in the case of the portion under Aldwych they are run in the separate pipe and cable subway alongside the tramway tunnel. As shown in the plan, special castings are used to connect up the standard slot rails with the bulb angle construction described above.

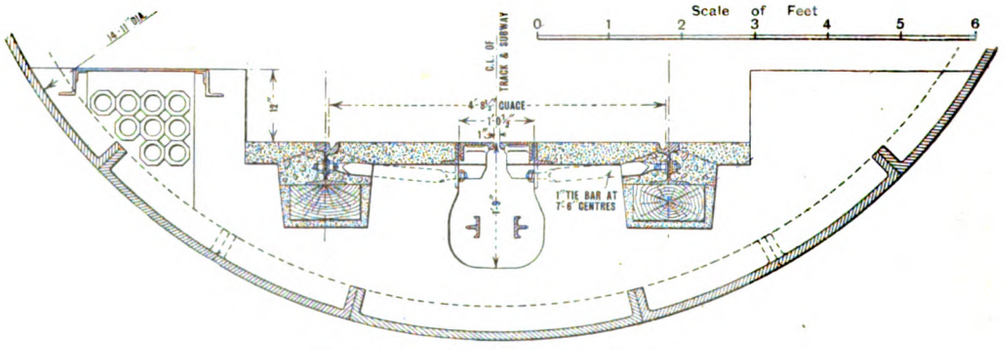
The whole of the track and conduit equipment, and



Scale—1/10th full size.

Fig. 7.—Details of Insulator Box.

also the construction of the subway, was carried out by the Works Department of the London County Council to the designs and under the direction of Mr. Maurice Fitzmaurice, C.M.G., Chief Engineer to the Council, while the laying of the cables and other electrical details are under the supervision of Mr. A. L. C.



CROSS SECTION OF TRACK IN SINGLE TUNNEL THROUGH C.C.

Fig. 8.—Section of Track and Conduit in Single Track Tube Portions of Subway.

a large part of this tube section of the tunnel is on a curve, and special care has been taken in the accurate cutting of the ends of the longitudinal timber sleepers and jointing them together.

In the design of the special form of construction for this work, use was made wherever possible of standard sections, and this, combined with the simplicity of the arrangement, has made the cost compare very favourably with that of the standard equipment. There is a short section just at the entrance of the tunnel at the Embankment, where the standard construction with cast-iron yokes has been employed, and the cross-over road just inside the tunnel entrance is also of the standard conduit construction. There are thus one or two points where transition is effected from the standard to the special construction, and here

Fell, Chief Officer of Tramways, who will also be responsible for the traffic arrangements.

In conclusion, we should express our thanks to these gentlemen, and also to their representatives, for having given us facilities for the preparation of this article, and for the drawings placed at our disposal, from a selection of which the accompanying illustrations have been prepared.

The Electrical Exhibition.—The Manchester Corporation has agreed to permit the use of Platt's Fields for the electrical exhibition to be held in Manchester in October. The use of the ground will be allowed free of rent. Temporary buildings will be constructed, and there is more than sufficient ground for extensions of the building to any size that will be necessary for the purpose. The site lies on a tramway route, and is close to a sub-station of the Corporation electricity department.

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THE ACCOUNTS OF THE CHARING CROSS, WEST-END, AND CITY ELECTRICITY SUPPLY COMPANY

IN considering the past year's working of the Charing Cross, West End, and City Electricity Supply Company, it is of some interest to compare the results in the West End and City districts, which are practically two independent undertakings carried on by the same company. As is well known, the West End area is supplied principally from the original generating station at Lambeth, through sub-stations at Maiden Lane, Short's Gardens, St. Martin's Lane, and Green Park; and the City area is supplied mainly from the newer generating station at Bow, through sub-stations at Fenchurch Street, Upper Thames Street, Ludgate Hill, and Beech Street.

The following table gives an idea of the size of the two undertakings, and the growth of the load during recent years:—

	1905.	1906.	1907.
Distributing mains laid—			
In West-end ... ... miles	273	278	280
In City ... ... ,,	229	230	231
Trunk mains inter-connecting stations and substations ... ... miles	112	113	113
Total connections in equivalent 8 c.-p. lamps—			
West-end	453,285	510,589	538,964
City	371,209	412,684	454,757
Motors connected (included in above totals)—			
Total for both areas ... ... B.H.P.	8,000	9,810	11,109

The connections at the close of last year were made up as follows:—

		8 c.p. (30 watt) lamps.
West-end ...	Lighting	391,201
	Heating	10,238
	Power	137,525 (5,501 h.p.)
	Total	**538,964**
City	Lighting	287,787
	Heating	26,770
	Power	140,200 (5,608 h.p.)
	Total	**454,757**
Total for both undertakings		**993,721**

The accounts of the West End and City undertakings are kept separately, but it is not possible to obtain detailed figures accurately analysing the costs in pence per unit sold for each division separately on account of the fact that in both cases a portion of the electrical energy distributed was purchased "in bulk" from the other undertaking. The units sold and generated by each undertaking do not correspond, so that simply to divide the costs of the units sold in each case does not give correct figures.

The units generated and sold by the two undertakings for the year ended December 31st, 1907, are shown, together with particulars of load factor, &c., below:—

	West-end undertaking.	City undertaking.
Units sold for private lighting and power	9,885,086	8,603,741
,, public lighting	452,647	
,, in bulk	576,064	9,567,690
Total units sold	10,913,797	18,172,431
Units used on works and in transmission	4,233,994	4,022,247
Total units accounted for	15,137,791	22,194,678
Units bought in bulk	9,568,690	576,064
Units generated	5,569,101	21,618,614
Total units sold to consumers ...	18,488,827	
Maximum demand load factor ...	5,681 kw.	10,849 kw.

The expenses for each undertaking and the costs per unit sold to consumers for the combined undertakings are given below:—

Generating costs.	West-end. £	City. £	Combined. £	Pence per unit.
Coal	8,349	24,532	32,881	0·428
Oil, waste, water, stores, &c. ...	350	900	1,250	0·016
Salaries and wages	6,801	8,799	15,600	0·203
Repairs and maintenance ..	3,488	6,925	10,413	0·135
Total generating costs ...	**18,988**	**41,156**	**60,144**	**0·782**
Distributing costs.				
Salaries and wages	412	268	680	0·009
Repairs and maintenance ...	5,939	3,732	9,671	0·125
Wayleaves and licences	1,139	147	1,286	0·017
Total works cost	**26,478**	**45,303**	**7,781**	**0·933**
Management expenses, &c.				
Rents, rates, and insurance ...	12,502	9,370	21,872	0·283
Salaries, fees, and establishment charges	6,096	6,481	12,517	0·163
Law, parliamentary, and other charges	974	1,200	2,174	0·028
Depreciation	11,000	—	11,000	0·143
Total, excluding capital charges	**56,990**	**62,354**	**119,344**	**1·550**

In the case of the West End undertaking, the expenditure as analysed above amounted to £56,990 (including £11,000 for depreciation), and £23,124 was paid for current purchased in bulk. The total receipts amounted to £131,920. To the balance of £51,806, last year's balance of £4,575 and interest amounting to £3,472 must be added, giving £59,853, of which £17,829 was absorbed by interest on debentures, leaving a final balance of £42,024 available for dividends.

Treating the accounts for the City undertaking in a similar way, we find a total expenditure of £63,748 (including £1,395 for current purchased in bulk), and receipts amounting to £118,543, giving a balance of £54,795, of which interest absorbed £30,133, leaving £24,662, out of which £18,000 was paid in dividends on preference stock.

The capital expenditure of the two undertakings up to December 31st, 1907, is shown below:—

West End Undertaking.

	£
Purchase of Station mains, &c., and acquisition of Rights	110,745
Additional Expenditure on—	
Land and Buildings	168,417
Machinery	232,189
Accumulators and Accessories at Generating and Distributing Stations	27,564
Mains, including cost of laying the Mains and Service Connections and Expenses	431,380
Meters, and Fees for certifying under the Act ...	25,635
Electrical Instruments	1,478
Provisional Orders, &c.	5,105
Plant and Tools	2,804
Artesian Well	2,525
Office Furniture	3,305
Total expenditure	£1,011,145

City Undertaking.

	£
Lands and Buildings	314,042
Machinery	359,298
Accumulators and Accessories at Generating and Distributing Stations	36,450
Mains, including cost of laying the Mains and Service Connections and Expenses	542,082
Meters, and Fees for certifying under the Act ...	25,554
Electrical Instruments	2,571
Provisional Order and Special Act	5,522
Plant and Tools	1,507
Artesian Wells	3,327
Office Furniture	925
Total expenditure	£1,291,278

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A DIRECTIVE SYSTEM OF WIRELESS TELEGRAPHY

By E. Bellini and A. Tosi

(*Translated and Communicated by* L. H. WALTER.)

IN a previous article by the same authors (ELECTRICAL ENGINEERING, Vol. II., p. 771), a directive system of wireless telegraphy was described, having an aërial system in the form of closed oscillatory circuits; and diagrams were published, together with particulars of some of the results obtained. The principle of an apparatus by means of which, using fixed and invariable aërial circuits, the direction of communication could be varied, was also briefly indicated. In the present article it is proposed to treat in a more detailed manner the theory and construction of the instruments above referred to, and to which the name of radio-goniometers has been given by the authors.

Radio-goniometer for Reception.—The points AA_1 and BB_1 (Fig. 1) represent the lower ends of the two closed

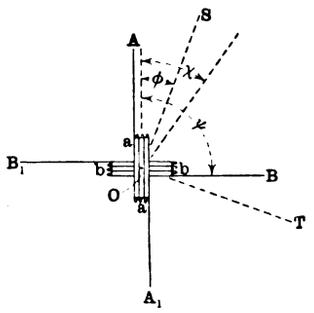


FIG. 1.

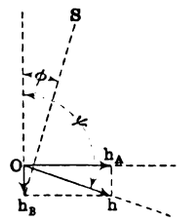


FIG. 2.

oscillatory circuits, which are at right angles to one another. These circuits are joined respectively to the equal and similar windings *aa* and *bb*, which are also mutually perpendicular, the plane of each winding being coincident with the plane of that closed circuit to which it is connected.

Let *S* represent a transmitting station whose direction makes an angle ϕ with the axis *OA*. The electromotive forces, ϵ_A and ϵ_B, respectively generated in the aërial circuits AA_1 and BB_1 by the electromagnetic field set up by the station *S*, will have (as has been shown in the previous article) the instantaneous values represented by the following expressions:—

$$\epsilon_A = Ee^{-\alpha t} \sin mt \cos \phi,$$

$$\epsilon_B = Ee^{-\alpha t} \sin mt \sin \phi,$$

where *E* represents the maximum amplitude of the electromotive force which would be produced in one of the two circuits if the transmitting station *S* were situated in its plane, and α is the damping factor of the oscillations.

Since the two circuits are tuned to the same wavelength, currents are set up in them having the instantaneous values:—

$$i_A = Ie^{-\alpha t} \sin mt \cos \phi,$$

$$i_B = Ie^{-\alpha t} \sin mt \sin \phi.$$

These currents in flowing through the windings *aa* and *bb* set up at the centre of the latter two damped oscillatory magnetic fields having the instantaneous values:—

$$h_A = He^{-\alpha t} \sin mt \cos \phi,$$

$$h_B = -He^{-\alpha t} \sin mt \sin \phi.$$

These fields, directed normal to the planes of the corresponding windings, are indicated by h_A and h_B in Fig. 2. It follows that the resultant field *h* at the centre of the windings will have the value:—

$$h = He^{-\alpha t} \sin mt,$$

which is thus independent of the angle ϕ, that is, of the position or bearing of the transmitting station *S*. The direction of the said field makes an angle ψ with the axis *OA*, which is defined by the relation

$$\tan \psi = h_A/h_B = -\cot \phi.$$

This signifies that the direction of *h* will be perpendicular to that of the transmitting station. It hence follows that if at the centre of the windings *aa* and *bb* there be suitably placed a very small secondary winding—rotatable on the intersecting axis of their planes and joined to a detector as well as being tuned to the waves emitted by the station *S*—the electromotive force induced in the secondary will have the instantaneous value:—

$$\epsilon_i = E_i e^{-\alpha t} \cos mt \sin (\psi - \chi) \ldots\ldots\ldots (1)$$

Here χ is the angle formed by the plane of the winding with the axis *OA*. The maximum of ϵ_i with reference to χ will be obtained when

$$\psi - \chi = 90^\circ \text{ or } \chi = \psi - 90^\circ = \phi.$$

Hence the maximum intensity of reception will also be obtained when the plane of the secondary winding is perpendicular to the resultant magnetic field *h*, that is, when the plane of this winding is in line with the transmitting station *S*. The intensity of the reception is therefore related by a simple harmonic function with the angle through which the secondary winding has to be turned. In consequence, if there be rigidly attached to the secondary winding a pointer movable over a graduated scale suitably oriented, one can determine the direction of the transmitting station *S*. With a view to obtaining indications of the greatest accuracy, it is essential that the secondary winding be very small as compared with the primary windings. As a matter of fact, were it otherwise the relation between the angle ϕ and the position of the secondary winding which gives the maximum reception, or zero reception, would be represented by a function so complicated that it could not be regarded as a practical solution. But, on the other hand, too small a secondary winding would result in an excessively loose coupling between the primaries and the secondary, which would greatly reduce the sensitiveness of the apparatus. On this account it is necessary to give the apparatus such a form that, without diminishing the sensitiveness, it is possible to secure the variation of intensity of the reception according to the sine law.

Two solutions of this problem are available. The first is based upon the properties of the magnetic field produced in the interior of a spherical winding traversed by a continuous current. Under these conditions the magnetic field set up in the interior is uniform, and has a constant direction parallel to the polar axis of the winding. If in the interior of this spherical winding there be suitably placed another, movable winding of arbitrary form and dimensions (Fig. 3), the magnetic flux which traverses the internal winding will vary as the sine of the angle made by its plane with the line *AB*. The movable winding can even be placed outside the spherical one, with the same results and without sensible error, provided the air space between the windings be sufficiently small. The coefficient of mutual

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inductance between the two windings will vary proportionally as sin γ. If one of the two windings—the exterior one, for example—be traversed by a damped sinusoidal oscillatory current $i_1 = Ie^{-at} \sin mt$, the electromotive force developed in the second winding will have the value:—

$$\epsilon_i = E_i e^{-at} \cos mt \sin \gamma.$$

This expression is equal to (1). It thus follows that if in the space enclosed by the windings of Fig. 1 there be placed a spherical winding which is closely embraced by the primaries *aa* and *bb*, a magnetic coupling between the two circuits is secured which may be as close as possible, and the sine law of variation of the induced electromotive force will always hold. The second solution has been worked out with a view to avoiding the complicated construction which the use of spherical windings involves. For this reason the secondary

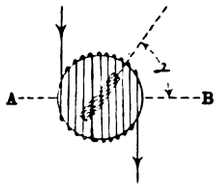


Fig. 3.

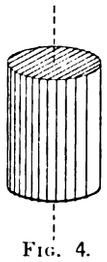


Fig. 4.

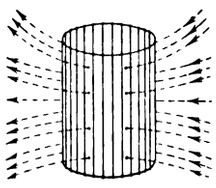


Fig. 5.

winding has been given a cylindrical form, and the turns have been wound on perpendicularly to the circular bases of the cylinder, as is shown in Fig. 4.

Owing to the great analytical complexity, it is impossible to calculate the value and direction for each interior point of a cylindrical winding, of the magnetic field set up by a current passing through such winding; but one can assume that the lines of force follow as near as can be the course outlined in Fig. 5. Since the vertical components of the magnetic lines do not create any flux, one has only to consider the horizontal components lying in the different right sections of the cylinder. It is evident that owing to the special construction of the cylindrical winding, the horizontal components of the magnetic lines of any right section will be equidistant and parallel to the polar axis of the winding; but the number of such lines of force will be different according to the section. It results that the magnetic flux across a rectangular winding, which closely surrounds the cylindrical winding, will be proportional to the sine of the angle that its plane makes with the polar axis of the cylindrical winding. For this reason the windings have been constructed in the manner shown in Fig. 6.

The adjustment of the oscillation constant of the two primary circuits should be effected by altering in an equal manner the number of primary turns, at the same time preserving the symmetry of each primary with respect to the axis of the instrument; and, further, this operation should be capable of being carried out very rapidly. This has been accomplished by the use of the device shown in Fig. 6. The turns of the two primaries, which cover almost the whole surface of the cylinder, are of silk-covered copper wire, the silk covering being removed from the lower end of the vertical part of each turn, the bared portion thus constituting an annular strip, 1 centimetre wide, of juxtaposed wires, the ends of the windings being insulated. Two diametrically opposite movable silver brushes are in contact with the bared portion of each winding, the two pairs of brushes, *aa* and *bb*, being connected respectively to the two aërial circuits. The four brushes, placed at the four extremities of two mutually perpendicular diameters, are fixed to a slate disc, movable around the axis of the instrument. Referring to Fig. 6, the winding $cAd\ r\ A_1 n$ is bared between Ad and $A_1 n$, and the winding $uBs\ m\ B_1 e$ between Bs and $B_1 e$. By turning the brushes in the direction of the arrow, the number of turns in circuit is increased equally in the two windings. When the brushes are in the position *dn* and *se*, all the turns are in circuit. The number of turns in the secondary winding is fixed, the ends of the winding being connected to two contact-rings upon which two further brushes bear, the latter being fastened to the base and connected to two terminals. Between these two terminals the detector is inserted, across a variable capacity and a variable inductance. By altering these latter one can vary the oscillation constant of the secondary circuit and the degree of magnetic coupling between the primary circuits and the secondary.

From the description of the radio-goniometer already given, it follows that in order to use it for locating the waves sent out by a station whose bearing and wave-length are both unknown, it is necessary to simultaneously carry out two different operations; that is to say, (1) to tune the apparatus to the wave-length, and (2) to set the movable winding in the direction of the unknown station; and reception is obtained only after both these operations have been accomplished. The reception would then be a function of two simultaneous adjustments, which is neither easy nor practical. For this reason the adjustment of the radio-goniometer has been reduced to two independent operations: first, the tuning to the wave-length of the signals to be received; and second, the orientation of the secondary in the plane of the transmitter station. This result is arrived at in the following manner:—

In the case of a symmetrical closed oscillatory circuit, the lowest middle point is the seat of a potential node; it is thus possible to earth the circuit at this point without causing any change in its behaviour. If one-half of such an aërial circuit be detached and one point of the winding earthed, the other half of the aërial circuit becomes an ordinary symmetrical antenna. To ensure that the frequency of this antenna is the same as that of the original closed oscillatory circuit, it is necessary that the earth connection should be made at a potential node; that is, the mid-point of the winding.

This method of reasoning has been applied to the radio-goniometer as follows:—The middle point of the

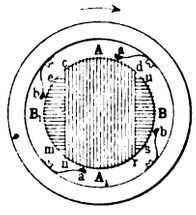


Fig. 6.

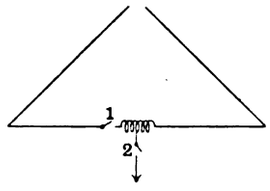


Fig. 7.

two primary windings (Fig. 7) can be earthed by the switch 2, and one-half of the aërial circuit which is connected to the winding can be cut out by means of the switch 1. These operations having been completed, and the secondary winding turned so that it is parallel to the primary in question, the radio-goniometer is reduced to an ordinary receiving jigger or transformer, whose primary is connected to a vertical antenna and to earth—an arrangement which permits of the tuning to the wave-length of the unknown transmitting station being carried out without troubling about its position. But since the tune of this symmetrical antenna is the same as that of the closed oscillatory circuit, by merely opening switch 2 and closing 1 the radio-goniometer is perfectly tuned for the directive reception. After this it only remains to turn the secondary winding until the reception is a maximum.

Fig. 10 shows the receiving radio-goniometer of average size for wave-lengths lying between about 300 and 800 metres. The ends of the two oscillatory circuits

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which constitute the aërial structure of the system are connected to the terminals *aa* and *bb*, each pair of terminals being joined up to one pair of the diametrically opposite brushes. (One such brush is shown at *c*.) The two primaries, mutually perpendicular, are wound—the one between the pillars p_2 p_3, and the other between the pillars p_1 p_4. The supporting end-discs for the windings are of slate, the vertical portion of the turns being free and unsupported. The bared region of the winding, over which the brushes make contact, is sustained by the thickness of the lower disc. The switch-arm *d* effects the simultaneous operations of the switches 1 and 2 of Fig. 7.

The twenty-five turns of the secondary, internal to the primary, are wound on an ebonite cylinder having a metal spindle, the two halves of which are insulated from one another. The ends of the windings are joined respectively to the upper and lower half of the spindle, and through two brushes (not shown in the figure) to the terminals *ss*. To the upper end of the spindle a milled head *r* and double pointer are rigidly attached. The one pointer *ff* is black, and parallel to the polar axis; the other *gg* is white, and perpendicular to the black one. The two pointers move over a graduated circular dial, which indicates the position of the transmitting station. The milled-head *m* enables one to turn the slate disc supporting the silver brushes *cc* provided for varying the number of primary turns. The terminals *ss* are joined up to an electrolytic detector across a variable capacity and variable inductance as already mentioned. The exterior dimensions of the instrument are:—Height, 28 centimetres; width, 24 × 24 centimetres.

With this apparatus the bearings have been determined of a number of stations in the English Channel, in France, England, &c., whose wave-lengths were within the range above mentioned. Using the same radio-goniometer, reception from stations using very long waves, such as the Eiffel Tower, Poldhu, Clifden, Nordeich, was effected by inserting in the two aërials four equal inductances, symmetrically placed with reference to the radio-goniometer, two in each oscillatory circuit. The reception under these conditions was obviously not as good as it might have been, owing to the coupling of the primaries with the secondary being too loose. On this account a larger size of apparatus has been constructed with which very good reception from the long-wave stations has been achieved. The exactitude with which the bearing of a transmitting station can be determined is quite remarkable, an accuracy of 1° being readily obtained after repeating once or twice the process of taking the limiting angles at which reception ceases; and this accuracy is independent of the azimuth of the transmitting station. The determination of the actual position, not merely the bearing, of a station by the intersection method has confirmed the great exactitude obtainable by the use of the radio-goniometer. The azimuths of the same station, determined from Dieppe and from Havre, always intersected at practically the exact spot where the station was situated.

So far as the zone, within which one is certain of not being troubled by transmissions other than the one desired, is concerned, this zone is a function of the azimuth of the other stations, of their distance, and of the intensity and damping of their transmissions. But to give an idea of the independence which is obtained by means of the radio-goniomenter, it is sufficient to refer to experiments made between Dieppe and Havre. In all cases it has been possible to receive clearly at Havre from Dieppe without being troubled by other transmissions; this, however, was in general impossible when the ordinary vertical antenna was employed.

The radio-goniometer for reception can conveniently be used for comparing the strengths of two or more transmissions. Suppose now that the detector employed is one which responds solely to the amplitude of the oscillations. For each transmission the two limiting angles on the radio-goniometer are determined for which the reception ceases. Calling α and β these angles for the one transmission, and γ and δ those for the other, the ratio of the amplitudes of the transmissions will be, according to what has already been given:—

$$\sin \frac{\alpha + \beta}{2} \Big/ \sin \frac{\gamma + \delta}{2}.$$

If the detector is of a type which responds to the total energy received, the preceding ratio is that of the energies emitted by the two different transmissions. This enables one, further, to determine the diagram of the field produced by a directive transmitter station at long distances.

The same means enables one also to determine whether a detector responds to the maximum amplitude or to the energy of the electro-magnetic field. To effect this purpose a directive transmitter station must be available for which the diagram of emitted energy has been determined by means of a thermo-galvanometer or similar instrument. If the detector under consideration, when used at a directive receiver station, gives a diagram similar to that obtained by the thermo-galvanometer, this means that the detector responds to the energy. If, on the other hand, it gives a diagram whose *radii vectores* are proportional to the square roots of the Duddell diagram, the detector responds to the amplitude of the field. If the detector gives an intermediate diagram, this may be taken as indicating that its operation is not clearly defined, and that it depends partly on the energy and partly on the maximum amplitude.

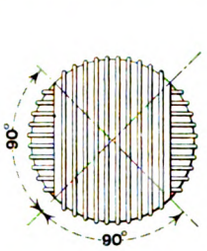


FIG. 8.

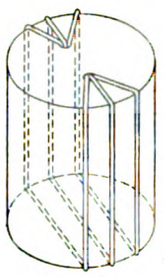


FIG. 9.

Radio-goniometer for Transmitting.—This apparatus is based upon a similar principle to that of the receiving radio-goniometer. Referring to Fig. 1, if in the interior of the two windings *aa* and *bb* there be an oscillatory magnetic field whose direction *OT* is perpendicular to *OS*, and whose equation is $h = He^{-\alpha t} \sin mt$, there will be created in the windings the electromotive forces:—

$$\epsilon_a = Ee^{-\alpha t} \cos mt \sin \psi,$$

$$\epsilon_b = -Ee^{-\alpha t} \cos mt \cos \psi.$$

These will give rise in the aërial circuits to oscillatory currents of proportional intensity; and each aërial will set up an electromagnetic field in space, which field will also vary sinusoidally in space, as has been shown in the first part of this article. These fields (having any direction whatsoever which makes the angle χ with the axis *OA* and at a definite distance) will be represented by the expressions:—

$$m_{A\psi} = Me^{-\alpha t} \cos mt \sin \psi \cos \chi,$$

$$m_{B\psi} = Me^{-\alpha t} \cos mt \cos \psi \sin \chi.$$

The resultant magnetic field at the point considered will be the algebraic sum of the component fields:—

$$m = Me^{-\alpha t} \cos m\,t\,(\sin \psi \cos \chi - \cos \psi \sin \chi),$$

$$= Me^{-\alpha t} \cos mt \sin (\psi - \chi).$$

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The maximum value of the field is obtained when between the angles ψ and χ the relation

$$\psi - \chi = 90^\circ \text{ or } \chi = \psi - 90^\circ = \phi$$

exists. This signifies that the maximum intensity of transmission occurs in the direction perpendicular to the magnetic field which excites the two windings *aa* and *bb*, and that this intensity is independent of the angle ϕ; that is, of the direction of transmission. In consequence, by causing the magnetic exciting field to be turned in a uniform manner, the direction of emission of the waves will turn equally and in the same sense in the horizontal plane.

The transmitting radio-goniometer, like that for receiving, can be made in the spherical or cylindrical form. The cylindrical form was preferred for the reasons already given in the case of the receiving radio-goniometer. The movable winding in the transmitting radio-goniometer forms part of the primary circuit. The magnetic coupling between this circuit and the aërial circuits is of a suitable value, such that the proportionality between the electromotive force and current in the aërial circuits may be obtained. The primary winding consists of three thick wires joined in parallel. This form of winding is necessary in order that the primary of the transformer should have the minimum inductance. The single turn of three wires is put on as shown in Fig. 9, the ten turns (in series) of the secondary winding being shown in Fig. 8. Although the primary winding does not cover the whole surface of the drum, nevertheless the measurements of the current in the aërials and others made at a distance with the aid of the thermo-galvanometer have shown that the partial winding is practically equivalent to the complete winding; and since the latter presented considerable constructional difficulties without any real advantages, the partial winding has been adopted.

The transmitting radio-goniometer can, as in the case of the receiving instrument, be constructed so that waves of different lengths can be emitted. When it is a case of sending signals to a station whose bearing is unknown, or to different stations at the same time, the problem is analogous to that at the receiving station. One solution is obtainable in the following manner:—Referring to Fig. 7, where the winding in the case of transmission represents one of the two secondary circuits, one can convert, by means of the switches 1 and 2, the closed aërial oscillatory circuit into an ordinary antenna. This makes it possible to send signals equally in all directions, and consequently also to the unknown station or to a plurality of stations. When, however, it is desired to use the directive system, one has merely to alter the switches 1 and 2 accordingly, and to set the primary in the direction of the corresponding station.

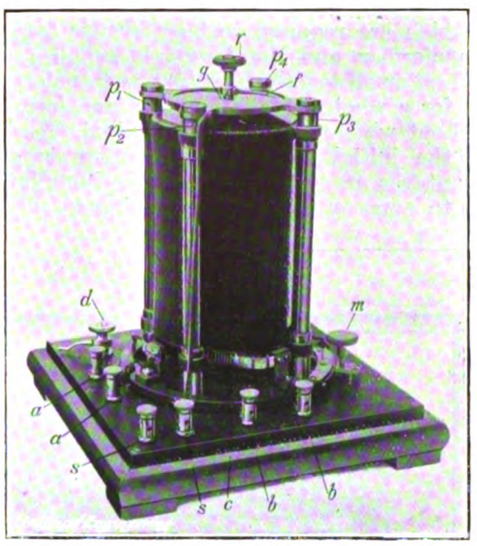


FIG. 10.

One can pass in this manner from the ordinary symmetrical transmission to directed transmission, and *vice versâ*, without its being necessary to touch the tuning in any way; and this for the same reason as was shown in the case of the reception. A divided circle is provided on the transmitting radio-goniometer, and a pointer fixed in this case to the primary winding, so that the latter can be oriented in the different azimuths.

The chief dimensions of the apparatus are:—Height, 50 centimetres; width, 35 × 35 centimetres.

SMALL TRANSFORMERS FOR USE WITH METALLIC FILAMENT LAMPS

THERE are many instaliations where difficulties present themselves in the way of taking full advantage of the very great economies which are offered by the high efficiency of metallic filament lamps as compared with ordinary carbon filament lamps. The principal obstacle is the fact that in a great number of cases metallic filament lamps cannot be obtained for voltages as high as that of the supply circuit available, or can be obtained only in sizes forming an inconveniently large unit of light. It is true that during the last few weeks a 16-candle-power, 100-volt, metallic filament lamp has been placed on the market, and one or two makes of lamps, of a much larger size, however, are being introduced for 200-volt circuits, but it is at comparatively few places that a supply voltage of 100 volts is available, and for 200-volt circuits the unit formed by two 100-volt lamps in series, or by such 200-volt lamps as are already available, is, in general, inconveniently large, especially in the case of existing installations planned for smaller lamps.

Where the supply is alternating, the difficulties can be got over by the use of appropriate transformers for reducing the voltage, and there is no doubt that, with a well-designed transformer, the first cost of the apparatus is soon paid for by the saving obtained by the use of high-efficieny lamps, notwithstanding such losses as there are due to the transformer itself. We cannot but think that if this were more widely realised, the use of metallic filament lamps for ordinary domestic lighting, office lighting, and other purposes, where that 16-candle-power lamp has been the standard, would on alternating-current circuits at any rate largely increase. Already a good deal of attention is being paid by manufacturers to the development of this class of apparatus, and it is the purpose of this article to call attention to a few examples of small transformers designed for this purpose which are at the present time on the market in this country.

Speaking generally, the type of transformer most suited to the purpose is that with a single winding, as it offers advantages both as regards efficiency and first cost. Although they can be used simply as step-down auto-transformers, it is advantageous wherever the nature of the installation allows it to adopt a distributing secondary pressure exactly one-half or one-third of the supply pressure, and connect the transformer as a balancer with the equivalent of a three-wire or four-wire distributor system. As to the secondary pressures which are most suitable, a good deal depends on the exact make of lamp adopted, and the size of lamp best

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adapted for the installation in question. In many cases 100 volts will be a sufficiently low pressure, but with some makes of lamps a convenient-sized lamp to replace the existing lamps of an installation is not obtainable until 25 volts is reached. There is no doubt, however, that there is some advantage in keeping the voltage fairly low, as the filaments of the lamps are thicker and less fragile.

In installing transformers for this purpose, two different methods of distribution may be adopted: (1) One transformer may be used for each lamp or group of lamps which are required to burn always together, so that transformer and the lamps it supplies may be switched on or off together; or (2) one transformer may be used for a whole installation, the transformer being switched out when no lamps are required. In the first system the initial cost of transformers is greatest; the advantages are, however, that the installation wiring has to carry current corresponding to the normal

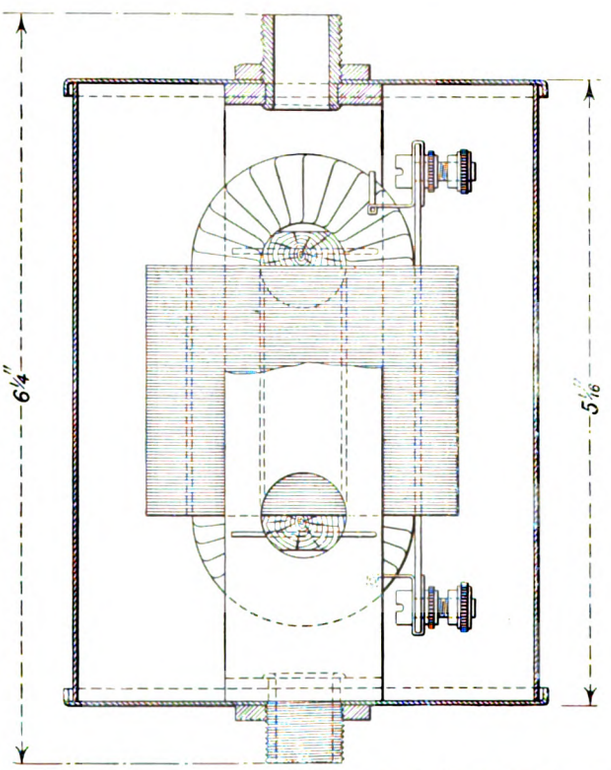


Fig. 1.—Section of Small Westinghouse Transformer for Single Metallic Filament Lamps or Small Groups.

circuit voltage instead of the reduced lamp voltage, and that no losses occur in the transformer when the lamps it supplies are not in use. Further, the transformer is always operating at full load corresponding to its highest efficiency. The second system has the advantage of lower first cost of transformers; on the other hand, the installation wiring must be suitable for carrying the current corresponding to the reduced voltage, and when only a few lamps are in use, the transformer will not be working at its highest efficiency. In arranging installations, therefore, it may often be found advisable to adopt a combination of these two systems, single-lamp transformers being used where it is necessary or convenient to always have the light available without having first to go to the main switch, as, for instance, in bedrooms, cellars, &c.; and the larger transformers for such lamps that are required for certain periods only, so that the switching in or out of the transformers does not cause any inconvenience, as, for instance, in sitting-rooms, shops, &c. With this arrangement the installation can be worked at its highest efficiency, the large transformers being cut out for the greater part of the time, and the cost of the no-load losses—which, although very small, otherwise go on continuously—is eliminated.

As already pointed out, the winding of these transformers with the single winding, and taking the required secondary voltage between one of the line wires and intermediate tapping, enables the same output to be obtained at a smaller cost and with lower losses than is possible with an ordinary two-winding transformer. Thus in all cases where special conditions do not compel the use of electrically separated primary and secondary

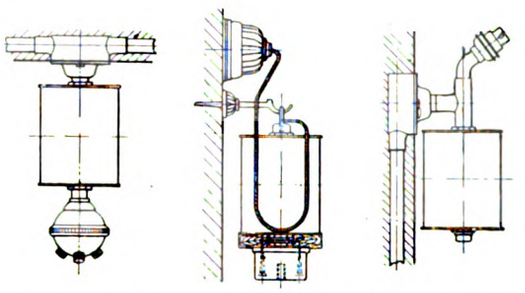


Fig. 2.—Small Westinghouse Auto-transformers for Single Lamps or Groups of Lamps.

circuits, the auto-transformer should be used in preference to that with two separate windings.

A balancing transformer possesses a single winding which is divided by means of tappings with two or more equal parts, each of which supplies a separate circuit. Each of these two circuits, separately controlled, can take approximately the same independent load as an auto-transformer of that ratio with about the same transforming losses. Whenever the distributing conditions permit, the balancer should therefore be used in preference to the auto-transformer. A further advantage of the balancer is that it can supply any number of lamps as long as the difference in load on the circuits having maximum and minimum currents is not larger than the "independent" load mentioned above, which may be termed the "balancing capacity." As the transforming losses remain unaltered, practically any efficiency can therefore be obtained.

As examples of the electrical performance of these



Fig. 3.—Westinghouse Transformer for Metallic Filament Lamp Installations.

types of transformers, a 50-watt, 50-period, 100- to 50-volt auto-transformer has total losses of approximately 4 watts (*i.e.*, an efficiency of 92 per cent.). The same transformer used as a two-circuit balancer with a load of 50 watts on each circuit (*i.e.*, a total load of 100 watts) has an efficiency of 97·6 per cent. An 800-watt, 50-period, 200- to 100-volt auto having an iron loss of 12½ watts has an efficiency of 97 per cent. If the same transformer is used as a two-circuit balancer, having 400 watts load one circuit, and 1,200 watts the other, the losses would remain the same, and the efficiency will be 98·45 per cent. If the two circuits are loaded,

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each with 800 watts, the efficiency will be 99·2 per cent. At higher frequencies somewhat higher efficiencies will be obtained.

A special line of transformers for the first of these systems of distribution has been developed by the British Westinghouse Electric & Manufacturing Co. A section showing the general construction of this simple design of transformer is shown in Fig. 1, and one or two of the numerous ways in which they can be applied to ordinary fittings are illustrated in Fig. 2.

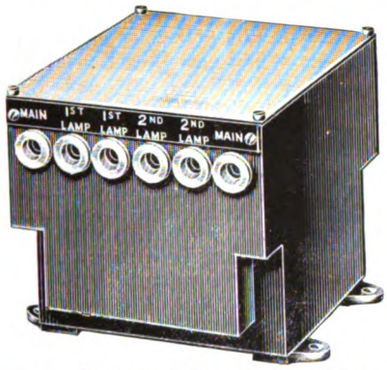


Fig. 4.—Auto-transformer for Metallic Filament Lamps. (General Electric Co.)

The transformer is encased in a sheet-iron cylinder with lids at top and bottom. By loosening one nut the casing can be readily removed, and the screw terminals to which the lamp and line are connected are disclosed. These transformers complete weigh for the various sizes from 5 to 7½ lb.

The transformers already shown in Fig. 1 can also be used for the second of the two systems described above, but as the output ranges only from about 25 to 100 watts, the British Westinghouse Co. has developed the larger type shown in Fig. 3, having capacities ranging from 200 to 2,000 watts. Both types are made for standard ratios of 200 to 100, 200 to 50, 100 to 50, and 100 to 25 volts, both as auto-transformers and balancers, and for different periodicities.

In these transformers, the portion of the windings not enclosed in the laminated iron are protected by end castings through which cable leads are brought out. Lugs are provided on these castings so that the transformers can be mounted in any position. A shell type construction is used with E-shaped laminations, interleaved and clamped so as to enable them to work absolutely

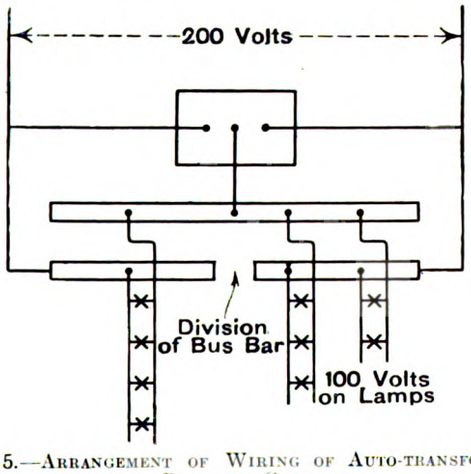


Fig. 5.—Arrangement of Wiring of Auto-transformer for Balanced Circuits.

without noise. These transformers vary in weight from 12 lb. for the 200 watt size to about 27 lb. for 2,000 watts.

Special transformers for metallic filament lamps have also been designed and placed upon the market by the General Electric Co., Ltd., with high all-day efficiency and small open-circuit loss. Fig. 4 shows the general appearance of one pattern of these, which is an auto-transformer with two balanced secondary circuits. This is suitable for use on a 200-220 volt circuit, and gives a secondary output of 100-110 volts, and where it is possible to balance the lamps in a building within 5 or 10 amperes, it will be found that with a transformer of this kind an efficiency of 99 per cent. is readily obtained, and under these circumstances the capacity of such a transformer is almost unlimited, as they only carry the out of balance portion of the load. In addition, the company make transformers from 200-25 volts, and from 100-25 volts, so that small c.p. metallic filament lamps may be used The efficiency of the ½-kw. size wound in this way would be as high as 95 per cent. full load, and over 90 per cent. quarter load, while the open circuit loss on 50 cycles would not exceed 16 watts.

Messrs. Siemens Bros. Dynamo Works, Ltd., have for some years been in a position to supply small transformers in patterns suitable for use both indoors and in the open air for obtaining lower voltages than are commonly available. These were originally designed when the only metallic filament lamp was the osmium lamp, and were for a secondary voltage of 40 volts. The standard arrangement listed is for 110 to 120 volt circuits, and is arranged with two tappings, to be used as a three-part balancing transformer for a four-wire distribution.

A special type of transformer which has been developed for use with the metallic filament lamps by Messrs. W. E. Burnand & Co., of Sheffield, who have for some time specialised in the manufacture of transformers of all kinds. Like most makers, this firm have adopted the auto-transformer in preference to the double-wound type, as being more efficient and cheaper in first cost. They also emphasise the advantage of arranging the transformer as a balancer and grouping the load as evenly as possible on both sides. The influence of the balancing on the efficiency is made clear by the following example, which relates to a 200/100 volt transformer for 18



Fig. 6.—Small Transformer for Metallic Filament Lamps. (Union Electric Co.)

amperes, 75 cycles, with a constant iron loss of 10 watts, connected as a balancer.

	Total loss.	Volts on heavier loaded side.
18 amperes on one side and nothing on the other	41 watts	98½
18 amperes on each side	10 ,,	100
18 amperes on one side and 9 amperes on the other	18 ,,	99¼
10 amperes on one side and 8 amperes on the other	10½ ,,	100

With regard to the arrangement of existing 200-volt installations for these transformers, where the system of wiring permits of its being divided into two or more bunches, of approximately equal current requirements, as, for instance, when supplied from a distribution board, the method shown in Fig. 5 may be adopted. Where a distribution board is used this involves only the cutting of one bus bar, and the removal of one main from the uncut bus bar to the half of the bus bar divided from the other main by the cut, in addition to joining in the transformer as shown. When this system is used only the *difference* between the current taken by the two halves of the bus bar passes through the transformer, and when these are balanced the only loss is the extremely small exciting current taken by the transformer. There is a further small loss in the transformer when the currents of the two halves are not equal, but this is only on whilst the currents are out of balance, and is almost negligible unless the two halves are *much* out of balance, which is a con-

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dition that seldom obtains for any length of time. Messrs. Burnand have considered the question of voltage regulation very carefully, and have in some cases only listed transformers at less than their rating, so far as ability to stand maximum current is concerned, in order to be able to keep the maximum variation of voltage within 1½ per cent. under extreme conditions. Two types are listed, one of which has a lower iron loss than the other, and in both of these care has been taken to employ non-ageing material, so that the iron losses do not increase with use. Transformers are also made for use where the wiring does not admit of dividing into approximately equal sections, so that it is necessary for the transformer to carry the whole current, the supply being led into one pair of terminals and the lower voltage out of another pair.

The Union Electric Co., Ltd., are also taking up this class of work, and are able to supply not only transformers for a secondary of 110 volts, but also for 25 volts. In designing these transformers, which are of the general form shown in Fig. 6, the object has been kept in view of striking a satisfactory balance between the initial cost and the economic requirements as to efficiency and open-circuit loss. They realise that by using special material of the very highest quality, it is possible to reduce the losses to the lowest, but at the same time the initial cost of the apparatus is considerably increased, and in their opinion the increased efficiency does not compensate for the increased cost. It is thus their object to supply an apparatus of the highest efficiency, compatible with reasonable cost. The 110-volt transformers would be used for Osram lamps of high candle-power, viz., 30-100, and also for use with tantalum

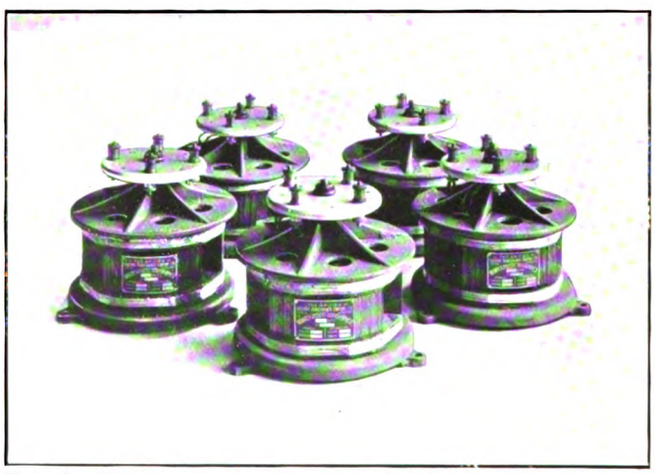


Fig. 7.—Group of Small Berry Transformers for Metallic Filament Lamps. (British Electric Transformer Co.)

lamps, for which this pressure is standard. The transformer giving 25 volts has been introduced, so that Osram lamps of 10 and 16 candle-power may be employed without alterations to the wirings and fittings at present fitted, for, of course, should lamps of perhaps twice or three times the candle-power have to be installed in present fittings, the lighting effect would be spoilt on account of certain places in the rooms being over-lighted.

Messrs. Johnson & Phillips have designed a special series of transformers for the purpose we are considering, and have adopted the following as the standard voltage ratio :—200/100, 200/50, 200/25, 100/50, and 100/25 volts. The standard frequency is 50, but they have also made these transformers for 85, 90, and 100 periods. The cores of these transformers are built up by a special process which reduces any additional iron losses in the clamping plates to a minimum, and it is owing to the careful way in which the laminations are insulated from one another, and to the minute inspection of every detail of manufacture of the core, that they are enabled to guarantee specially low figures for iron loss. The iron is of the very best quality, and similar to that employed in the standard line of transformers which they have lately put on the market. The ageing co-efficient of the iron is very small, and they claim that there is practically no increase in the iron loss as time goes on. The coils are former wound of a special ventilated type, which allows free access to both the core which they surround and to every part of the coils. They are insulated from the core by distance pieces of special material, which act as spacers to allow free ventilation. Finally, the coils and core are assembled and fitted in a cast-iron case of very substantial construction, the lid of the case being removable, so that the transformer is open to inspection. Terminals are provided at the side with leading-out wires, to which the connections are made. The transformers are of the auto-type, as by this means the output as well as efficiency of any given size is very much increased, and the iron loss and volt drop made very much smaller.

The following maximum efficiencies are claimed for the different sizes. The best efficiency is obtained at about three-quarter load :—

Watts.....	500	1000	1500	2000	3000	5000
Efficiency ...	92·5	95·0	95·5	95·8	96·4	97·0

A very simply constructed auto-transformer for use with metallic filament lamps is supplied by Messrs. Ward & Goldstone, of Manchester. These are fully standardised for primary voltages of 250, 220, 200, and 100 volts, and secondary voltages of 110, 100, and 25 volts, in capacities ranging from 250 to 1,750 watts.

The British Electric Transformer Co. have given so much attention to improving the design of transformers of all sizes that we naturally look with interest to the special apparatus for the purpose we are considering manufactured by this firm. As may be seen in Fig. 7, which illustrates a group of these small transformers, the general principle of their construction is the same as for the larger transformers, for which the company has earned so high a reputation. They are manufactured under the Berry Patents, and are insulated and built up in exactly the same way as the largest Berry transformers, for use on circuits of the highest voltages, with radial laminations arranged with ventilating spaces so as to ensure as large a cooling surface for the iron as possible, and as short a length of mean turn as is obtainable for the winding. The efficiencies are kept as high as possible, and special attention is paid to reducing the open circuit loss to a minimum. Transformers can be supplied to any requirements, and it must be realised that the losses and efficiencies given on any transformer are necessarily dependent on the price to be paid for the apparatus. In all cases where the supply voltage does not exceed 250 volts they recommend the use of auto-transformers, and where it is possible to adopt them they supply these with the terminals arranged for use on two or more balanced secondary circuits, in the manner we have already indicated. The transformers are compact and neatly finished, and can be mounted in any position. We understand that the company have anticipated the demand for the particular type of transformer by extensions to their shops laid out so as to be specially suitable for this class of work.

Messrs. Drake & Gorham, who have always been to the fore where metallic filament lamps are concerned, have made arrangements for the supply of a thoroughly well-made transformer for this purpose. These transformers are made in three sizes, namely, for maximum outputs of 1,500, 750, and 500 watts. The winding of the transformer is split into two circuits, each of which is one-half the line voltage. The highest efficiency, that is to say, the least loss, is obtained by dividing the lamps equally between the two legs; if this is done there will be a balanced load, and the only loss in the transformer will be the open circuit loss. The secondary E.M.F. will not be affected by an unequal number of lamps being connected to the two legs of the transformer, either of which may be fully or partially loaded or not at all, but for the reason mentioned above it is better to divide the circuits up so that there may be as near as possible the same load on each leg. The open circuit losses of the three sizes are 16·2, 9·5 and 5 watts respectively. These, of course, continue the whole of the time the transformers are connected to circuit; further losses depend, of course, upon the out-of-balance load on the secondary or lamp circuits. The copper losses vary up to 12 watts, according to the state of the balance on the two legs, and are reduced to nothing when the load on the legs is evenly balanced. The open circuit losses can, of course, be reduced to a very great extent if a main switch is connected on the high voltage side of the transformer, so that when light is not required the transformer can be switched out of circuit.

The Foster Arc Lamp & Engineering Co., Ltd., have made a speciality of a compact form of auto-transformer for use with metallic filament lamps, which they have been able to put on the market at a very reasonable price, notwithstanding its high efficiency and excellent voltage regulation. The range of stock sizes is very extensive, and they are constructed for frequencies of 40, 50, 60, 75, and 83 cycles for secondary voltage of 25, 2 × 55, 45, 50, 60, 3 × 60, 65, 3 × 65, 100, 105, 110, and 165 volts, and for primary voltages of 240, 230, 220, 210, 205, 200, 110, 105, and 100 volts. We hope at an early date to be able to give fuller particulars of this apparatus.

A number of other firms have already completed or are engaged upon the design of special apparatus of this nature, and we hope at a future time to be able to give particulars of the more interesting of the new pieces of apparatus.

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THE NEW EAST HAM TELEPHONE EXCHANGE

By J. W. O. Sandell

A CENTRAL battery telephone exchange equipment, of a type which is a novelty to London, was brought into use by the National Telephone Company last January at East Ham. The premises in which the plant is installed have been specially built for the purposes of a telephone exchange, and consist of a ground and first floor each having an area of approximately 1,870 square feet. The switchboard and its attendant apparatus, together with the operators' quarters, are accommodated on the first floor, the ground floor at present being divided up into offices and stores which are in use by the company, and two lock-up shops.

The main distributing frame, upon the vertical side of which the underground cables are terminated, is of the same standard design as that described in ELECTRICAL ENGINEERING of October 31st last in connection with the new Gerrard telephone exchange. It has a capacity for 1,760 outside lines, and is at present equipped with arresters for 1,050 lines. From the terminal strips on the horizontal side, 42-wire asbestos-

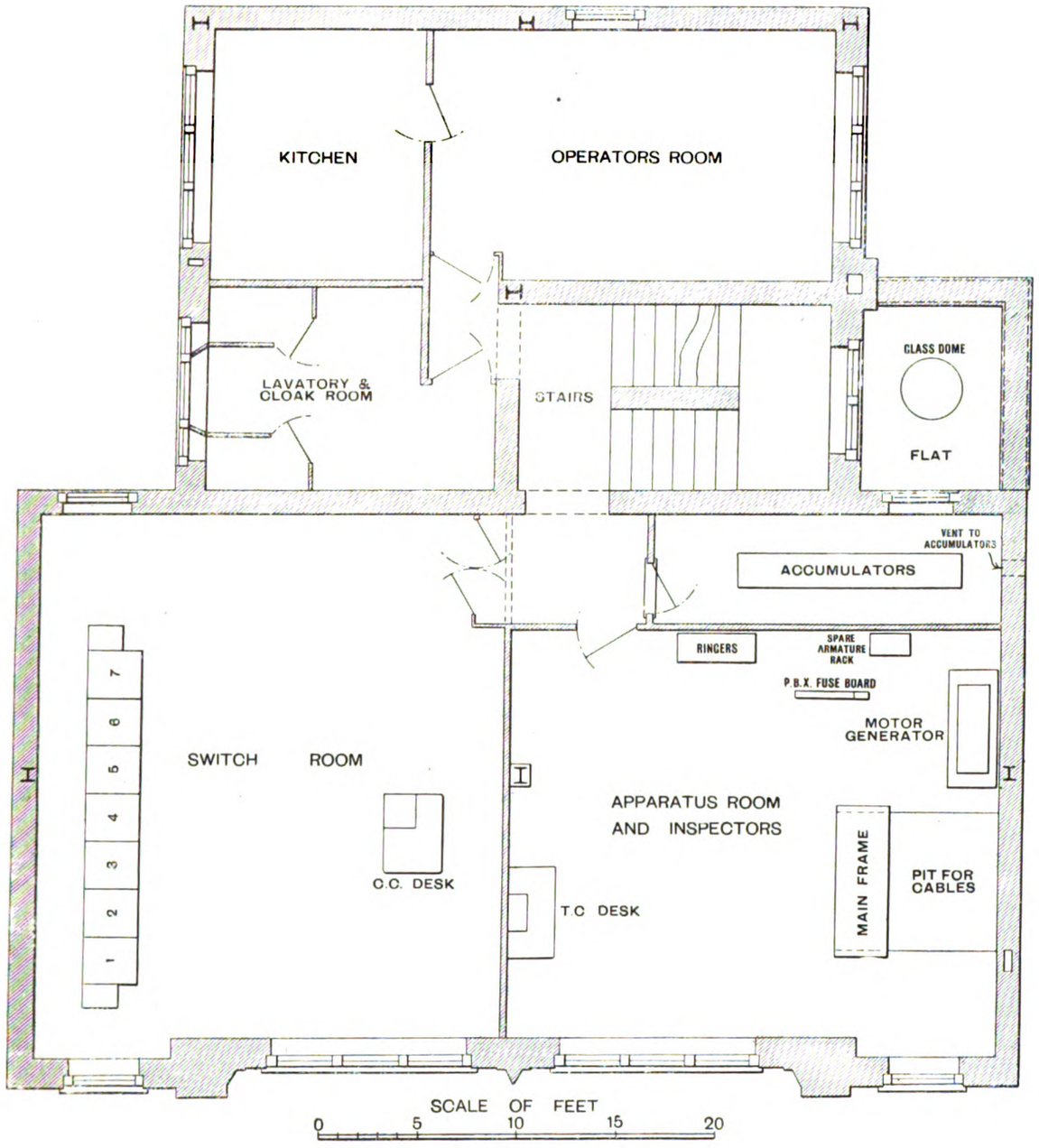


FIG. 1.—PLAN OF EXCHANGE, SHOWING LAY-OUT OF APPARATUS.

covered cable is carried to the switchboard, and there connected to the first jack of a series multiple, which is repeated every fourth panel through the switchboard.

Each section has accommodation for 400 subscribers' multiple jacks, and 80 outgoing junction multiple jacks in strips of 20 each, and the switchboard is designed for an ultimate capacity of 800 subscribers' lines and 160 outgoing junctions. It may here be noted that the

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answering jack, in the ordinary acceptation of the term, has been abolished, the multiple jack serving a dual

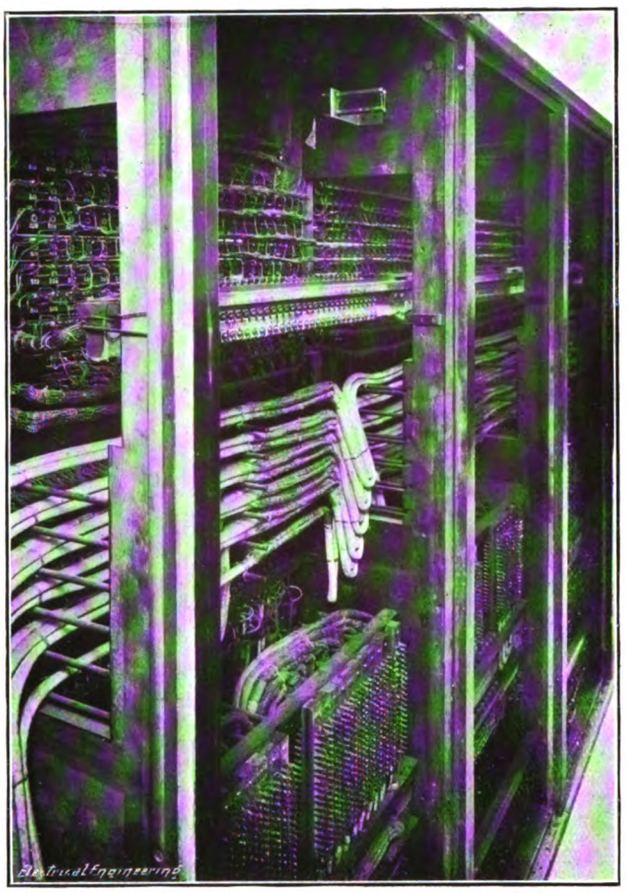


Fig. 2.—Rear View of Switchboard with Panels Removed.

purpose. To the inner springs and bush of the last strip of jacks in the multiple is connected a 63-wire cable of sufficient length to reach the next multiple jack when the switchboard is extended.

This cable is terminated on a strip of connecting terminals fitted in the rear of the last section, as shown in Fig. 2. At this point the tip or "A" lines are commoned together and connected to the positive side of the battery, and the ring or "B" lines are carried in 21-wire cable to terminals at the rear of the particular section in which the signals with corresponding numbers to the jacks are situated. Between these terminal strips and the connectors at the bottom of the section to which one end of the winding of the subscribers' calling signal is wired there exists a cross-connecting field, where, by means of single jumper wire—or, as is the case at East Ham, by wires made up in cable—the calling signal is connected to the "B" line inner spring of the jack.

The calling signal is of an automatic mechanical type, consisting of an electromagnet and a pendulous armature, to which is attached a spherical-shaped piece of aluminium, the latter being brought into view with the energising of the electromagnet is restored by gravitation when the electromagnet is de-energised.

The operation of the line circuit, shown in Fig. 3, will be readily grasped. When the circuit is completed by the removal of the subscribers' receiver from the switchhook, current flows from the positive pole of the battery through the "A" line jack contacts, the primary winding of the induction coil and transmitter of the instrument returning through the "B" line jack contacts and 300-ohm calling signal to the negative pole of the battery. The armature of the signal is thereby attracted, closing a local circuit which lights a pilot lamp common to a section. With the insertion of the answering plug into the jack, the calling signal is disconnected from the line, and restores mechanically as previously described.

The subscribers' operators' cord circuit is shown in Fig. 4. It will be seen that this circuit is divided by condensers instead of the repeating coil, which is usual with the regular central battery cord circuit used in larger exchanges; and, further, that a 16-cell battery is used in place of 11 cells, the purpose of this being to keep the transmission efficiency standard. The impedance coils, through which current is supplied for transmission, serve also as supervisory signals, and are of a similar type to the subscribers' calling signal, and the 500-ohm retardation coil connected to the sleeve conductors of the plugs provides the current for the engaged test. Provision has been made in the equipment of five ringing keys per cord circuit, for calling party-line subscribers by the selective system of pulsating ringing currents.

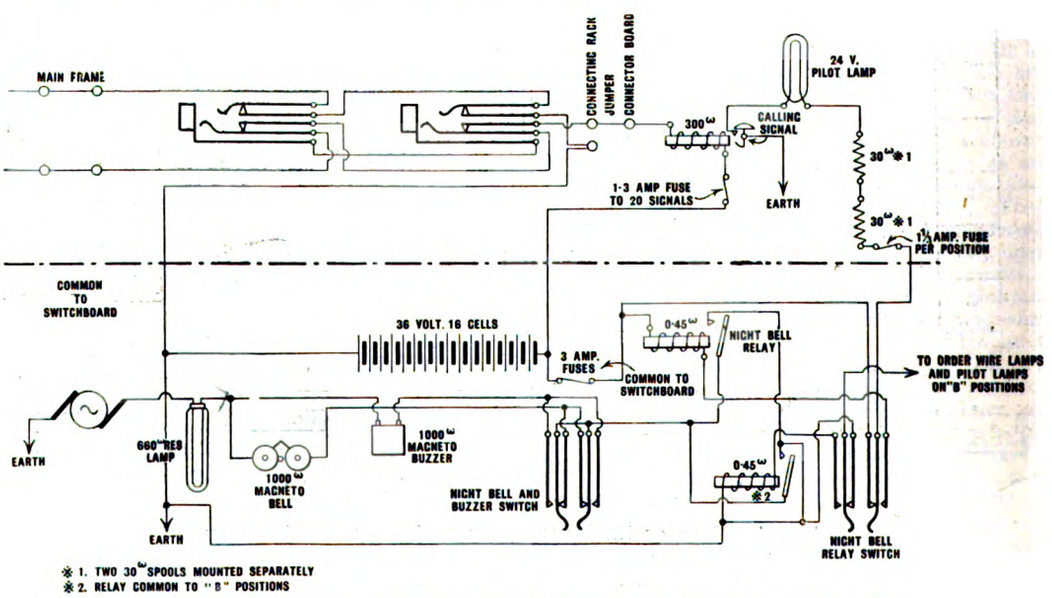


Fig. 3.—Diagram of Subscribers' Line and Night Alarm Circuits.

Fig. 5 shows a general view of the switchboard, the first three sections of which are junction positions, one of these is being used temporarily as an electrophone position, and the remaining four are subscribers' positions.

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Each section constitutes one operator's position, and the principal dimensions are:—Length, 2 ft. 5 in.; width (including keyboard), 2 ft. 9 in.; height overall, 6 ft. 3 in. The "B" positions have each a capacity for 27 incoming junctions, and are at present equipped with 25. The connections of the junctions are practically the same as the standard circuits, the chief point of difference being that the cut-off relay, which is usually fitted in connection with the sleeve conductor of the plug, is in this case operated either by a key or plug-socket switch. The "A" positions have each a capacity for 200 subscribers' calling signals, which are mounted above the multiple jacks in strips of twenty; the present equipment is 500 signals divided between four positions. The keyboard and plug-shelf have capacity for 15 cord circuits, the full number being equipped; and the supervisory signals in connection with the cords are mounted immediately below the bottom strip of calling signals, in two strips of 15 each.

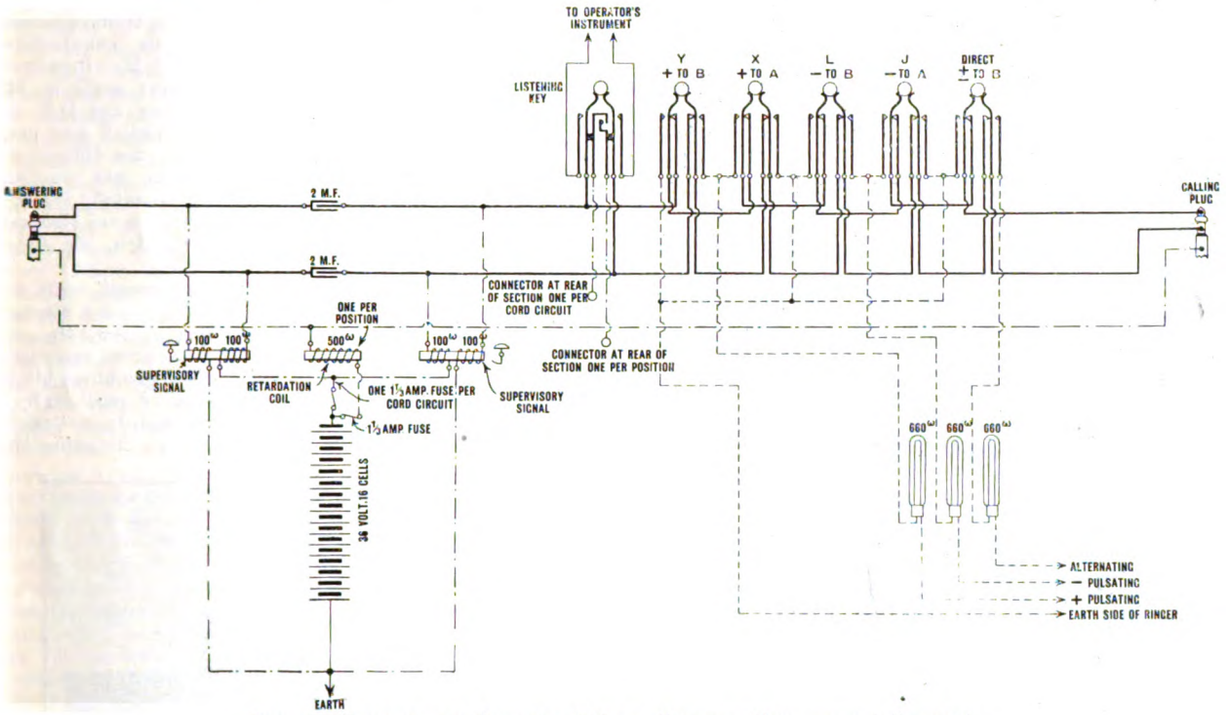


FIG. 4.—DIAGRAM OF OPERATORS' CORD CIRCUIT (SUBSCRIBERS' SECTION).

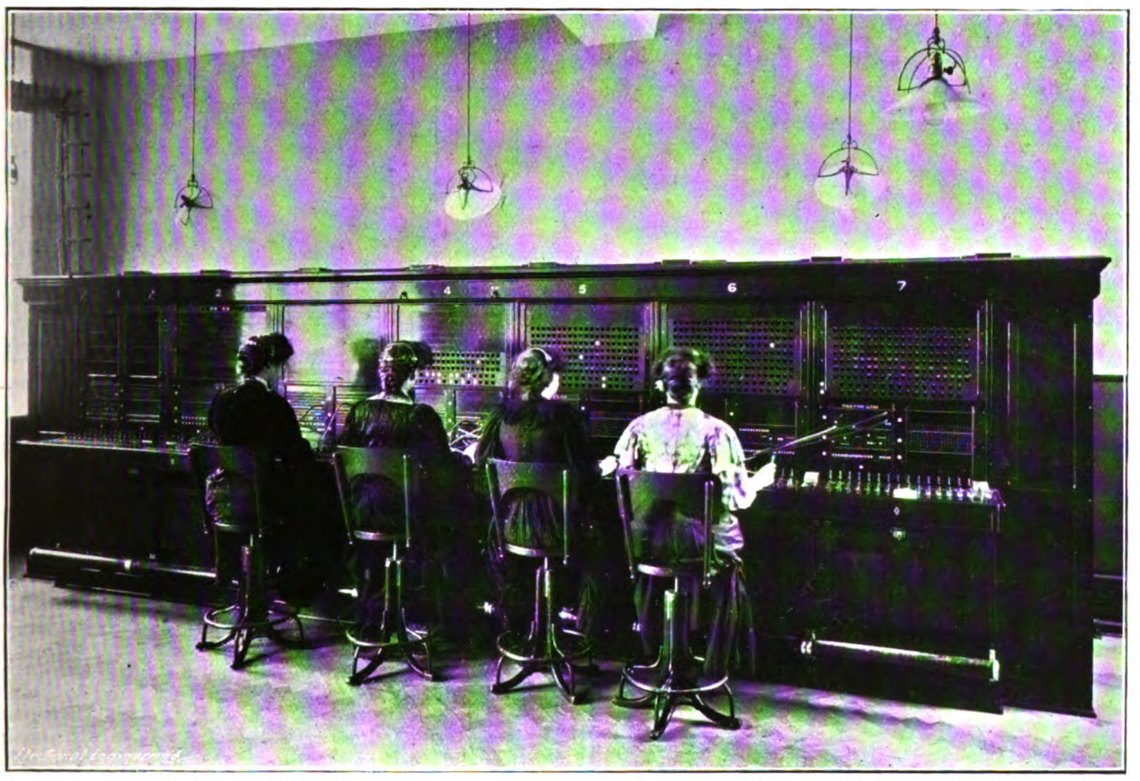


FIG. 5.—GENERAL VIEW OF SWITCHBOARD.

Fig. 6 shows the test clerk's panel. This embodies

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all the principal features of the familiar test clerks' desk of larger central battery exchange equipments, but at the same time takes up less space. All the apparatus in connection with the testing circuits is contained in the panel with the exception of the battery of primary cells and condensers, which are accommodated in a teak case underneath.

A set of 16 Chloride cells in lead tanks supplies the switchboard with current for transmission and signalling purposes. The present capacity of the battery is 420 ampere-hours at a 9-hour discharge rate, but the tanks are large enough to allow of the plates being increased

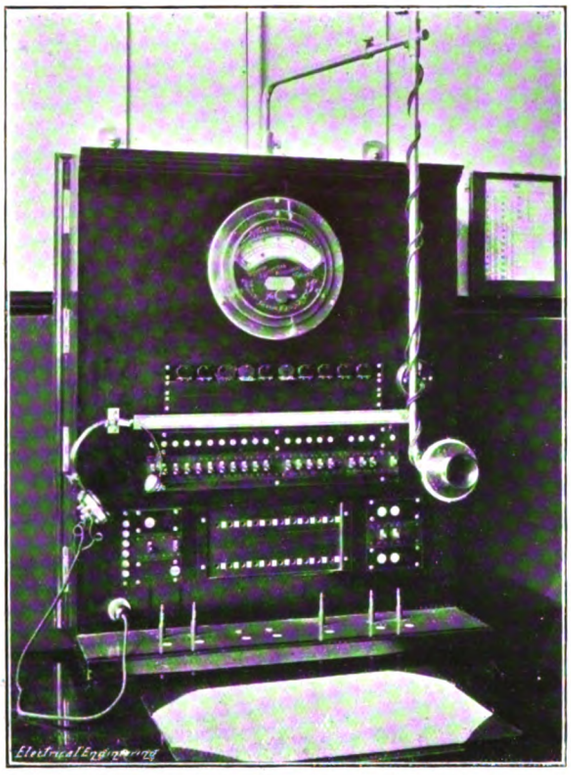


Fig. 6.—Front View of Test Clerk's Panel.

when necessary to give 720 ampere-hours at the 9-hour rate.

The charging set consists of a direct-coupled motor-generator, the output of the generator of which is 90 amperes at 45 volts. In addition, two ringing machines have been put in, which supply the alternating, negative, and positive pulsating currents required for ringing subscribers' bells, and also the busy-back and tone-test signals. One of these machines is a direct-coupled motor-generator, and the other a dynamotor which is supplied with current through a choke coil from the battery.

The number of subscribers' and junction lines with which the exchange was opened was 208 and 41 respectively, these figures including 178 lines transferred from the Barking exchange, which is now closed.

The building has been designed so that an additional floor can be added for installing a standard central battery equipment when the ultimate capacity of the present switchboard is reached.

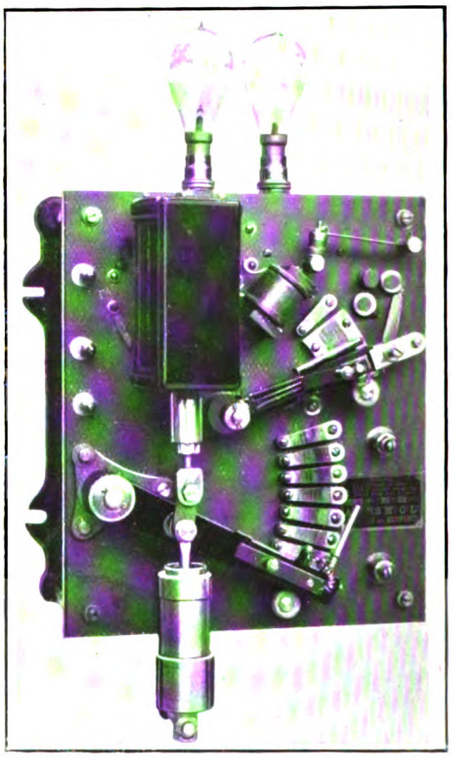
Electrical Imports into Switzerland.—According to a consular report, the total imports of electrical apparatus into Switzerland during 1906, amounted in value to £148,400, as against £147,700 in 1905. Of these £1,700 and £1,900 were imported from the United Kingdom, showing a slight decrease. The average decrease of imports from the United Kingdom during the five years, has been 1·5 per cent. Germany is the principal country from which electrical apparatus is imported into Switzerland, and during 1906 no less than £113,000 of the total of £148,400 came from Germany.

A NEW PRINTING PRESS CONTROLLER

THE accompanying illustration shows an automatic starting switch specially designed for use in connection with printing machines, which has been patented by Mr. Frank Broadbent, and has been put on the market by the Adams Manufacturing Co., of Bedford, who hold a sole licence for its manufacture and sale. This new switch is not the first that Mr. Broadbent has invented for controlling printing machines; early in 1899 he took out a patent for an interlocked starter and D.P. switch, which he had designed in 1898, and the switch now produced has really grown out of the earlier switch, the difference being that while the switch patented in 1899 was mechanically operated, the new switch is electrically operated, and by this means quite a number of important advantages are claimed.

In explanation of the evolution of this switch, Mr. Broadbent says :—

"Some ten years or so ago it was impressed upon me that for special work, such as the control (that is, the starting and 'inching') of such machines as printing presses, the ordinary starter was a very poor device. Printing-press operators had for years been accustomed to 'inch' their machines bit by bit in order to bring the 'forme' to the required position by means of the ordinary striking gear. They simply see-sawed the striking handle backwards and forwards, so throwing the belt



Controller for Printing Press Motor (Adams Manufacturing Co.)

from the fast to the loose pulley, and *vice versa*. This enabled them to move the machine very slowly, or, as they called it, to 'inch' it along. When printing presses were electrically driven by individual motors the starting switch got precisely the same treatment as the ordinary belt-striking device, which means that the motor got several times its normal working current suddenly thrown upon it, and this current was repeatedly broken across the starting-switch contacts. The wear and tear on the switches was terrible; the overloads thrown on the motor were most destructive to the commutator and brush gear, to say nothing of the mechanical strains thrown upon the armature shaft and driving pinion. We endeavoured to induce machine operators to 'inch' with a D.P. switch whilst holding the starter on the first or second button of the starting switch. They did this, as long as we stood by and watched them, but no longer."

Early in 1899 Mr. Broadbent took out a patent for an interlocked starter and D.P. switch. The essential principle of this was that the starting handle, in being pushed over, carried with it the D.P. or circuit closing switch, and, when at the end of the travel, this switch was closed, all resistance was in circuit, and the starting handle automatically returned without any assistance from the operator and so started up the motor

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gradually. By this means it was impossible for the operator to put the D.P. switch in unless all resistance was in circuit, and it was impossible also for him to "inch" or to break the circuit on the starting contacts. A disadvantage of this switch was the room it took up on the press, and to alleviate this an arrangement of solenoid control was introduced into the switch, by means of which it can be placed at a convenient distance from the machine, and operated by press buttons or a small "inching" switch placed near the operator's hand. We understand that the troubles and breakdowns due to ordinary methods of starting, including both the rheostat type of starter and also the drum controller, had reached such a pitch in 1904 that the Operative Printers' Assistants' Society made a claim for extra wages for those of their members who had to operate this class of apparatus. The reason for this may not be quite obvious, but it was a result of the large number of discharges that had taken place owing to the breakdowns of motors and starting gear. There was nothing now, of course, in the principle of solenoid control, but hitherto it had been usual and necessary to use two solenoids, one to operate the main switch, which in turn closed the circuit of a solenoid actuating the rheostat proper. The method of operation was to use a small switch to energise the main solenoid. As soon as the solenoid circuit was closed by this switch, the solenoid pulled up the main switch, thus closing the motor circuit and energising the rheostat solenoid, which then commenced to pull the rheostat starting lever slowly upwards against the retarding action of a dashpot or some equivalent device. This permitted of the starting gear being placed at a distance from the machine and operated by means of a small switch near the operator's hand, and by opening and closing the switch rapidly the machine could be "inched" and controlled with precision. There are, however, several disadvantages appertaining to this arrangement, first, on the score of initial cost, and also on the cost of erecting and connecting up the two separate pieces of apparatus. Further, electrical interlocking devices are required to make it impossible for the main switch to be energised unless the rheostat is at its bottom position with all the starting resistance in circuit. This means the introduction of a resistance (either composed of lamps or resistance units) into the solenoid circuit as soon as the starting lever commenced to travel. A fault or break in this circuit causes pumping, and renders the switch practically inoperative. Again, in order to economise in the consumption of energy by the rheostat solenoid, it is necessary to introduce resistance into its circuit, when in the normal full running position. Without these resistances the solenoids would have to be so liberally rated, to prevent overheating, as to make the solenoid system impracticable. Another disadvantage of the system is the difficulty of using a self-setting overload device, and it is only possible to protect the motor from overload by using either a circuit breaker which must be set by hand, or a safety fuse which has the same and other disadvantages.

The new switch has been designed with a view to obviating these disadvantages, and it may be pointed out that if the proposed Home Office Regulations come into force this year, the present method of solenoid control, that is, by means of a tumbler switch, will not be approved, and any accident arising therefrom, such for instance as the starting up of a machine on the restoring of a supply current after a failure, may, in the event of a fatal accident, place the switch manufacturer and contractor in a very serious position. The construction of the switch is simple and robust, and, as there is only one solenoid, no waste of energy takes place when the motor is running. The switch may be automatically released in the event of a break in the shunt field by connecting the holding on coil in that circuit. It will then pause automatically on the first resistance contact until the shunt field is built up, so preventing a rush of current. The cost, both initially and of erection, is reduced, due to the use of one apparatus instead of two. Electrical interlocking devices are eliminated as the switch is mechanically operated. There is thus a saving in the space occupied by the switch gear. As will be seen, the simple design permits of a very simple interlock between the rheostat and the shunt regulating rheostat. The motor can always start on its strong field, the shunt resistance being gradually introduced whilst the motor is accelerating, without the use of any additional solenoid. A self-setting overload release can thus be used, and cooling resistances are eliminated. The more certain action due to the cleaning of the contacts on the upward travel of the switch arm before the dashpot comes into play on the downward travel. There is a reduction in the amount of attention necessary, and there is the further advantage that it is impossible for it to start without the pilot switch being properly closed.

THE GRIEVANCE AGAINST THE NATIONAL PHYSICAL LABORATORY

The Committee's Report

FOR some two or three years a feeling has existed among professional men connected with the engineering and chemical industries, that the National Physical Laboratory was trespassing on the ground of private institutions and individuals, in conducting tests and investigations for ordinary commercial purposes. Public attention was directed to the matter in the Press, and, largely as a result of the energetic action of the Institute of Chemistry, the Treasury, on December 31st, 1906, appointed Mr. Gerald Balfour, Sir Andrew Noble, Bart., K.C.B., F.R.S., Sir John Wolfe Barry, K.C.B., F.R.S., Mr. W. J. Crossley, M.P., and Mr. R. Chalmers, C.B., as a Committee to inquire generally as to the work performed at the Laboratory. The Committee was instructed to give special attention to the following points:—

(i.) The character of the mechanical, physical, and chemical tests undertaken there;

(ii.) The possibility of their interfering unduly with the business of other agencies;

(iii.) The desirability of publishing the results of all such testing work;

and to report:—

(1) Whether having regard to the industrial interests of the country generally and to those of private agencies, any change is desirable in the scope of the work of the Laboratory; and

(2) On what lines any further development of its business should proceed.

The Committee sat for nine days, between March 18th and June 28th, to hear evidence from the following witnesses:—

Dr. R. T. Glazebrook, F.R.S. (Director of the National Physical Laboratory), Sir William Ramsay, K.C.B., F.R.S. (Vice-President of the Institute of Chemistry), Dr. Percy F. Frankland, F.R.S. (President of the Institute of Chemistry), Mr. Bertram Blount, F.I.C., Mr. David Howard (Past President of the Institute of Chemistry), Mr. E. W. Monkhouse (Burstall and Monkhouse), Mr. W. G. Kirkaldy, Mr. J. E. Stead, F.R.S. (Metallurgical Chemist), Mr. R. B. Haldane, K.C., M.P., Mr. C. J. Bagley (nominated by the Iron and Steel Institute), Mr. T. Nash (nominated by the Iron and Steel Institute), Mr. R. E. Spencer (nominated by Sir W. G. Armstrong, Whitworth & Co.), Mr. H. E. Harrison (Principal of the Electrical Standardising, Testing, and Training Institution, Faraday House), Sir Joseph Swan, F.R.S., Sir Arthur Rucker, F.R.S., Sir Alexander Kennedy, F.R.S. (President of the Institution of Civil Engineers), Sir William Preece, K.C.B., F.R.S., Mr. Alexander Siemens, Mr. R. Kaye Gray, Mr. W. H. Maw, Lord Rayleigh (President of the Executive Committee of the National Physical Laboratory), Mr. H. F. Donaldson (Chief Superintendent of the Ordnance Factories at Woolwich), and Mr. D. B. Butler (Owner of a Cement-testing Works).

The Committee's report, dated December 16th, 1907, was issued last week.

After reviewing the events which led to the foundation of the Laboratory and its opening in 1902, the report states that all the witnesses were unanimous as to the great value to the commercial community of the research work conducted there, and as to the high efficiency with which it is carried out. Particular reference in this connection is made to the investigations into electrical and engineering questions undertaken in connection with the Engineering Standards Committee, including those relating to the standardisation of electric glow-lamps.

There is ample evidence, the Committee says, that

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work of this kind supplies a long-felt want in this country, and is already widely appreciated by manufacturers and "scientists"; and it has no doubt that the importance of the Laboratory will meet with a steadily increasing recognition. Various investigations have already been conducted on behalf of manufacturers yielding results of general scientific interest, such, for example, as a comparison of the properties of gutta percha and balata, undertaken for the India Rubber Company of Silvertown (made to confirm work done in the company's own laboratory).

The Committee is of opinion that any grievance which private agencies may urge against the Laboratory is, so far, "more theoretical than practical," for the number of cases in which routine or commercial testing of materials has hitherto been undertaken by the Laboratory has been exceedingly small, and the fees earned by this means are of "inappreciable amount." This has, however, rather been due to the want of adequate equipment than to any desire on the part of the Laboratory to abstain from competition with private enterprise; for, in the official statement issued by the Laboratory, and in the pamphlets giving lists of tests undertaken and scales of fees, no suggestion was made that any restriction as to the scope of the work was required in the interests of private agencies until 1906, when, as a result of the protests of the Institute of Chemistry, an exception was made in connection with chemical analyses. Incidentally, the argument that commercial work is financially necessary to the Laboratory is dismissed.

While looking upon the apprehensions of those interested in testing work as exaggerated, the Committee does not regard them as unreasonable or entirely without foundation, and considers that "a more precise formulation of the testing work proper to be undertaken by the Laboratory is evidently desirable in order that public and private interests may be, as far as possible, harmonised. To this end the Committee recommends that, subject to certain exceptions, the Laboratory should be debarred from undertaking "Contractual Testing," but should be free with regard to "Investigatory Testing." Contractual Testing is defined as "the ordinary testing of materials to ascertain whether their quality and behaviour are in accordance with the requirement of contracts. . . . It is usually strictly routine work within defined lines to determine whether samples accord with specification, and does not call for anything but care and observation." Investigatory Testing "is in the nature of investigation for commercial purposes of various substances in which no question of contract arises."

The following exceptions to this general rule are made:—

(1) There are some tests, chiefly electrical, thermal, optical, and other physical tests, which cannot be carried out adequately, if at all, in any existing private establishment. In such cases it would obviously be absurd to debar the Laboratory from undertaking the work merely on the ground that the tests are intended to ascertain whether certain materials comply with the requirements of a contract.

(2) No restriction should apply to "reference" testing wherever, in cases of dispute, the parties concerned agree to refer their differences to the authoritative decision of the Laboratory, or where the Laboratory is called in by a Court of Law or of Arbitration.

(3) In view of the character of the Laboratory as a public institution, it ought to be free to accept any work which any Government Department may desire to commit to it. In this category is included the work until lately carried out at Cooper's Hill on behalf of the Indian Government.

(4) The restrictions which should be observed by the Laboratory in connection with the testing of materials are not intended to apply to the testing and verification of instruments (and, in connection therewith, of their component parts), which is much more generally, and quite rightly, admitted to be within its proper functions. There are, however, some cases in which it is difficult to draw a clear line between instruments and materials. One important case of this kind which has been brought to the Committee's notice is that of glow lamps. Where such a doubt exists, it must be left to the executive committee of the Laboratory to decide what course of action should be followed.

As an additional safeguard against injurious competition with private enterprise, the Committee thinks that, wherever the same tests of materials are carried out by the Laboratory and outside agencies, care should be taken that the fees charged by the former should be at least as high as those normally current; in the case of reference testing they should be distinctly higher. While the Committee fully accepts the assurances of the Laboratory authorities that it was not their intention in any case to undercut prices, it thinks that more attention should be paid to this matter than appears to have been done heretofore.

On the question of the publication of all testing work conducted at the Laboratory, the Committee proposes to give the Laboratory more latitude. The existing rule is to publish all the results of investigations undertaken at the request of private individuals and fully paid for by them, except in special cases approved beforehand by the Executive Committee. In practice very few, if any, exceptions have been admitted. The Committee thinks that the rule, as interpreted, has proved too rigid and should be relaxed:

There is cogent evidence that insistence on immediate publication of results has already deterred, and must often deter, manufacturers and others from submitting to the Laboratory investigations likely to yield new results of great importance that would hardly be attainable through any other agencies. In one case it has been suggested that the operation of the rule has been to hand over to Germany an important branch of industry which might otherwise have been secured for this country.

This case, relating as it does to research in connection with metallic filament lamps, is interesting, and we therefore quote from the evidence given by Dr. Glazebrook in this connection:—

Another case in which difficulties have arisen is that which was mentioned by Sir Joseph Swan in his evidence. I should like, if I may, to read two or three sentences from Sir Joseph Swan's letter: "The question has occurred to me whether the Committee of the National Physical Laboratory would be agreeable to enter into any arrangement with me with the object of ascertaining the properties, electrical and general, of certain substances, more or less nearly related to the materials which have been examined in Dr. Harker's recent researches on high temperature furnaces. The substances I refer to are, generally speaking, the metals or metaloids of the more infusible earths, of which thorium, titanium, and tungsten would be types, and it might be desirable to extend the research so as to find the electrical properties of some of their compounds, particularly the carbides and oxides, in a compact and filamentary form." That was an enquiry into the materials which are now being used for the newest forms of incandescent lamps. As a matter of fact, the inquiry into the properties of some of these metals has since* been taken up in Germany, and lamps which are likely to supplant in great measure the carbon filament lamp are being made in Germany, and imported from Germany in large quantities. It is quite probable that, had we been able to take the research at that date, the German work on these lamps would have been done here, and the advantages that have accrued from the introduction of the lamps would have belonged to us rather than to Germany. It was Sir Joseph Swan's intention at first that the tests should be carried out with assistance from a company and worked for a company with which he is connected, and the negotiations occupied some little time. Finally he decided to take it up himself and to assist the Laboratory with his experience in the matter. By that time, however, this question of publication had been raised in a somewhat acute form. It appeared probable that this Committee was to be appointed, and the Laboratory Committee decided that while so important a matter was under the consideration of this Committee it was not desirable for them to undertake the work, with the result that the work has not been undertaken, and some of the results I have no doubt we should have arrived at have been obtained in Germany.

The Committee is of opinion that the Executive Committee of the Laboratory should hold itself somewhat freer than heretofore to exercise a discretion as to the withholding of results from publication, either wholly or in part, for a limited number of years. But they also

* From this it would appear that the correspondence in question took place some time ago, as the "Osram" lamp with its tungsten filament appeared on the market in 1905, and naturally must have been preceded by a long course of experimental work. In the interest of historical accuracy we beg Dr. Glazebrook to give us the date of this correspondence.—Ed. *E. E.*

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think that in cases where publication is thus deferred a considerably higher fee should be charged to the persons for whose immediate benefit the investigation is to be carried out.

It was also suggested that the authorities of the Laboratory might with advantage be kept more closely in touch with the practical needs of industry by the institution of small Advisory Committees representative of different technical interests. The Executive Committee has already power to appoint sub-Committees of this kind, including members not already on the General Board or Executive Committee, although no regular meetings are held; and it is now recommended that these Committees be kept up-to-date and in close touch with the Executive Committee.

Sir Andrew Noble and Sir John Wolfe Barry, who are themselves members of the Executive Committee of the Laboratory, differ from the above report with regard to the restriction on "Contractual Testing," and recommend that a restrictive period of ten years would safeguard the interests of the public, which, they believe, would be best served by leaving the authorities entrusted with the administration of the National Physical Laboratory completely free (as is the case in the National Laboratories of Germany) to exercise their discretion in accepting or refusing any description of testing work.

This view of the minority has, however, not been accepted by the Treasury, who, in a Treasury Minute dated February 1st, 1908, approve of the recommendations made by the majority of the Committee. A note is appended to the Treasury Minute to the effect that the President and Council of the Royal Society accept in principle the recommendations contained in the report of the Committee, and the Executive Committee of the National Physical Laboratory have expressed their readiness to use their best endeavours to carry the recommendations into effect.

In addition to the quotations we have already made, several other interesting matters of a miscellaneous nature were referred to in the evidence.

Dr. Glazebrook, speaking in reference to the necessity of the performance of some routine commercial test work to maintain a connection with actual engineering practice, said: "For instance, just lately we have been asked to investigate for the Board of Trade the material of a steam drum that burst in the south-west of London, and we have one or two other tests of that kind on hand. Of course we can carry out the actual measurements, but the measurements, if made by men who have no real experience of the behaviour of the ordinary materials of construction, lose a very great deal of their value." This presumably refers to the thermal storage drum that exploded at Greenwich, upon which the Board of Trade has recently issued its report.

Regarding the fees charged for testing instruments, Dr. Glazebrook said that if the Laboratory charged high fees this work would go to Germany, and, in fact, this was the case to a certain extent already.

Sir William Ramsay, in the course of his evidence, expressed the opinion that the analysts at the National Physical Laboratory were not sufficiently experienced to carry out some of the commercial tests submitted to them, and instanced two cases in which their results had been at fault.

Dr. Frankland particularly attacked the "Test Pamphlet" issued by the Laboratory to the general public, containing lists of tests carried out and scales of fees. Private practitioners, he said, "have now to meet the competition of a State-aided, non-rate-paying concern, which advertises for work in a manner which would universally be regarded as derogatory to the dignity of a professional man, and which charges low fees, and issues certificates bearing the seal and imprimatur of a national institution. No professional man would ever think of sending out a document of this kind. Amongst all professional men, every form of advertisement is regarded as in the highest degree derogatory. . . It is entirely contrary to professional etiquette to issue a list of charges to the general public." He also compared the Laboratory's fees in some instances with those charged by private practitioners: Determination of calorific value of coal, fee, 15s., for a single sample; the usual professional fee for this would be £1 1s. Determination of percentage of ash in arc lamp carbons, per carbon, 10s. 6d.; the usual fee is £1 1s. The National Physical Laboratory authorities propose to charge two guineas for chemical tests of steel rails, or about half the fees formerly and usually charged. Probably if the National Physical Laboratory charges only two guineas for a steel rail it will be impossible for a private practitioner to get more, although he has been getting more.

Mr. H. E. Harrison drew particular attention to the advantage which has been taken in some instances by private firms, who use the National Physical Laboratory certificate for purposes of advertisement. He read the following extract from the prospectus of the Premier Accumulator Co., Ltd.:—"The Premier Accumulators have recently been exhaustively tested by Dr. Glazebrook, the Director of the National Physical Laboratory (President of the Institution of Electrical Engineers). The tests, which were of the severest description, extended over four months. They thoroughly demonstrated the solidity of the special paste and the ability of the accumulators to withstand abnormal rates of charges and discharge and yet attain the average efficiency of 92·5 per cent., which is much larger than that obtained by any other accumulator. A reprint of the article in the *Electrical Review* of 1906, embodying Dr. Glazebrook's report, is enclosed herewith. The original report is in the possession of the Premier Accumulator Co., of Northampton, and can be inspected by anyone interested." That appeared in the original prospectus, and no doubt assisted very materially to float the company. Mr. Harrison also showed a copy of the firm's present price list with the report. Another document he produced related to a "Lamp Guarantee." "The British Thomson-Houston Co. offered to supply three standard 240-volt B.T.-H. Edison lamps of each c.p. for test by the National Physical Laboratory, provided a competitor who, it was understood, had agreed to this alternative guarantee of 775 hours at 3·9 watts per candle, would do likewise. This suggestion was accepted, and in due course the 18 sample lamps (nine selected by each maker) were received by the National Physical Laboratory and the test begun." The lamps were tested, Mr. Harrison continued, and although it says definitely in the report of the Committee that unless special permission is obtained not to have results published, they shall be published, yet they were not published. The lamps by the other maker, which are called A, did not come up to the requisite standard, and instead of these results being published they are kept secret. Owing to the fact that results are not always published, a maker does not hesitate to send his lamps up to Teddington as he would send them to Faraday House. When we hand over a report it becomes the property of our clients, but we say either it must be published in full or not at all. That is our usual condition. Teddington is in a very different position.

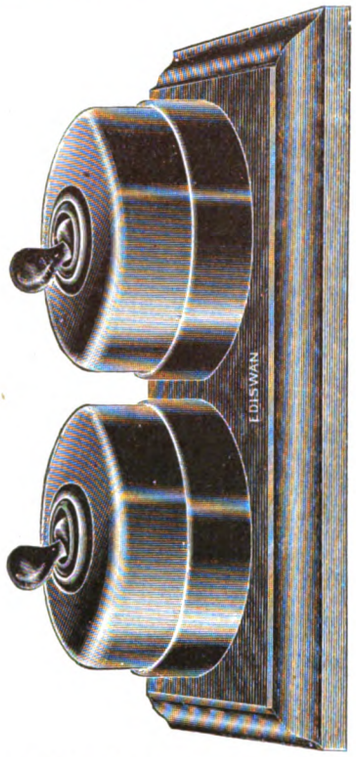
Sir William Preece, in the course of his evidence, said:—"Here is a place open to the whole country, and if anybody knows that any fad that occurs to him can be scientifically tested for a small sum by the National Physical Laboratory, he will go to the National Physical Laboratory and get it tested. You cannot go to private individuals; they charge too much. It is so difficult to get any private man who owns a laboratory to go thoroughly and earnestly into another man's fad, but with a national institution like the National Physical Laboratory, with such able assistants and such a capable director, whatever question is brought to them they seem to take in the same earnest way as if it had been their own suggestion. I think there is a very large field for the National Physical Laboratory for research in that direction. . . . In my own case I have sent to them three or four times new accumulators for secondary batteries, that have been brought to me, particularly for ignition purposes in motor-cars. When they come I invariably send them to the National Physical Laboratory and get them tested there. They are thoroughly well tested, and reports and certificates are always very complete, and the charges are very moderate. Those are things that you cannot give to private people. Sir William Preece also spoke at considerable length with regard to the testing of incandescent lamps. He thought it desirable that they should bear a mark which would be some guarantee of their conforming with the standards of the Engineering Standards Committee, and said that the Board of Trade, although they sympathised very much with the desirability, said that the only way of its being brought about would be for some testing authority to be legalised by licence to hold the mark. He suggested that the National Physical Laboratory should be this authority, and that Edinburgh, Dublin, Manchester, and Bristol might be made subsidiary to the National Physical Laboratory, so as to avoid undue concentration of work at Bushey.

New System of Wiring.—A description is given in a recent number of the *Elektrotechnischer Anzeiger* of a system of interior wiring in which protected insulated wires are used. The two insulated wires are surrounded by a rigid tube of copper, brass, or iron, which fits tight around the pair. This covering may be a seamless tube, in which case the material can be procured in lengths not longer than 22 ft. If the covering is rolled and folded, however, it can be obtained in lengths of 325 ft. if necessary. These tubes are very small in diameter, and as the metal covering is only 0·3 mm. thick, they are easily handled, and bent to the required shape. Special clamp joints and other fittings are provided, and it is practically impossible for moisture to get to the insulation. The tubes can be laid on the surface or in the plaster.

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A NEW SWITCH

THE accompanying illustration shows a new form of switch which has been introduced by the Edison & Swan United Electric Light Co. for use in positions where a "Wedge" switch with the usual elevation could not be used. So short is the projection of this new type, which has been named the "Phlatta," that it can be fixed close to the moulding in places where doors open against a side wall, and where consequently the ordinary tumbler switch has to be placed some distance away in order that the door, in opening, may clear it. Its neat appearance also renders it suitable for use in positions



Specially Flat Form of Switch introduced by the Edison & Swan Electric Light Co.

where other types would look unsightly. The parts are made and assembled at the Ediswan Works, Ponder's End, Middlesex. The principle on which it works is identical with that of the well-known "Wedge" type, also made by the company, in which the contact-making parts are enclosed in a block of vitreous porcelain, thus rendering arcing impossible, and, in addition, securing an exceptionally high insulation resistance. The movements are carefully balanced, and owing to the high quality of the spring action a particularly quick make and break is effected. In action the switch is noiseless, and works much more smoothly than the ordinary type of "tumbler." A specially thin polished wood base, which may be round, square, or oblong, is made for this form of switch.

BULK SUPPLY TO THE MIDDLESBROUGH CORPORATION

IT will be common knowledge to many of our readers that when the Cleveland and Durham County Electric Power Company applied for parliamentary powers in 1900 many Corporations in Durham and Yorkshire opposed their application, among the opposers being included the Corporation of Middlesbrough. The opposition was unsuccessful, but the Corporation continued to extend their undertaking, and obtained some valuable consumers within the Borough. At the end of 1906, when the Cleveland Company became associated with new management and with Messrs. Merz and McLellan as its consulting engineers, an extremely progressive policy was adopted about that time. The Corporation of Middlesbrough were in the position of requiring more plant; unfortunately, their generating station had been erected upon a very poor site as regards foundations, and was, moreover, situated too far from some of the large works in the area to make it possible for its system of low tension continuous current supply to be extended to reach these works economically.

The Corporation, therefore, were face to face with the choice of two alternatives, the first being to lay down a new generating station, and, hampered with double capital upon the back of the undertaking, to endeavour to compete with the larger Power Company who had the right to supply within the Borough. The second was to take a bulk supply from the Power Company and act as authorised distributors. After due consideration they very wisely selected the latter alternative, and the value to them of this decision was accentuated by the fact that when the question of price was discussed the Company agreed to offer better terms if the Corporation were prepared to allow them to supply a portion of the district containing some of the large iron and steel works directly without passing through the Corporation as a distributor. This the Corporation agreed to, the Company in its turn agreeing that the Corporation should continue to supply the valuable district containing sundry shipyards and engineering works, in which it had already laid mains. One of the conditions of the agreement is that the Cleveland and Durham Electric Power Company will give the Middlesbrough Corporation supply in the form of continuous current, and at a sub-station provided by the Company in the heart of the works district reserved by the Corporation. As the Corporation generating station contains small plants and is not very commercially efficient, it is proposed to use this generating plant to a great extent as a peak load station, and to take most of the flat load current from the Company's sub-station. By this means the Corporation will purchase at an exceedingly low price, and their own high generating costs being only on peak load will not affect to a great extent the average cost of all units consumed.

The sub-station built for the bulk supply to the Corporation is situated at a point approximately four miles from the Grangetown power station and one mile from the Newport power station of the Power Company, and two one square inch mains for carrying three-phase current at 11,000 volts are laid into the sub-station. The whole of the high-tension switch gear is of the Electric Co.'s (A.E.G.) make, and the high-tension board consists of two feeder panels and two transformer panels, each of the brick-work type, and a bus-bar isolating switch, the feeder panels being equipped with "Merz Price" patent protective relays; the current transformer panels are also fitted with overload relays for the protection of the transformers.

In the sub-station are installed two rotary converter sets each of the capacity of 700 kilowatts, and comprising a three-phase static transformer for each machine, suitable starting and synchronising panels (the synchronising being done on the low tension side), and two six-phase rotary converters (whose synchronous speed is 480 revolutions per minute), fitted with a shunt wound mid-wire booster direct coupled. The rotary converter sets are of Westinghouse manufacture, as is also the low tension three-wire direct current switchboard. This board contains panels for four cables and two machines, and has two sets of bus-bars, to either of which any machine or feeder may be switched without the use of plugs.

A CHEAP FORM OF ELECTRIC KETTLE

THE most serious obstacle in the way of the introduction of electric heating and cooking appliances in small installations has been the expense of the apparatus. The cost of current in such appliances is not as serious as is often supposed, on



New Electric Kettle (Simplex Conduits, Ltd.)

account not only of the cheaper rates available in most districts for power and heating, but the very short time which efficiently constructed apparatus requires to be in use. In order to popularise the use of electric kettles by the small consumer, Simplex Conduits, Ltd., have introduced the type of kettle shown in the accompanying illustration, which is listed at the low figure of 10s. It is made of tin of pleasing design, and has a capacity of 1¾ pints. The consumption is 500 watts, and it will boil its full capacity of water in about 12 minutes.

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ELECTROCHEMISTRY AND ELECTRO-METALLURGY

IN the *Elektrochemische Zeitschrift* of February, Josef Rieder describes "Impressions produced upon Photographic Plates by means of Electric Waves." The method adopted for retaining the impressions of electrical waves is the coherer, which is a tube filled with powdered metal, and which under the influence of electric impulses alters its resistance. The exact cause of this change of conductivity so produced is not quite clear. It is, however, supposed that the waves of electricity cause sparks to spring between the particles of metal powder; this causes partial fusion, and thus conducting bridges are produced. If this explanation is correct, Rieder thought that it should be possible to cause these impulses to become impressed upon a photographic plate. Accordingly, he drew a figure upon a glass plate with a solution of shellac; before allowing it to dry fine aluminium powder was sprinkled over it, and after drying it was placed, with its back against a very sensitive photographic plate, in a box, so that it was completely shut out from the light. He found after subjecting it to the action of electric waves produced by the sparking of an induction machine that on developing the plate a complete image of the drawing had been produced. In order to test whether aluminium powder itself would act upon a photographic plate without the influence of the electric impulses, another plate prepared in a similar manner was left in contact with a photographic plate, but no image was produced.

He found, also, that the thinner the layer of aluminium powder the greater the intensity of the action upon the plate. It was further found that the action was greatest when the back of the glass plate upon which the aluminium coated drawing had been sketched was backed with a sheet of metal. Further experiments were then made in the following manner. A rubber stamp was dipped into a solution of rosin and then pressed down carefully upon a clean sheet of glass. By this means a fairly clear impression was obtained. After drying the plate was gently warmed so as to soften the rosin, and then sprinkled over with aluminium powder, the excess of aluminium being dusted off when the rosin had hardened again. This plate so prepared was then placed with its back against a sheet of copper, and against this, in turn, a photographic plate was placed. The plates were then put into a light-tight box. In order to produce the electric impulses a small influence machine, capable of producing a 3 cm. spark, was used, a receiving rod 50 cm. high being employed on the box. The machine was placed in the author's dwelling, and the box and plates were removed 70 metres away from the house. After working the machine the plate was developed, when a complete photograph of the stamp was found to have been produced. Rieder thinks that an apparatus might be constructed to show the atmospheric conditions, the intensity of the photographic image depending upon the intensity of the waves. He suggests that a glass plate with only one spot of powder upon it should be fixed in a box, and a sensitised film should be passed before it by means of clock-work or other mechanical arrangement. By this means if there were electrical disturbances in the neighbourhood the film would show them, the intensity of the influences being shown by the intensity of the photographic image. It might also be used for taking the Morse code, the dot and dash being shown by the length of the mark upon the sensitised film, the powdered spot acting upon the plate during the period that it was subjected to the electrical impulses. If this principle can be satisfactorily worked out, it appears we have here a very valuable advance, or the possibilities of a very valuable advance, in wireless telegraphy.

In the *Elektrochemische Zeitschrift* of February there is also an account of the German Government plant for the electrolytic production of hydrogen for the purpose of inflating the army balloons. The oxygen which is at the same time produced is compressed into cylinders, and can be employed for a variety of purposes. Until recently the electrolytic methods of preparing hydrogen for filling balloons have not been able to compete with the purely chemical. The gas obtained by chemical methods, *e.g.*, by the action of sulphuric acid upon iron, is not so pure as that produced electrolytically, and has therefore less lifting power. The plant referred to has been erected by Messrs. Schuckert & Co., of Nuremberg (Electrizitäts-Aktiengesellschaft vormals Schuckert & Co.), and is made to deliver 600 cubic metres (21,190 cubic feet) of hydrogen in 24 hours. It is, however, capable of being worked to almost double this capacity. The power is obtained from a dynamo directly coupled with a 300 h.p. motor. The current delivered is 1,800 amps. at 85 to 110 volts. The compressing machinery is driven by a 70 h.p. motor. In order to provide against accidental explosions should the gases leak into the buildings, the dynamos and motors are all cased in, and the electric lamps are enclosed in air-tight globes. The electrolysing cells are divided up into three groups, which can be separately operated from the switchboard. Each group contains 34 cells connected up in series, and which require 600 amperes. In the Schuckert system no diaphragm is used to separate the anode from the cathode compartment. The electrolysing cells consist of iron tanks, and the anode and cathode are separated by means of bells, consequently the pressure of the gas must not be too great either at anode or cathode space, or the gases will mix and an explosive mixture be produced. The electrolyte is 20 per cent. potassium hydrate, and both anode and cathode are of iron. The maximum efficiency is said to be obtained when the electrolyte has a temperature of 60—70°. This temperature is reached when the plant has been in operation for about six hours. At this temperature 6·4 kilowatt hours are required to produce 1 cubic metre (35·16 cubic feet) of gas. To prevent the solution being cooled by external influences, the whole electrolysing tank is placed in a wooden box, the spaces between the iron walls and the wood being packed in with sand. The whole plant, with the exception of the copper current conductors and the insulating material, is made of iron. The renewals required are very slight. Once a year insulating material requires to be renewed, and every now and then fresh iron anodes are required. About 2 kilograms (4·41 lb.) of anode is consumed for every 100 cubic meters (3,530 cubic feet) of hydrogen produced. The gas is produced at a water pressure of 80 mm. (3·1 in.), and has a purity of 97-99 per cent. It is washed free from any alkali which may spray over it by first passing over a surface of water, and then up a tower containing coke, over which water trickles

TANTALUM LAMPS FOR ALTERNATING CURRENT

IN the earlier days of the tantalum lamp a good deal of unexpected trouble was experienced with the peculiar behaviour of the filaments when used on alternating currents, which made the life of the lamps when used on these circuits so uncertain that the makers were forced to recommend that their use be confined to continuous-current circuits. The effect produced by alternating currents was very peculiar, and consisted in a breaking up of the filament into short sections in a way quite absent in the case of continuous currents. The phenomenon was well illustrated in some micro-photographs of tantalum filaments which had been used on continuous and alternating circuits, under our own observation, which were shown at a meeting of the Institution of Electrical Engineers, and reproduced in Electrical Engineering, Vol. I., page 153. A satisfactory explanation of the effect has never been forthcoming, but we were pleased to be able to make the announcement last week that Messrs. Siemens Brothers Dynamo Works, Ltd., were now able to supply lamps of certain sizes, suitable for use on alternating as well as continuous-current circuits. Messrs. Drake and Gorham, who have always been to the fore regarding the sale of these lamps, have during the week issued a circular that sets forth the sizes now available. Looking through the list we find that all the lamps from 50 to 75 volts, which range in sizes from 12 to 32 c.p., are available for alternating currents, as are also the 100 to 130-volt 25-c.p. lamps, and the 32 and 50 c.p. lamps for 100 to 160 volts. The 16-c.p. lamp for 100 to 120 volts, of the same efficiency as those already mentioned, viz., 1·7 watts per British candle-power, is only recommended for continuous currents, but a 16-c.p. lamp of slightly lower efficiency (2·2 watts per c.p.), is available for alternating currents at these voltages. Another size which is at present only available for continuous current is that for 25 c.p. at 140 to 160 volts. It should be said that better results are, as a rule, obtained on 50 cycle circuits than on those of higher frequency.

Manchester Local Section of the Institution of Electrical Engineers.—The annual dinner, at which some 150 members were present, was held at the Midland Hotel, Manchester, on Friday last. Mr. M. B. Field in the chair. Among those present were the Mayor of Salford (Mr. I. Frankenburg), Dr. R. T. Glazebrook, Mr. Robert Hammond, Dr. C. Hopkinson, and Mr. S. Z. de Ferranti. The Lord Mayor of Manchester (Mr. Holt), in a letter of apology for his absence, said that he would have liked to have been able to give official recognition to the representatives of an industry by which the city had benefited so much. After the loyal toasts, Mr. Robert Hammond proposed the Corporations of Manchester and Salford, and in the course of his speech mentioned that the supply of electricity per head of population was larger in Manchester than in almost any town in the country. The Mayor of Salford responded for both Corporations. Mr. J. Adamson proposed "The Institution of Electrical Engineers," and stated that a technical library was urgently needed, as well as a suitable assembly room where the meetings of the many scientific societies in Manchester could be held. Dr. R. T. Glazebrook, in responding to the toast, mentioned that the Institution intended perpetuating the memory of Lord Kelvin, their late president, in some suitable way; and he had no doubt that the Manchester Local Section would be anxious to help. Dr. Glazebrook also spoke of the success of the London volunteer corps of electrical engineers. Other speakers were Mr. Ferranti, Mr. Miles Walker, and Prof. F. G. Baily (Chairman of the Glasgow Local Section).

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ELECTRICAL SCIENCE

British and American

On the Contact E.M.F.'s between Mercury and Electrolytes.—A Paper on this subject was presented at last Friday's meeting of the Physical Society by S. W. J. Smith and H. Moss. It is well known that if the surface tension between mercury and an electrolyte be examined by the Lippmann capillary electrometer method, the surface tension in the case of practically all electrolytes rises to a maximum and falls as the E.M.F. applied to the electrometer increases. Paschen showed that in many cases this E.M.F. of maximum surface tension was equal to the natural contact potential difference between a dropping mercury electrode and a still mercury electrode immersed in the same mass of electrolyte. Since the dropping electrode is supposed to attain the same potential as the electrolyte, this observed E.M.F. is the measure of the contact E.M.F. of mercury and the electrolyte. Recently Palmaer has shown that he could reduce the observed potential difference between the still and dropping mercury until it became zero, and even changed sign, by the expedient of adding small portions of certain substances to the electrolyte. Solutions giving the zero E.M.F. between still and dropping electrodes are called "null" solutions, and were supposed by Palmaer to make absolutely no contact potential difference with still mercury, which implies that the zero potential difference between mercury and a null solution occurs at the point of maximum surface tension. The present authors now show in their Paper that this deduction of Palmaer's is not necessarily true, and that his results leave the knowledge of the contact potential difference between mercury and an electrolyte substantially in the same state of uncertainty as before. To show this the authors first investigated new ways of producing null solutions. One way consisted in adding sodium sulphide in very minute quantity to potassium chloride solution as electrolyte till the electrocapillary curve (between surface tension and applied E.M.F.) had its maximum at zero applied E.M.F.; and a second kind of null solution was obtained by using a different electrolyte and altering its concentration till the maximum of the electrocapillary curve was at zero E.M.F. In the Paper, the laws governing the effect of adding minute proportions of sodium sulphide to potassium chloride solution are fully worked out, and are shown to be remarkably affected by the presence of dissolved oxygen in the solution. But the point of principal interest is brought out by the measurements of one null solution against another; it is seen that the potential differences between different null solutions are not the same, after allowing for the small contact E.M.F. between electrolytes.

Continental

Specific Inductive Capacity and Dissolving Power.—That there is a certain parallelism between the dissolving power and the dissociating or ionising power of a solvent has been suspected for some time. And as the power of a solvent to split a solute into ions goes hand in hand with its dielectric constant, it is natural to expect a close connection between the dielectric constant and the dissolving power of a liquid. Such a relation has now been discovered by P. Walden, who gives the results of his researches in No. 5 of the *Zeitschrift für Physikalische Chemie*. According to Rothmund, the mutual solubility of liquids is proportional to their dielectric constants. The author, however, takes a "normal electrolyte" in the solid state, viz., tetra-ethyl ammonium iodide, $N(C_2H_5)_4I$, and dissolves it to saturation in a number of different liquids, comprising such various types as water, acetone, ethyl bromide, and benzonitrile. He compares the dissolving powers of these with their dielectric constants as determined by their refractive indices for long waves, and finds that the dielectric constant is proportional to the cube root of the dissolving power. This law resembles that found by Baur for the concentration of an electrolyte in two contiguous solvents.

Radium and Lithium.—In the *Comptes Rendus* for February 17th, Miss Gleditsch publishes the results of her search for lithium in radium minerals, a search the interest of which lies in the connection between radium and lithium discovered by Sir W. Ramsay. The authoress finds that all the radium minerals analysed do contain lithium, but in quantities too minute for chemical analysis. These quantities were therefore estimated spectroscopically, by preparing definite mixtures of lithium and sodium salts, and observing the prominence of their respective lines. Among the minerals investigated were pitchblende of Joachimsthal and Colorado, carnotite, Cornish chalcolite, autunite, and thorite. Of all these, carnotite contained the largest proportion of lithium (0·05 per cent.), and Cornish chalcolite the smallest (0·0001 per cent.). Autunite and thorite contain no copper, but a good deal of lithium. This might be attributed to the transformation of the copper into lithium, but then chalcolite contains 6·54 per cent. of copper, and very little lithium. The authoress finds no conclusive evidence against Ramsay's hypothesis, but also very little to corroborate it.

CATALOGUES AND PAMPHLETS RECEIVED

FOLDING STEPS.—We have received a new leaflet from Messrs. J. H. Heathman & Co., describing a form of folding lattice step-ladder, in which an ingenious arrangement of folding treads is adopted, whereby the thickness of the appliance when closed is reduced to 2¾, as against about 6 in. with the ordinary design. A form without supporting legs is made to close to 1½ in., and open to 6 in. width of tread.

INCANDESCENT LAMPS.—A neat coloured show-card is to hand from Cryselco, Ltd., calling attention to the carbon-filament lamps made at their works at Bedford.

MAGNETIC SEPARATORS.—Messrs. Plutte, Scheele & Co. send us a list of electro-magnetic separators of the "Geist" type, in which the magnet is stationary, and is surrounded by a revolving non-magnetic drum provided at intervals with thin iron projections on its periphery. The material to be treated is conveyed past the drum at a tangent and, as soon as it comes under the influence of the magnet, the iron particles are attracted, and are drawn off by the revolving drum until they are no longer under the influence of the magnet when they fall off by their own weight. The non-magnetic material is not attracted by the magnet, and consequently falls off at once.

MOTOR-CAR ACCESSORIES.—The newest catalogue from the General Electric Co. deals with motor-car accessories. A full series of ignition apparatus is included, comprising multiple and distributor coils, small coils for cycles, contact makers and distributors, sparking plugs, high and low-tension wires, connectors, switches, pocket ammeters and voltmeters, electric light fittings for omnibuses and private cars to take small Osram lamps, direction indicators, speaking tubes, accumulators for ignition and lighting, dry batteries, primary batteries, motor generators, and switchboards for accumulator charging, portable lamps, various tools, and Coates' patent high-tension magneto apparatus, which is manufactured at the company's Manchester works.

SMALL MOTORS AND GENERATORS.—Two new leaflets dealing with small machines have been issued by the Crypto Electrical Co. A series of small motor-generators is listed, ranging in output from 200 to 4,000 watts for converting from alternating to continuous current. A combined machine with a single frame for the same purpose is also included, which is specially intended for the charging of ignition accumulators in garages, &c. The output of this set is 6 to 7 amperes at 15 volts. Another leaflet deals with small induction motors for single, two- and three-phase circuits.

THE WORKING MEN'S COLLEGE, MELBOURNE.—The prospectus of this College for the year 1908 contains complete information concerning the various courses of instruction which can be taken there. The College, founded in 1883, by the Hon. F. Ormond, has been repeatedly enlarged by means of private, public, and government subscription, and now provides classes in all the conceivable branches of the handicrafts, arts, and sciences. The average number of students enrolled per term is over 2,000, the total number of students at present enrolled being 4,130.

WATTMETERS AND PHASEMETERS.—A new list from the Union Electric Co. contains particulars of a series of Hartmann & Braun moving coil wattmeters of switchboard type for continuous and alternating currents, with suitable resistances, &c., including special neutral point resistances for use on three-phase circuits, where the neutral point is not accessible, and a direct-reading phasemeter, which can be graduated in degrees or power factor. Full size reproductions of the scales are given, from which it is seen that they are particularly clear and easy to read

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Applications of Electricity in Korea.—The American Consul-General at Seoul, reporting upon Korea as a market for electrical appliances, fans, and motors, says that the Koreans are rapidly installing small motors in their shops and lights in the homes at Seoul. The modern Korean palace has been lighted for some time by electricity, and of late commercial plants have been established at Chemulpo and Fusan, while two plants under one management, supply light and power to Seoul, the capital. The Seoul company installs fixtures of a standard nature, charging a monthly rental for these, in addition to the regular current charges. This company is steadily importing and installing American fixtures. The company has also been installing many small motors, capable of running rice mills and other light machinery. It is believed that electrical fans will be used in Korea as soon as the natives able to purchase them become accustomed to the various uses of electricity. The American-Korean Electric Co., of Seoul, intends to introduce fans extensively during next summer, and electric flat-irons, warming pads, and other novelties will probably follow in due course. The steady market demand at present, however, is limited to motors and fixtures. The Oriental Consolidated Mining Co., operating at Unsan, has recently installed a modern and complete turbine electrical generating plant, capable of operating their stamp-mill machinery and mine hoists. Water is carried from a reservoir, with 111,599.231 cubic feet of available water, through a flume to the power house.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published Feb. 27th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from abroad.

1906 Patents

24,925, J. S. Raworth. In traction systems in which regenerative motors are used, it is possible that the voltage of the system may rise considerably above the normal voltage. In order that the machinery and instruments, connected to the traction mains, shall be protected from such excessive voltage or reverse current, a diverting circuit between the positive and negative conductors is provided, in which are a resistance and a switch operated by a relay. This switch is automatically closed by a rise in voltage or by a reverse current, and is also automatically opened on the restoration of normal conditions. One claim, one figure.

1907 Patents

440, British Thomson-Houston (*Allgemeine Elektricitats Ges.*). An improved method of starting alternating-current commutator motors of the type in which the armature is short-circuited in one axis and excites the motor field. At starting the short-circuited brushes are moved from their running positions until the motor speeds up, when they are moved back. The other brushes connected to the supply mains are kept stationary. Two claims, one figure.

3,060, A. D. Jones. The composition in the grooves of the positive carbon of the enclosed flame arc-lamp, which was described in Electrical Engineering, February 27th, 1908, page 299. The composition is a mixture of two parts of calcium fluoride (which alone would give the arc a whitish-yellow colour), and two parts of calcium tungstate (which alone would give the arc a purple-white colour). One part of sodium tungstate or potassium sulphate is added to steady the arc. The mixture is formed into a paste with a suitable binder, such as dextrine solution, and laid in the grooves of the positive carbon. The resultant light from the arc is of a brilliant yellow colour, and the colour and brilliancy are maintained, although the arc is enclosed. Two claims, no figures.

8,642. British Thomson-Houston (*General Electric Co.*). A method of connecting metallic filaments of tungsten, molybdenum, titanium, and similar metals to the leading in or supporting wires of incandescent filament lamps. The end of the supporting or conducting wire is fused round the filament by means of an electric arc. The fusing is done below the surface of a liquid, such as water, alcohol, or benzine, in which inert or reducing elements are liberated by the action of the arc. The liquid cools the globule of metal quickly, and ensures a good contact with the filament. Three claims, three figures.

9,294. H. L. Holden and G. B. Elphinstone. An improvement in the device described in Pat. No. 3,593, 1907, for automatically connecting the primary winding of a transformer to a source of electric supply, when current is required to be supplied by the secondary. This specification describes a relay switch which governs the main switch. Two claims, one figure.

11,071, Allgemeine Elektricitäts Gesellschaft. A method of automatically reducing the speed of electrically-operated winding gear (for instance, of a mine-cage when a passenger load is to be carried). The insertion of a resistance in the field circuit of the generator supplying the winding motor has the disadvantage that the regulating resistances in the same field circuit are then no longer correctly proportioned to give uniform acceleration and retardation. This method consists in exciting the generator field from a source of lower potential when a lower speed is required. The regulating resistances thus remain correctly proportioned and a uniform acceleration is obtained. The switching over from one source of potential to the other is performed automatically when the signal is given to the operator that a passenger load is to be carried. Three claims, one figure.

11,873. Siemens Bros. Dynamo Works and H. B. Poynder. A modification of the method of speed control of polyphase motors, as described in the specification for Pat. No. 10,007, 1907. (See Electrical Engineering, February 20th, 1908, page 285.) The low-frequency machine of the motor generator is a synchronous machine, and the main motor is supplied from this machine with a rotary field, either in the same or in the opposite direction to that in the stator. An increased as well as a decreased speed can thus be obtained, and further, by alteration of the excitation of the low-frequency machine, the power-factor of the main motor can be made equal to unity, or the motor can be made to take a leading current. Four claims, two figures.

19,856. Siemens Bros. Dynamo Works, Ltd. (*Siemens Schuckertwerke Akt.-Ges.*) An elastic device for insertion between an alternator and its prime mover in order to render it impossible for oscillations to be transmitted from the engine to the generator, or *vice versâ*. The elasticity or the natural period of vibration of the device can be altered by adjusting screws or similar means. One claim, no figures.

22,746. Siemens & Halske Akt. Ges. The preparation of metallic filaments for incandescent filament lamps. The metallic filament, for instance, of tantalum, is drawn through a solution or plastic mass consisting of a chemical compound of another difficultly fusible metal; for instance, tungsten. The coating thus obtained is reduced in an atmosphere of hydrogen by passing the coated filament through a tube, which is heated by an electric current, and through which hydrogen is passing. The coating is thus reduced to a metallic skin, and the final filament combines to a certain degree the favourable properties of both metals. Nine claims, no figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Summaries of the more important of these patents will appear in our next issue.

1907 Patents

555, Clark & Vlasto. Electric switches.
634, British Thomson-Houston Co. & Wedmore. Distribution systems.
634A, British Thomson-Houston Co. & Wedmore. Switches.
2,926, Armgur. Electric recording pyrometers.
3,025, Hope. Electric cut-outs.
3,226, Holmes. Electric heating apparatus.
3,305, Reuter. Electrical brakes for cranes.
3,543, Shellhamer. Electric heating-pads.
3,740, Wood, McLeod, & Lancashire Dynamo & Motor Co. Alternating-current motor control.
3,914, Reynolds. Electric furnaces.
3,982, Cowper-Coles. Electrolytic apparatus.
4,055, Meyer. Safety plugs.
4,125, Cabot. Wireless telegraphy.
4,128, Cabot. Systems of wireless telegraphy.
4,152, Peck. Systems of electrical distribution.
4,154, Cabot. Systems of wireless telegraphy.
4,833, British Thomson-Houston Co. & Garton. Regulation of motor-generator sets.
5,836, Franklin & Seyfert. Alternating-current motor.
5,952, Hill. Jointing and distributing boxes for cables.
7,048, British Thomson-Houston Co. (*General Electric Co.*). Magnetic wedges for dynamo armatures.
7,410, Haigh. Marine electric steering gear.
7,432, Cooper. Electric contact makers.
8,173, Milton. Inductor alternators.
9,172, Ingram & Hunt. Electric arc lamps.
9,572, British Thomson-Houston Co. (*General Electric Co.*) Incandescing bodies for electric lamps.
9,913, Hawkins. Recording meters.
10,861, Punga. Multiple circuit armature winding.
12,574, Lake (*Hallock*). Inductor type generator.
13,983, Little. Storage batteries.
14,752, Scott. Prevention of inductive disturbances in telephone circuits.
14,935, Torda & Torda. Distribution systems.
15,810, Pfanstiehl. Sectional induction coils.
23,416. Féry. Electrically-controlled pendulums.
24,751, Siemens-Schuckertwerke Ges. Commutators.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patents

16,366, Mayo & Houlehan. Motor starters.
26,435, Bosch. Electrical ignition apparatus.

1908 Patents

1,754, Lertourné. Electrical projectors.
2,195, Derain. Dynamos.
2,308, Siemens & Halske Akt.-Ges. Selecting receivers.
2,685, Fessenden. Receivers for wireless telegraphy.
2,955, Fessenden. Wireless signalling.

Expiring Patent

The following Patent expires during the current week, after a life of fourteen years:—

4,572, of March 5th, 1894. C. Adam-Randall. A telephone transmitter, consisting of one diaphragm, with two or more carbon contacts, each with independent battery and induction coil. The secondaries of the induction coils are in parallel and are connected to the line Four claims, four figures.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ltd.	10	7	5/-*	10¾—11¾	+¼
Do. 4½% Cum. Pref.	10	4½	4½%	10—11	
Do. 6% Cum. Second Pref.	10	6	6%	10—10¾	
Do. 4½% Debenture, Red.	Stock	4½	4½%	100—103	
Bromley (Kent) E.L.& Power Co., Ltd.	5	5½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	95—98	
Brompton & Kensington E. S. Co., Ltd.	5	10	4½%*	7⅞—8¾	+¼
Do. 7% Cum. Pref.	5	7	7%*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	97—100	
Ch. Cross. W. E. & City E. S. Co.	5	5	5%*	4¼—4⅜	-⅛
Do. 4½% Cum. Pref.	5	4½	2½%	4¼—4½	-⅛
Do. 4% Deb. Red	Stock	4	4%	97—100	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	4¼—4½	-⅛
Chelsea Electric Supply Co., Ltd.	5	4½	2/-*	3⅞—4	-⅛
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	5%*	10—11	
Do. 6% Cum. Pref.	10	6	6%*	11⅛—12⅛	
Do. 5% Deb. Red	Stock	5	5%	122—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	99—102	
Cty of Durham E. P. Dis. Co.	5	4	2/1%*	3—3⅛	
Do. 5% Pref.	5	5	5%*	4⅜—4⅝	
County of London Elect. Sup. Co. Ltd.	10	5	4%*	7⅞—8⅛	+⅛
Do. 6% Cum. Pref.	10	6	6%*	11—11½	
Do. 4½% Deb. Red	Stock	4½	4½%	105—108	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	96—99	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	¼—⅜	
Do. 6% Cum. Pref.	5	3½	—	⅜—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	65—75	-5
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4⅝—5½	
Do. 5% Cum. Pref.	5	5	2/6*	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6¼—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%	95—98	
Kens. & N't'ng Hill E.L. Cos. Db. Rd.	Stock	4	4%*	99—103	
London Electric Supply Corporation	3	4	2/4½d*	1¼—1⅜	
Do. 6% Pref.	5	6	6%*	4⅝—5⅛	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	91—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	5¼—5⅜	-½
Do. 4½% Cum. Pref.	5	4½	4½%	4⅞—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D	100 & 500	4½	4½%	98—101	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	9¼—10½ xd	-¼
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6½—6⅝	
Do. £2 Pm.	5	8	1/4⅔d*	6¼—6⅜	
Do. 5% Pref. (fully paid)	5	5	5%*	5—5⅛	
Do. 10/- Pm.	5	5	1/4⅔d	5—5¼	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11—12 xd	-½
Oxford Electric Co., Ltd.	5	7	2/6*	5⅜—6¼	
Do. 4% Deb. Red	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7½—8½ xd	-¼
Do. 7% Non-Cum. Pref.	5	7	7%	6¾—7 xd	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅜—1½	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2½—3	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅝—⅝ xd	-⅛
Do. 7% Cum. Pref.	1	7	7%	1⅛—1⅜ xd	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	101—104	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1½—2¼	
Do. 5% Cum. Pref.	5	5	2/6*	2—2½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7⅞—8⅜ xd	-½
Do. 4½% Cum. Pref.	5	4½	4½%	5—5⅛	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	88—90	
Central London	Stock	4	3%	64—67	
Do. 4% Preferred	Stock	4	4%	82—84	
Do. Deferred	Stock	4	2%	44—47	
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	77—81	+1
City and South London Cons.	Stock	2⅝	4¼%	38—40	
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	114—117	
Do. 5% Perp. Pref. 1895	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11½d.	1¼—1⅜	
Gt. Northern, Piccadilly & Brompton	10	4	4%	5½—6½	
Do. 4% Perp. Deb.	Stock	4	4%	86—89	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1%	36½—37½	-½
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½%	72—75	
Metropolitan District	Stock	nil	—	9—10	-1½
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Deb.	Stock	4	4%	70—75	-1
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pr. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	40—44	-2
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅝—¾	
Do. 5% Cum. Pref.	1	5	5%	1⅜—1½	
Do. 4½% Deb. Red.	Stock	4½	4½%	91—96	+1
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	4½—5	-⅛
Do. 5% Perp. Deb.	Stock	5	5%	97—101	
Do. 4½% 2nd Deb.	Stock	4½	4½%	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4⅜—4⅝	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	98—101	

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%			
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅜—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7—8	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	90—94	-1
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—⅛	
Do. 5% Cum. Pref.	1	5	5%	⅛—⅛	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	98—100	
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—⅜	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅜—1⅛	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅛—⅜	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9¾d*	⅛—⅛	
Do. 5% Cum. Pref.	1	5	5%	⅛—⅜	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4¼—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	1/1¼	¾—1⅛	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dist. E. Trs. 1st Mt. Db. Rd.	100	5	5%	63—68	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1⅛	
Do. 6% Cum. Pref.	5	nil	—	3⅛—3⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	3½%	54—57	-1
Do. 6% Pref. Ord.	Stock	6	6%	97½—99½	-1½
Do. Def. Ord.	Stock	1¾	1%	12¾—13¼	-1
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	87—90	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3¾	
Do. 10% Cum. Pref.	5	10	5/-*	8¼—9¼	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4½	4½%	13⅜—14½	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12¾—13½	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5¾	5%	131—136	
Do. 3½% Pref.	Stock	3½	3½%	83—86	-1
Do. 4% Mort. Deb.	Stock	4	4%	100—103	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	32—34	
Indo-European Telegraph Co. Ltd.	25	13	65/-	54—57	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	
National Telephone Co., Ltd., Pref.	Stock	6	6%	108—110 xd	-3
Do. Deferred	Stock	5½	6%	108¼—110½ xd	-3
Do. 6% Cum. 1st Pref.	10	6	6%	10½—12½ xd	-½
Do. 6% Cum. 2nd Pref.	10	6	6%	10—12 xd	-½
Do. 5% 3rd Pref.	5	5	5%	5⅜—5⅝ xd	-1/16
Do. 3½% Deb. Red.	Stock	3½	3½%	97—99	
Do. 4% Deb. Red.	Stock	4	4%	100½—102½	
West African Telegraph Co. Ltd.	10	4	4/-	10—10½	
Western Telegraph Co., Ltd.	10	7	6%	13½—13⅝	
Do. 4% Deb.	Stock	4	4%	98½—101½	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅛—⅜	
Do. 6% Cum. Pref.	1	6	7½d	33/32—1	
Babcock & Wilcox, Ord.	1	20	1/7½*	3½—3⅝	-⅛
Do. 6% Pref.	1	6	7½d	1 1/16—1 1/16	
British Insulated & Helsby Cables, Ltd.	5	10	4/-*	6⅞—7¼	+⅛
Do. 6% Cum. Pref.	5	6	6%	5½—6	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	101—104	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	83—87 xd	-2
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—⅜	
Do. 4% Mort. Deb. Red.	Stock	4	4%	43—48	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	1/16—⅛	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	77—80 xd	-2
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10⅜—11⅜	-½
Do. 5% Cum. Pref.	5	5	5%	5⅜—5⅝	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106—108	
Consolidated Electrical Co., Ltd.	1	3	8¾d*	1/16—1/16	
Crompton & Co., Ltd.	3	5	5%	1⅛—2 1/16	-1/16
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1—1¼	
Do. 6% Cum. Pref.	1	6	7½d	1—1⅛	
Do. 4½% Deb. Red.	Stock	4½	4½%	99—102	
Edison & Swan United "A," £3 paid	5	4½	2/6	⅜—1	
Do. do. (fully paid)	5	4½	4/2	1⅛—2⅛	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	¼—⅜	-1/16
Do. 7% Cum. Pref.	2	7	—	1¼—1⅜	-⅛
Do. 4% 1st Mort. Deb.	Stock	4	4%	65—69	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8½	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	11⅜—12⅜	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—5⅛ xd	-¼
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	+½
Do. 4% Deb. Red.	100	4	4%*	99—101	
Tel. Const. & Maintenance Co.	12	15	5%*	33—35	
Do. 4% Deb. Bds. Red.	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3¼—3⅜	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

ARGENTINE: *Electric Lighting and Tramways.*—The *Review of the River Plate* states that an extension of three months has been granted to the concessionaires of the electric light station at Necochea, in which to complete the works. The latest reports from La Plata are to the effect that the question of the electrification of the tramways of that city will be definitely settled in a few weeks time.

Rosario Tramways.—The *Review of the River Plate* states that on January 15th the term expired within which the Rosario Electric Tramway Co. should have had the whole of its fifteen lines of tramways in operation, but only nine lines had been completed on that date, two were running over a portion of the route, and four were uncompleted. A communication has been received by the Council from the Tramway Co., however, stating that they expect to finish all the lines by April.

ASTON: *Electricity Supply Tariff.*—The committee have approved a new tariff for lighting purposes as follows:—For consumption not exceeding 150 units per quarter, 3½d. per unit; from 150 to 600 units per quarter, 3¼d. per unit; from 600 to 1,000 units per quarter, 3d. per unit; from 1,000 to 1,500 units per quarter, 2¾d. per unit; and 1,500 units, 2½d. per unit. During January, 91,243 units have been sold for lighting, 73,946 units for power, and 109,190 units for traction. The advance over the corresponding period of last year is 7,685, 9,212, and 50,430 respectively.

BARNES: *West London, Barnes, and Richmond Tramways.*—At a meeting of the Council last week it was decided to oppose the West London, Barnes, and Richmond Tramways Bill.

BEDFORD: *Mains.*—The Electrical Engineer has been authorised to make sundry connections on the low-tension mains, in order to equalise the pressure, at an estimated cost of £156.

BEXLEY: *"Free" Wiring.*—The Council is inquiring of the Local Government Board whether they would be prepared to sanction a loan under the Bexley Tramways Act, 1901, for the purpose of free wiring, &c.

BIRMINGHAM: *The Tividale Tramway Accident.*—At the inquest concerning the death of the conductor of the tramway car belonging to the Birmingham and Midland Tramways Joint Committee, which ran off the points at Tividale on February 20th, and overturned, the jury returned a verdict of accidental death. The driver of the car stated that when he took charge of the car, everything was in perfect running order. When he reached the loop at Tividale, however, the car swayed to the right and immediately toppled over. An examination of the track afterwards showed that both the front wheels had passed through the points, but that the two back ones were still in the points when the car went over. The driver maintained that he did not exceed the specified limit of eight miles an hour at this point; in fact, he had had to stop on account of a restive horse thirty yards from the spot where the car overturned. An official of the tramway company expressed the opinion that strain on the car, due to the fact that the two front wheels were off the rails, and the two back ones on the rails, caused the car to collapse. He could give no other reason for the car leaving the track except that it was driven at an excessive speed, but if, as the driver stated, he had had to stop thirty yards away, he admitted that it would be difficult to get up an excessive speed in that distance. An examination of the broken wheel of the car showed seven of the spokes fractured at the hub and at the rim. In summing up the coroner stated that there was not the slightest evidence that the car was being driven at a reckless rate, and the jury added a rider to the effect that a better class of wheel should be used upon the cars.

BLACKROCK: *Dublin and Central Ireland Electric Power Bill.*—The Urban District Council has unanimously decided to support the Dublin and Central Ireland Electric Power Bill, subject to the inclusion of protective clauses.

BOLTON: *Tramway Men's Holidays.*—The Tramways Committee has arranged that the motor men and conductors shall have seven days' holiday annually, and be paid for 60 hours in respect thereof.

BRADFORD: *Inspection of Electricity Works.*—A party of seventy municipal officials, with their ladies, were shown over the Corporation Electricity Works, by Mr. T. Roles, the City Electrical Engineer, last Friday evening.

Workmen's Tramway Fares.—A report has been prepared by Mr. C. J. Spencer, General Manager of the Corporation Tramways System, in regard to the facilities already offered to workmen upon the tramway service. At present there is a universal fare of 1d. before eight o'clock in the morning, the maximum distance which a passenger can travel being five miles, and the average 4·16 miles. Taking all figures into consideration, Mr. Spencer comes to the conclusion that at Bradford, workmen are given greater facilities than upon any other tramway system in the Kingdom, and he produced figures to show that any extension of these facilities will result in a considerable loss to the undertaking.

BRAY: *Bray and Enniskerry Tramway.*—A project for the connecting of Bray and Enniskerry by an electric tramway has been revived. Years ago the proposed route was surveyed for a light railway, but the venture did not come off. A Greenwich firm is now seeking for an Order in Council to construct an electric tram track between the places mentioned, and also for the lighting of Enniskerry. The proposed line will start at Bray Station, and proceed *via* the Dargle Road to Enniskerry, which is an alternative to the original proposal of running the line along the bank of the Dargle River. The engineering portion of the work does not present many difficulties.

BUENOS AIRES.—The returns of the tramway companies in this city for the year 1907 have been issued. There are now 325 miles of track (electric), and the total number of passengers carried was 218 millions, as against 176 millions in the year 1906. The German Electric Light Co. continues to show a heavy increase in the output for private lighting and power purposes. In 1907 the output was 27 million units, as against 22 million in 1906 for these purposes. The output for traction purposes in 1907 was 44 million units.

BURTON: *Extensions of Power Supply.*—With a view to the Corporation being able to supplement the already particularly good facilities they can offer in the way of cheap land, labour, fuel, &c., to new industries establishing themselves in the town, they have recently instructed Mr. P. J. Pringle, the Borough Electrical Engineer, to prepare estimates as to the best means of extending the generating plant and mains so as to deal with the supply of electric power on as favourable terms as possible. It is stated that twenty-three manufacturing firms have sent in inquiries with a view to establishing works at Burton, and that in the case of seven or eight firms, negotiations are now proceeding.

CARDIFF: *Tramway and Lighting Estimates.*—The estimates prepared by the Electric and Tramways Committee in respect of the tramways for the coming year show anticipated traffic expenses of £32,244; general expenses, £8,356; power expenses, £14,150; general repairs, £13,475; loan charges, £45,156; and special items, £588. The estimated income is £112,500 for fares; £14,250 sale of current to electric light department; advertising, £2,000; a total of £128,750, leaving a surplus of £13,779. In respect of the electric lighting department, Mr. Arthur Ellis anticipates a net profit of £1,594, after meeting expenditure, and loan charges to the extent of £43,905.

Charge for Tramway Power.—In a report dealing with the charge which should be made to the Electric Lighting Committee for energy supplied from the tramway power station, Mr. Arthur Ellis, engineer and manager, reports that this should be reduced, as this charged has become excessive during the past year, due to the plant installed on account of the electric lighting department becoming remunerative in consequence of the big load. Mr. Ellis states in his report that the present tramway station at Roath tends to become more and more a lighting station, and that eventually the time will arrive when the output for tramways will form a very small proportion of the total. He therefore recommends that the tramway and lighting departments should in future be charged at cost price for the actual number of units taken, plus a proper proportion for loan charges and depreciation, based upon the actual amount of capital expenditure for the respective purposes. The recommendation has been adopted.

CHATHAM: *Alleged Theft of Fittings.*—A. E. Tyrell was charged at the Chatham Police Court last week with stealing electric fittings from an unoccupied house, and was remanded.

COBHAM: *Electric Lighting.*—The Epsom Rural District Council has had under consideration an application by the Woking Electricity Supply Co. for consent to the company's application for a Provisional Order to supply electricity in Cobham. The company had been informed that the Council would agree, provided they paid the costs of the Council, amounting to £20. In reply to this, an offer of £10 10s. has been made, but the Council, having positively refused to give their consent upon such terms, an agreement has been come to by the company to pay a higher sum.

DUBLIN: *Employees' Provident Society.*—The fourteenth annual meeting of the Dublin Tramways Employees' Provident Society was held last week. During the year £1,498 was received in subscriptions, &c., and £1,263 was expended for sick benefits, medical aid, mortality allowance, &c.

DUMBARTON: *Commencement of Tramways.*—Messrs. J. G. White & Co., contractors for the Dalmuir-Balloch tramways, have begun laying the track.

DUNDEE: *Coal Costs.*—The committee appointed to investigate the increase in the coal charges at the electricity works met last week, when it was remitted to the convener of the Electricity Committee and Mr. Richardson to prepare a report on the matter. The question was first raised at a meeting of the committee by a report, in which Mr. Richardson stated that the coal costs had increased owing to the quality of the coal and the conditions under which it was supplied.

DUNFERMLINE: *The Electricity Scheme.*—A communication has been received from Sir Alexander Kennedy declining to

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accept the appointment of consulting engineer to the Council as reported in our last issue, on the ground that his report recommending the transfer of the Council's Provisional Order to the Fife Electric Power Co. has been rejected.

GERMISTON (SOUTH AFRICA): *Electric Lighting and Trams.*—A scheme for the electric lighting and tramways has been submitted to the Town Council. It is probable that the opinion of an expert will be taken on the matter.

GUAYAQUIL: *Electric Tramways.*—Work on the new electric street-car line is being pushed forward as rapidly as possible. It is expected that a portion of it will be in operation shortly. The charter for this line was granted by the city some months ago to an independent company. It is believed that eventually the new company will either absorb the old company operating the mule lines, or be absorbed by it, and that the whole system will then be electrified.

HALIFAX: *Local Government Board Loans.*—The Electricity Committee have passed the following resolution:—That the Town Clerk be instructed to communicate with the Local Government Board protesting against the excision by the Board, from sanctions for borrowing powers, of wages of permanent workmen paid out of capital account, and that the electrical engineer be instructed to discharge, in future, permanent workmen when about to deal with work entailing capital expenditure, and then to re-engage such workmen as contractors.

HASTINGS: *Electricity Deficit.*—The Electricity Committee has reported that it anticipates a deficiency of £3,581 upon the electrical undertaking for the year ending March 31st, 1908. This includes the deficiency brought forward from last year, namely, £258, an increase in interest and sinking fund charges of £944, and an increase in working expenses of £242. The remainder of the anticipated loss is accounted for by reduced revenue. In their report the committee state that the reduced income from private lighting is almost entirely due to lower consumption, in consequence of the increasing use of metallic filament lamps.

HORSHAM: *Lamp Connections.*—The Electrical Engineer has reported that there are 13,825 lamps connected to the mains, and that a further 108 have been applied for. 1,400 have been connected during the past financial year, against 1,420 for the corresponding period of last year.

LEICESTER: *Tramway Statistics.*—In moving the tramway accounts for the year 1907 at the last meeting of the Corporation, Councillor Flint, Chairman of the Tramways Committee, stated that the past twelve months had not been a very favourable one for tramway receipts. The revenue account shows that 27,417,227 passengers were carried, giving a total revenue of £114,667. Working expenses amounted to £70,887, sinking fund to £12,029, interest £22,872, and income tax £968. Adding the bank balance, there is a net balance to be carried forward of about £10,538, which the Committee propose to add to the reserve fund, bringing this to £53,145. The working expenses have increased by £2,572, and coal by £800. In the Committee's report, the following statistics were given:—In 1901, when the tramway system was opened, the number of car miles run was 868,000, whereas last year, these amounted to 3,334,924. Similarly, in 1901, 10,000,000 passengers were carried, whilst in 1907 the figure, as already stated above, was 27,417,227. The average receipts per car mile were slightly less than 8d., which it is pointed out is well below the average of other towns.

LEYTON: *Electric Supply Charges.*—A memorial has been presented to the Council, bearing some 113 signatures, urging a reduction of the charges to consumers of electricity, the member who introduced the petition expressing a fear that unless they secured more advantageous terms, many of the shopkeepers at present using electricity would revert to the use of gas. The matter has been referred to the Electric Lighting Committee.

LLANDUDNO: *Sunday Tramways.*—A private meeting of the shareholders of the Llandudno Electric Tramways Co. has been held to consider the question of petitioning the Urban District Council to sanction tramways on Sunday. There seems to be a general consensus of opinion in the town that Sunday tramways should be sanctioned, although some difference of opinion exists upon the board of the company, as one of the directors opposes the proposal. This gentleman, Mr. J. Owen, has indicated his intention of resigning his directorship if the shareholders go so far as to apply to the Council. A sub-committee was appointed with a view to making the question a test question at the next election at Llandudno, and a poll is to be taken of the shareholders of the company.

LONDON: *London County Council: Electric Lighting Loans.*—The Finance Committee reported on Tuesday as follows, with regard to an application from the Islington Borough Council, for sanction to the borrowing of £23,304, repayable in 20 years, for extensions at the Borough Council's generating station in Eden Grove. "We have considered an application from the Islington Metropolitan Borough Council for sanction to the borrowing of £23,304, repayable in 20 years, for providing additional plant at the borough council's electric generating-station in Eden Grove. The proposed plant consists of a 1,500 kilowatt turbo-alternator with boilers, cooling tower, condenser, pumps, pipes, &c. The total estimated cost works out at the rate of £15 10s. a kilowatt, which we are advised is not unreasonable. It is 2½ years since the loan for the last turbine-driven alternator was applied for. We understand that the maximum output of the station (3,485 kilowatts) now exceeds the safe capacity, which is about 3,200 kilowatts. We are informed, moreover, that the maximum requirement during 1908-9 will probably reach 4,000 kilowatts. Having regard to the general financial position of the undertaking and to the largeness of the amount of the present application, we have obtained from the borough council a statement as to the probable financial results of the undertaking during the years 1907-8 to 1909-10 inclusive. We are still in communication with the borough council on financial matters connected with the undertaking, but as we are satisfied that the present application is reasonable, and as the borough council represents that the proposed additional plant is urgently needed, we are of opinion that sanction may be given forthwith to the borrowing of the amount applied for, repayable within the usual period of 20 years." This was agreed to.

On the advice of the Finance Committee the Council has sanctioned a loan of £2,394 to the Woolwich Borough Council, repayable in 20 years, for additional boiler plant at their generating station. This plant will partly supplement and partly replace existing plant, and the Borough Council proposes to repay to the London County Council the sum of £966 in respect of displaced plant.

Greenwich Footway Tunnel.—The L.C.C., at the meeting on Tuesday, approved a revised agreement to be entered into with the London Electric Supply Corporation for the supply of current at Greenwich footway tunnel. Hitherto the Company has charged for current at the rate of 2d. per unit for lighting purposes, and 1½d. per unit for working lifts, &c., but now they have agreed to reduce the price, subject to a four years' contract, to 1½d. a unit for lighting, and 1¼d. per unit for power. The saving to the Council will be about £345 a year.

Paddington.—At a meeting of the Borough Council on Tuesday, a report was presented by the Works Committee stating that since the question of improving the lighting in Harrow Road was last before the Council, the Metropolitan Electric Supply Co., Ltd., and the Gas Light & Coke Co. had lighted, as an experiment, certain lengths of the thoroughfare, in order to give a further opportunity of comparing the present and the proposed gas schemes with flame arc lamps. The cost of the present system of gas lighting, the report explained, is £198 per annum (*i.e.*, 66 lamps at £3). The Gas Light & Coke Co. now offer an improved system on the following terms:—66 lamps at £4 12s. 6d., totalling £305 5s. per annum. There would be no initial cost. If the lamps were taken over from the company at the end of five years, the Council would pay £164 (*i.e.*, 50s. per lamp); but, in the event of the proposed arrangement lasting for ten years, the lamps would become the property of the Council without payment. Under this scheme, the lamps would consist of two Kern burners in improved lanterns, one-half of the lamps being turned out at midnight. The Metropolitan Electric Supply Co., Ltd., offer a system of 24 flame arc lamps, at an average of £13 each, *i.e.*, £312 per annum. The initial cost would be about £170, as it would be necessary to erect new pillars on a section of the road where tram-poles are not available. This offer is made on the understanding that the arrangement would be in force for seven years. As in the case of gas, half the lamps would be turned out at midnight. The figures do not include any cost for the removal of the disused gas-lamp columns, as the value of the lamps, &c., would more than cover this. The committee reported that they had again come to the conclusion that the electric system was undoubtedly better than the gas for the purpose of improving the lighting and appearance of the thoroughfare, and that the Council would be justified in it, notwithstanding the slight additional cost in this case. The Council were also reminded that a memorial, signed by 200 ratepayers in Harrow Road, had urged the advantage of electric lighting, and it was announced that a further memorial to the same purpose had now been sent in containing 75 signatures. The Finance Committee called the Council's attention to the fact that the proposal opened the question of electric lighting for the whole borough, which would involve the Council in additional expense, and it was decided to adjourn consideration of the same until the next meeting of the Council.

Stepney.—The Thames Conservancy, at the meeting on Monday, refused an application by Stepney Borough Council for permission to construct, for the purposes of the generating station at Blyth's Wharf, an L jetty with overhead transporter, and to place two 48-in. suction pipes in the foreshore and river bed, with suction boxes at the outer ends.

MIDDLESEX: *Light Railway Undertaking.*—In connection with the revenue account of the light railway undertaking, the lessee company (the Metropolitan Electric Tramways Co.) claim that under the agreements they are justified in charging against the joint account each year as part of the working expenses a sum for the reconstruction and renewal, at some future date, of the tramways and light railway track. The Light Railways Committee, although agreeing that the provision might be prudent, expressed the opinion that the company were not entitled under the agreements to charge against the joint revenue any amount for reconstruction and renewal, but they agree as to the desirability of a joint reserve fund. The recommendation is, therefore, made that a joint reserve fund should be created out of revenue for the purpose of the recon-

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struction and renewal of the light railway and tramway track in the future, subject to the fund being invested in an approved stock in the joint names of the County Council and the company, without earmarking it as between the tramways and light railways, and that the fund only be drawn on for reconstruction and renewal of tracks with the consent of the County Council. It is further recommended that any part of the reserve fund not expended at the end of the lease be divided in the agreed proportions of 45 per cent. to the County Council and 55 per cent. to the company, and that dividends received in respect of the reserve fund be invested from time to time and added to the fund. The Finance Committee is to report upon the financial proposals. The adjusted accounts for 1905 now show a net profit of £2,109, the Council's share of which is £949: in 1906 there was a profit of £2.299, the Council's share being £1,034: while the 1907 accounts show a profit of £9.200, the County Council's share being £4,140. The following figures of traffic receipts, car-mileage, and revenue per car-mile are interesting:—Traffic receipts: 1905, £140,000; 1906, £179,600; 1907, £239,600. Car-mileage: 1905, 3,286,712 miles: 1906, 3,975,463: 1907, 5,037,204. Earnings per car-mile: 1905, 10·64d.; 1906, 10·85d.; 1907, 11·64d.

NEW ZEALAND: *Electrical Enterprises.*—The Auckland municipality is installing an electric lighting plant, the material for which has been purchased chiefly in the United Kingdom. The authorised expenditure is £25,000, but already extensions are contemplated.

A company is being formed, called the Takapune Tramways & Ferry Co., with a capital of £100,000, for the purpose of constructing a tramway around Lake Takapune, a distance of ten miles. An American Consular report states that English concerns have men on the spot in New Zealand looking after this business, and urges electrical firms in the United States, if they wish to compete, to send competent salesmen.

NOTTINGHAM: *Lecture.*—Mr. W. H. Patchell gave a lecture at the University, Nottingham, last Saturday, on "The Sources of Economy in Power Production." The lecture was one of a series arranged by the Derbyshire and Notts Education Committee, and the Midland Branch of the National Association of Colliery Managers.

PENARTH: *Proposed Tramways for Cardiff.*—The District Council has received a letter from the solicitors to the Penarth Tramways Syndicate asking the Council's consent to the construction of a tramway to Penarth from Cardiff.

SOUTHAMPTON: *Light Railways.*—The Board of Trade has confirmed the Portsdown and Horndean Light Railway Order, 1908, authorising the construction of an extension of the Portsdown and Horndean Light Railway.

STOKE-UPON-TRENT: *Potteries Electric Traction Co.*—The Board of Trade have communicated with the Town Council with regard to their objections to a Provisional Order under the Tramways Act applied for by the Potteries Electric Traction Co., and North Staffordshire Tramways Co. The Council desire that their consent should be given to certain street works, and also to the manner in which these shall be carried out. The Board of Trade state that, having given careful consideration to the point, they see no reason to refuse the promoters the benefit of clause 5 of the Order which dispenses with its consent. Considerable objection was taken to this at the meeting of the Town Council last week, it being stated that if this decision be taken as a precedent, their roads could be taken possession of by the Tramways Co. without the local authority having any voice in the matter at all. Arrangements are being taken to oppose the Confirmation Bill in Parliament.

SUNDERLAND: *Collection of Accounts.*—It is stated by a local paper that owing to the large possible loss by the Corporation in connection with the account owing to them by Messrs. J. Laing & Sons, for electric power supply, the system of collecting accounts is to be revised.

Death from Electric Shock.—A young man named Nicolls, employed in the testing department at the works of Messrs. Bruce Peebles & Co., East Pelton, near Edinburgh, accidentally received a shock from a 6,000-volt testing circuit, and was immediately killed.

Dublin Local Section of the Institution of Electrical Engineers.—The annual dinner of the Dublin Section of the Institution of Electrical Engineers was held on Saturday evening, February 29th, in the Aberdeen Hall at the Gresham Hotel. A large number of the members were present, the chair being occupied by Mr. T. Tomlinson, chairman of the Dublin Section. Amongst the guests were Sir Charles Cameron, Mr. J. P. Griffith, engineer to the Port and Docks Board; Mr. J. H. Moore, President of the Institution of Civil Engineers of Ireland; Mr. R. M. Butler, President of the Architectural Association; Mr. Frank Gill, chief engineer of the National Telephone Co., formerly hon. sec. of the Dublin Section; and Mr. P. P. O'Sullivan, engineer to the Tramway Co. The toasts of the King, the Guests, Kindred Institutions, the Parent Institution, and the Chairman were duly honoured, and the programme was enlivened by the musical talent of a number both of the guests and the members of the Institution.

PARLIAMENTARY INTELLIGENCE

CAVEHILL AND WHITEWELL TRAMWAYS.—A long debate took place upon the motion for the second reading of the Belfast Corporation Bill in the House of Commons on Tuesday. This Bill, it will be remembered, embodies an agreement with the Cavehill and Whitewell Tramways Co., for the purchase of their undertaking for an agreed sum of £60,000. From the commencement of the negotiations there has been considerable opposition to the acquisition of the company's undertaking, although a poll of the ratepayers resulted in a large majority in favour of the Bill. Mr. J. Devlin, the Member for West Belfast, in moving the rejection of the Bill, set forth the circumstances which have led up to the opposition, and proposed a compromise of £40,000, provided the tramways company purchase and hand over to the Corporation a recreation ground on the lines of the road. Mr. J. Muldoon (Wicklow E.), in seconding the amendment, referred to the poll as "job," and contended that the transaction was too transparent for its provision to be set out in consecutive sections in the Bill, and consequently the promoters had hidden them away in a schedule. The real company with which they were dealing was the British Electric Traction Co. Mr. Emmett, the Chairman of Committees in the House of Commons, said that he was unable to form any opinion as to whether the Bill ought or ought not to have a second reading, as he knew nothing about the merits. After listening very carefully, however, to the debate, he thought that it would be meeting the interests of all parties if he made a suggestion that the Bill should be allowed to go before the Unopposed Committee of the House of Commons, and that the House should pass a resolution allowing petitioners against the Bill to be heard. After several other speeches for and against the Bill, a division was taken, when the second reading was rejected by 46 votes.

DUNDALK ELECTRICITY BILL.—Before the Court of Referees, on Wednesday, an application was heard for a *locus* against the Dundalk Bill by the Property Owners' Association of Dundalk. The Corporation, in order to put into force its electric lighting provisional order, has found it necessary to secure Parliamentary sanction for a loan, their existing borrowing powers (amounting to twice the rateable value) being almost exhausted. In order to oppose the Bill, a number of influential ratepayers came together, and, after an informal meeting, decided to call themselves the Property Owners' Association of Dundalk with the one object of opposing the Bill in question. The Committee, after considering the fact, decided not to grant a *locus* on the ground that the "Association" was not properly constituted, *i.e.*, had not been incorporated.

LONDON ELECTRIC POWER BILLS. In the House of Lords to-day, the Chairman of Committees will move that it is desirable that the London Electric Supply, London and District Electric Power, and the London (Westminster and Kensington) Electric Supply Bills be referred to a Joint Committee of both Houses.

PROGRESS OF ELECTRICAL BILLS.—The Wishaw Burgh Electricity Bill was read a first time in the House of Commons on Wednesday last week.

The London County Council Tramways Bill, which had been referred to the Standing Orders Committee, is to be allowed to proceed, subject to the deletion of clauses relating to certain lines in Hackney, for which the consent of the local authority had not been obtained.

The Croydon and District Tramways Bill and the West London, Barnes, and Richmond Tramways Bill were read a first time in the House of Lords on Wednesday last week.

The London County Council (Tramways and Improvements) Bill was read a second time in the House of Lords on Thursday.

London Underground Railways.—The station hitherto known as Tottenham Court Road, on the Charing Cross, Euston, & Hampstead Railway, is to be known on and after March 9th, as Goodge Street, and the name of the present Oxford Street station on that line is to be changed to Tottenham Court Road, in order to be the same as the station of the Central London Railway, which it adjoins.

London Electric Power Bills.—The first intimation of an important decision arrived at with reference to the future supply of electricity by municipalities within the metropolitan area is given by a circular letter which has been sent out from Islington to the other 27 Borough Councils. In this communication it is stated that on February 20th an informal private conference of representatives of Borough Councils who are electrical lighting undertakers was held on the subject of the Power Supply Bills now before Parliament, with a view to common action being taken thereon. The conference recommended strenuous opposition to the Bills in question, expressed the opinion that the development of the electricity supply of London could best be carried out by a combination of the existing undertakers, and urged that a conference of the electrical or consulting engineers of all the Metropolitan Borough Councils be held for the purpose of drafting a scheme on the basis referred to. The conference asks the various Metropolitan Borough Councils to endorse these recommendations.

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TENDERS INVITED AND PROSPECTIVE BUSINESS

AUSTRALIA.—The Commonwealth Government calls for tenders by April 14th for the construction and laying of two cables between Victoria and Tasmania. £1,000 deposit is required, and full particulars and specifications may be inspected at the Commonwealth Government office, 72 Victoria Street, Westminster.

The Queensland Postmaster-General's Department invites tenders by April 20th for the supply and delivery at the Post and Telegraph Stores, Brisbane, of lead-covered cable.

The Camperdown (Victoria) Municipality has decided upon having an electrical installation, at an estimated cost of £8,000.

It is stated that tenders will not be called for with regard to the electrification of the Victorian railways, in accordance with Mr. C. H. Merz's scheme, until the middle of the present year.

BELFAST.—The Tramways and Electricity Committee invite tenders for twelve months' supply of stores, including electrical accessories. Particulars from the rolling stock superintendent, Tramway Offices, Napier Street, and tenders to the Town Clerk by March 16th.

BRISTOL.—The Docks Committee of the city and county of Bristol invite tenders for the electric lighting of the second tobacco warehouse, Cumberland Basin, and the maintenance of the work twelve months after completion. Applications to examine drawings and for specifications to be made to the Secretary of the Docks Committee (fee, £3, returnable). Tenders to be sent in by March 20th.

BURNLEY.—The Tramways Committee invite tenders for the supply of sundry stores and raw material used in maintenance for the year ending March 31st, 1909, including brass, gunmetal, &c., castings, brushes, washleathers, chamois, &c., cleaning cloths, cast-iron, brake blocks, and sundry castings, ironmongery, iron and steel, timber, nuts, bolts, and washers, india-rubber, car painters' requirements, and oil, grease, &c. Tenders close on March 10th.

The Guardians for the Burnley Union invite tenders for electrical supplies for the ensuing year. Tenders close on March 16th.

BURY.—The Corporation invite tenders for the supply, delivery, and erection of two 2,000-kw. turbo-alternators with exciters and condensers. Specifications and general conditions may be obtained from Mr. S. J. Watson, Electricity Works, Bury (fee £2 2s., returnable), and tenders to the Town Clerk by March 16th.

DUBLIN.—Tenders are invited for the supply of arc-lamp carbons. Particulars from the City Engineer, and tenders to the Town Clerk by March 11th.

ERITH.—Tenders are invited for stores for the year ending March 31st, 1909, including carbons, meters, lamps, cables, joint boxes, bitumen, insulating tapes, and compound and cut-outs. Specification and forms of tender from the Chief Electrical Engineer (fee £1 1s., returnable), and tenders by March 18th.

EAST LONDON (SOUTH AFRICA).—The Town Council has decided to abandon the existing electric power station, and proceed with the immediate construction of a new one at an estimated cost of £35,000.

EASTBOURNE.—A Local Government Board inquiry has been held with regard to an application for a further loan for extensions in the electricity department.

GLASGOW.—The redecoration and electric lighting of St. Ninian's Parish Church, is to be proceeded with in the summer.

The Tramways Department invite tenders for the supply and erection of two movable bridges over the Forth and Clyde Canal at Dalmuir and Kilbowie. Full particulars from the General Manager, 46 Bath Street, Glasgow, and tenders to the Town Clerk by April 15th.

HASLINGDEN.—The Haslingden Board of Guardians has engaged Messrs. Peers, Copeland & Cardin, of Manchester, to prepare a scheme for the electrical lighting of the new infirmary.

HEYWOOD.—The Electricity Department invite tenders for the supply, delivery and erection of the following:—(1) A Lancashire boiler, feed pump, steam, feed, and blow-off piping, water filter, and economiser; (2) steam engine and dynamo, condensers, air and circulating pumps, water-cooling tower, exhaust and circulating piping, return water and oil separator pumps; (3) lighting switchboard, alterations to traction generator, panels, combined booster and balancer set, and cable connections between machines and boards. Full particulars from the Consulting Engineer, Mr. J. R. Salter, Atherton, Lancashire, fee £3 3s. (returnable), and tenders to the Chairman of the Electricity Committee, Town Hall, Heywood, by March 16th.

HULL.—In connection with the renewal of old mains, the Electrical Engineer has estimated that the cost of the entire replacement of the New Town cables, based upon present prices, will amount to £6,075. The replacement of the Crompton bare copper strip system in the Old Town is estimated to amount to £12,130. The Local Government Board has sanctioned the borrowing of £6,959 for additional plant and mains; £8,088 in connection with the supply of electrical energy to the National Radiator Co.; £16,800 for actual and prospective expenditure from January 1st, 1907, and £4,140 for actual and prospective expenditure upon house service from January, 1907. The authorised periods of repayment are as follows:—17, 15, 20, and 15 years. The total amount is £35,967.

ILFORD.—The Council invites tenders for the supply of the following, required during the year ending March 31st, 1909, for the electricity department:—Meters, cables, incandescent lamps (carbon and metallic filament), arc lamp carbons, house service fuse boxes, joint boxes, coal. Full particulars from Mr. A. H. Shaw, Electricity Works, Ley Street, Ilford, Essex, and tenders to the Clerk by March 10th.

LANCASHIRE COUNTY ASYLUM.—Tenders are requested for the supply of electrical goods and supplies to the Lancashire County Asylum, Preston, for the year ending April 5th, 1909. March 13th and March 19 are the respective dates for tendering.

LEYTON.—At its last meeting the Urban District Council approved a list of 27 roads in which the conversion of gas lamps to electric lamps is to be proceeded with during the ensuing half-year, at an estimated cost of between £400 and £500.

LONDON: *London County Council.*—Tenders are invited for the supply and delivery of the points and crossings for junctions and cross-overs, &c., required for the reconstruction on the overhead trolley system of the existing tramways from Brixton Road to Camberwell Green. Full particulars from the Chief Engineer to the Council, fee £2 2s. (returnable), and tenders by March 10th.

St. Pancras.—Tenders are invited for the supply of arc lamp carbons for twelve months. Full particulars from the Electricity Offices, 57 Pratt Street, Camden Town (fee, £2, returnable), and tenders to the Town Clerk by March 23rd.

MANCHESTER.—The Electricity Committee invites tenders for the supply, delivery, and erection at the Stuart Street station of natural draught cooling towers. Particulars from Mr. F. E. Hughes, secretary to the electricity department, Town Hall (fee, two guineas, returnable), and tenders to the chairman of the Electricity Committee by March 10th.

NETHERLANDS.—H.M. Consul reports that the Town Council of Renkum have granted the concession to Mr. E. F. Blase, of Amsterdam, for the building of an electric tramway from Renkum *via* Oosterbeek to Arnhem, with lines to the neighbouring places, Waldfriede, Doornwerth, Wolfheze, and Ede, about 50 kilometres in all. Communications in regard to supplies should be addressed to Mr. E. F. Blase, Heerengracht No. 136, Amsterdam.

NEW ZEALAND.—The Napier Municipality is open to receive offers for the construction of electric tramways in that city.

STOKE-UPON-TRENT.—Tenders are invited for a 300-kw. steam generator (single acting engine and direct-current dynamo), together with a water-tube boiler and surface condensing plant. Full particulars from Mr. P. J. S. Tiddemann, Electrical Engineer, and tenders to the Chairman of the Electricity Committee by March 14th.

WAKEFIELD.—The Corporation invite tenders for a surface condensing plant. Full particulars from the City Electrical Engineer, and tenders to the Town Clerk by March 14th.

WALTHAMSTOW.—Two dozen lamp columns and 2½ dozen meter columns are to be obtained.

WATFORD.—Tenders are invited for the yearly supply of stores. Schedules and forms of tender from the Chief Electrical Engineer, and tenders to the Town Clerk by March 11th.

WEST HAM.—Tenders are invited for a 3,000-kw. 2-phase turbo generator. Particulars from the Engineer and Manager, 84 Romford Road, Stratford, and tenders to the Town Clerk by March 12th.

Anglo-Japanese Water Power Scheme.—An American Consular report mentions the establishment of an enterprise for the supplying of electricity for several cities in southern Japan. On December 6th, 1907, the minister of home affairs granted a license to the Anglo-Japanese Oi-gawa Hydro-Electric Power Co., which has for its object the supplying of electricity to Shizuoka and other cities on the Tokaido and neighbourhood by utilising the cataracts of the great Oi River. The company intends to develop water power of about 66,000 h.p. at Tamochimura, about 27,000 h.p. at a point between Ikama-mura and Hambaraumechi, and about 8,000 h.p. at Uchinakubi, in Yamanashi prefecture, respectively. The first, being the largest of the three works, will be postponed for some time. The second and third will be started in 1908 at an estimated cost of $5,000,000. The company is backed by a capital of $5,250,000, half of which will be equally subscribed by the British and Japanese promoters. It is further reported that the company will issue $2,500,000 worth of its shares for subscription.

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TENDERS RECEIVED AND ACCEPTED

AUSTRALIA.—The Tasmanian Postmaster-General's Department has accepted the following tenders:—Lead-covered cable, silk and cotton insulated, with 104 pairs of 12½lb. conductors, £163, W. T. Henley's Telegraph Works Co., Ltd., Melbourne; hard-drawn copper wire, 70 lb. to the mile, £532, British Insulated & Helsby Cables, Ltd., Melbourne.

The New South Wales Postmaster-General's Department has accepted the following tenders:—Five additional subscribers' sections and one junction line section and extension in connection with new switchboard at the Central Telephone Exchange, Sydney, R. B. Hungerford, Sydney, £9,809.

The Victorian Postmaster-General's Department has accepted the following tenders:—Supply of 5,850 conduits of six ducts each, and 3,750 conduits of four ducts each, £1,643 18s. 1d., George Sweet, Carlton. The conduits are to be made of stoneware, and are to be manufactured in Australia. Half of the total quantity is to be delivered within three months, and the balance six weeks later. Supply of 50 telephones (wall sets), at £3 4s. 3d. each, £160 12s. 6d., W. McLean & Co., Melbourne.

BLACKPOOL.—The Electricity Department of the Corporation of Blackpool has placed an order with Ed. Bennis & Co., Ltd., Little Hulton, Bolton, for two stokers and self-cleaning compressed air furnaces for a new Lancashire boiler. This is a repeat order Ed. Bennis & Co., Ltd., have received from this Corporation, who have used "Bennis" stokers for about six years.

DUBLIN.—Since the North Dublin Board of Guardians have had under consideration the question of electric lighting at the North Union Workhouse, an offer has been received from the Gas Company undertaking to light the building by gas for an annual charge of £595, which sum will include the maintenance of lights, &c. The company also offer for a sum of £125 to fit up all the new lights necessary. The gas company, in a covering letter, state that this will show a saving of £405 over the present system if their offer is accepted, whereas the proposal to use electric light would only give a saving of £142 per annum. During the discussion upon this offer, several members supported the proposed electrical installation, and the matter was referred to the Lighting Committee.

FRODINGHAM IRON AND STEEL CO.—A repeat order for a 500-kw. generator for direct coupling to a gas engine running at 120 revs. per minute has been placed with the Lancashire Dynamo and Motor Co.

HULL.—Six tenders have been received for three high-tension dynamos required at the Sculcoates generating station. The tenders are as follows:—The Electric Construction Co., £2.812; Messrs. Crompton & Co., £4.099 10s.; Messrs. Greenwood & Batley, £5.305; Maschinenfabrik Oerlikon, £3.961; General Electric Co., £5.079; Lahmeyer Electrical Co., £4.591. The Engineer is to submit a special report upon the tenders.

ILFORD.—At the last meeting of the Urban District Council the Tramways Committee reported having further considered the question of extension of tramways in Cranbrook Road, and the estimated cost of the "Robrow" surface-contact system in comparison with that of overhead equipment. They recommended that the "Robrow" system be adopted for the proposed extension, and the tender of the Traction Corporation, Ltd., be accepted, subject to Parliamentary powers being obtained, and a satisfactory agreement being entered into with the company, embodying the whole of their guarantees.

LEYTON.—The Urban District Council has accepted the tender of the Brilliant Sign Co., Ltd., at £18 12s., for fascias for the Council's electric show rooms, and the tender of Selig, Sonnenthal and Co., at £66, for a shaping machine of 14 in. stroke, for the generating station. An order has been placed with Messrs. Mountain and Gibson for 250 wheel tyres for the tramway undertaking, to be delivered at the rate of 25 per month.

LLANDUDNO.—The tender of the Chloride Electrical Storage Co., for the supply of an Entz booster and battery at £607 and £1,255 respectively, has been accepted.

LONDON: *County Council Tramways.*—The Highways Committee have recommended that the offer of Messrs. Reid Bros., to lay cable ducts for the Hammersmith and Harlesden tramways and across Putney Bridge, at the rate of 23s. per lineal yard, including the reinstating of the pavement, be accepted, and that the Works Committee carry out this latter portion of the work.

Hampstead.—The Borough Council has accepted the tender of Pryke and Palmer for the annual supply of engineer's stores, and that of R. Ballard for the annual removal of ashes, clinker, and boiler refuse at 3d. per ton, to be paid to the Council.

Islington.—The Borough Council has accepted the following tenders for annual supplies for the generating station:—Engine-room stores, &c., Pryke & Palmer; arc lamps, carbons, and globes, Sloan Electrical Co., H. G. Mayer & Co., City Glass Co.; oils and lubricants, W. H. Wilcox & Co.; transformers and accessories, British Electric Transformer Co., Ferranti, Ltd.; iron, tools, belting, cotton, rope, &c., Pryke & Palmer; earthenware pipes troughs, bricks, fire-brick, fire-clay, &c., Young & Son; electricity supply meters and prepayment meters, Marples, Leach & Co., British Westinghouse Electrical & Manufacturing Co., Batt Electrical Co.; cables, British Insulated & Helsby Cable Co., W. T. Henley's Telegraph Works Co., Ltd.; electrical sundries, lamps, brushes, arc lamp parts, &c., Bryant Trading Syndicate, Ltd., General Electric Co., Heath & Johnson, Johnson & Phillips; terminal service and network boxes, British Insulated & Helsby Cable Co., Callender's Cable Construction Co.

Southwark.—The Borough Council has received the following tenders for 440 yards of 0·2×0·2×0·075 cable:—Union Cable Co. (accepted), £142 16s. 6d.; British Insulated & Helsby Cables, £176 2s.; Johnson & Phillips, £178 6s.; Callender's Cable & Construction Co., £179 5s.; Western Electric Co., £180; Siemens Bros. & Co., £183 12s. An order has been placed by the same authority with the British Insulated and Helsby Cables, Ltd., for a feeder pillar at £34 10s.

Westminster.—The Works Committee of the City Council have received the following tenders for the lighting required in connection with the Marble Arch Improvement Scheme:—Gas Light and Coke Co., high-pressure lamps similar to those fixed in Kingsway, £20 per lamp (for five lamps) for installation, and £16 9s. 6d. per lamp per annum for maintenance and lighting, subject to the usual increase or decrease in the price of gas; Westminster Electric Supply Corporation, flame arc lamps upon standards of the pattern now in use in the parish of St. George, Hanover Square, £40 per lamp (for five lamps) for installation, and £14 per lamp per annum for maintenance and lighting, subject to the Council undertaking any replacements or repairs due to accidents caused by third parties. The committee recommend the acceptance of the tender of the Westminster Electric Supply Corporation.

MUMBLES.—The Oystermouth Council having considered the offer made by Mr. A. H. Gibbings for a system of public electric lamps (ELECTRICAL ENGINEERING, February 27th, page 330), has decided not to accept the offer as the price works out higher than the present cost of public lighting.

WALTHAMSTOW.—The Urban District Council has accepted the tender of the Vulcan Boiler & General Insurance Co. for the insurance of eleven armatures at the lighting station against breakdown at an annual premium of £90. An Ohmer is to be purchased from Naider Bros. & Thompson for £16 12s., and steam coal is to be obtained from Rickett, Smith & Co. at 19s. 3d. per ton until the expiration of the present contract.

WIGAN.—The following tenders have been accepted for stores:—Electric lamps, the General Electric Co., and the British Westinghouse Electric & Manufacturing Co.; electrical accessories, The Armorduct Manufacturing Co., The General Electric Co., and The Electrical Co.; cables, Messrs. W. T. Glover, Ltd.

YARMOUTH.—Messrs. Bowers & Barr's tender for the maintenance of telephones, fire alarms, and electric bells at the workhouse, for three years at £21 12s. 6d. per annum, has been accepted.

Tramway Rating.—On Friday Mr. Justice Darling and Mr. Justice Phillimore, in the King's Bench Division, had before them in the Divisional Court a motion in which Mr. Page, K.C., moved on behalf of the Guardians of Hendon Union for a rule *nisi* for a writ of prohibition, calling upon the Justices of Middlesex to abstain from hearing a rating appeal brought before their court by the Metropolitan Electric Tramways, Ltd., whilst certain members of the Middlesex County Council were upon the Bench. The Metropolitan Electric Tramways, Ltd., have leased the Hendon tramways from the Middlesex County Council until August 6th, 1925, at a fixed rent, plus 45 per cent. of the net profits, these latter to be arrived at by deducting all expenses of running and management and rates. The Tramway Co. had appealed against their assessment for rating in the Hendon Union, and the appeal, in the ordinary course, would come up for determination by the Middlesex County Justices, but upon that Bench, stated counsel, there were various gentlemen who were also members of the Middlesex County Council, and he contended that it would be obviously improper for them, forming part of the corporate body which owned the tramways, and which must benefit if the Tramway Co. obtained a reduction in their rateable value, to act as judges in the appeal. Sir Ralph Littler was both Chairman of the County Council and of the Justices; Sir Francis Cory Wright was both a justice and the chairman of the Tramway Committee of the County Council, and there were other gentlemen who were both members of the County Council and Justices Mr. Page said that on an application for a respite of the appeal the point was raised before the magistrates, and they sat specially about three weeks ago and heard it argued. The magistrates not only came to the conclusion that the members of the County Council on the Bench might sit, but that, in fact, they would. Sir Ralph Littler, in giving the decision of the magistrates, said they were of opinion that there was no likelihood of bias on the part of the members of the County Council, and that the Justices were unanimous in wishing them to sit. Their lordships reserved their decision till Friday next.

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MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars net c.i.f. port of arrival quoted on Tuesday night was £58 15s. to £59 5s. per ton (last week, £58 10s. to £59).

DISSOLUTION OF PARTNERSHIP.—The partnership between W. T. Garnett and R. R. Stell, carrying on business at Barkerend Mills, Bradford, as W. T. Garnett's Cable Company, has been dissolved. The business will be carried on under the same style by W. T. Garnett, by whom all debts will be received and paid.

LIQUIDATIONS, &c.—The Accumulator and Motor Construction Co., Ltd., is to be wound up voluntarily. Mr. Jesse Smith, of 79 Queen Street, Cheapside, E.C., has been appointed liquidator.

A meeting of the creditors of Messrs. T. A. Evans & Co., electrical engineers, of 14 Heathfield Street, Swansea, was held a few days ago at Swansea, when a statement was submitted showing liabilities amounting to £1,561 15s. 1d., of which trade creditors were scheduled for £478 2s. 7d. It was stated that the debtor commenced business about seven years ago, with a capital of £250. Of that amount £100 was his own money, and the balance was borrowed from his wife. The position two years ago showed a clear profit of about £130, after taking into account his own drawings. It appeared that the turn-over for 1905-6 totalled £1,667, with a gross profit of £555. Against this the trade expenses amounted to £235, and the debtor's drawings were £125, but it was impossible to get any definite figures as to the trading during the past eighteen months. He attributed his present position to his having taken a big interest in a colliery in South Wales, in connection with which he has expended approximately £600. At the present time the mine is flooded, and the landlord has taken possession. The cash creditors were made up of an overdraft at the bank of £550, who were guaranteed by third parties, and there were also three other claims in respect of money. On behalf of the debtor, an offer was made of a composition of 10s. in the £, payable as to 5s. in three months, and the balance of 5s. in six months, secured by certain of the debtor's local friends. After some discussion it was decided that the offer should be accepted, subject to the securities being found satisfactory to a committee of inspection. It was also resolved that if the outstanding creditors did not assent to the debtor's proposal within ten days, that a deed of assignment should be executed to Mr. E. H. Hawkins (Messrs. Poppleton & Appleby) and Mr. J. F. Harvey, Swansea, as trustees on behalf of the creditors. The committee of inspection appointed was as follows:—Mr. E. H. Hawkins, Mr. Howlett (G. Strauss & Co., Ltd.), and Mr. Jones.

MOTORS.—Messrs. Marples, Leach & Co. inform us that they have at the present time a particularly large stock of motors at their stores in London ready for immediate delivery. The list comprise some 80 continuous-current machines, ranging from ½ to 10 h.p., for various speeds and voltages. The self-starting single-phase motors are included from ½ to 5 h.p., and for 50, 60, 83, 93, and 100 cycles, as well as a series of fourteen 50-cycle high-speed single-phase induction motors. The two-phase induction motors are also for 50 cycles, and range up to 30 h.p. Those up to 3 h.p. are of the squirrel-cage type, but the larger machines have slip rings. The series of three-phase motors includes 25-cycle machines, as well as those for 50 cycles, and also range up to 30 B.H.P. Of course, provided they are not overloaded, the 50 cycles machines may be used on 60-cycle circuits. In addition to this large stock of motors ready for immediate delivery in London, we understand that a considerable number are in stock at the works, and can be delivered in a week on the receipt of an order.

Telegraph Traffic.—The lines of the Indo-European Telegraph Company were interrupted between Soukhoum and Kall on February 28th, but were again restored on the same day. The cable between Chio and Tenedos, belonging to the Eastern Telegraph Company, ceased operating on the 28th ult. Very few cables are now interrupted; the only ones requiring to be repaired or reopened are those to Venezeula, between Tangier and Cadiz and Port Arthur and Chefoo. The landline to Ohvaz, Persia, is also still down.

Tramway Frauds at Wigan.—A remarkable case of frauds committed against the Tramway Department of the Wigan Corporation was heard on Friday before the Wigan magistrates, when a young man named J. H. Higham was charged with aiding, abetting, and procuring a tramway conductor in the service of the Wigan Corporation to commit embezzlement and larceny. It was alleged that the accused, who was formerly a tramway inspector, had in fifteen cases prevailed upon conductors to join with him in defrauding the Corporation in respect of money taken as tram fares, using bogus tickets and a stolen punch. Several conductors had shared in the stolen money. The accused was sentenced to three months' imprisonment.

APPOINTMENTS AND PERSONAL NOTES

Some fifty applications have been received for the post of electrical engineer to the Sydney Council, which carries with it a salary of £900 per annum, from Australia, Great Britain, United States, and Japan. Mr. T. R. Johnson, the Chief Commissioner for Railways, has agreed to advise upon the merits of the different candidates.

The Hampstead Borough Council has decided to increase the salaries of officers connected with the Electricity Department as follows:—J. E. Barnes, assistant shift engineer, £78 to £85 per annum; F. V. Northey, assistant mains department, £110 to £125; J. Goodchild, assistant mains department, £112 to £118; F. E. Limbrey, outdoor inspector, £110 to £120 per annum.

The Leyton Council has agreed to increase the salary of Mr. Speight, who has been acting on probation as station superintendent since the death of the late superintendent, Mr. Noles, from £156 per annum to £180 per annum, the amount of the salary paid to his predecessor.

Mr. O. B. Richardson, the engineer in charge of the refuse destructor and steam plant of the Shoreditch electricity undertaking at Coronet Street, has been appointed engineer at Whiston Street, having charge also of the engines at Coronet Street. The vacancy filled at Whiston Street was caused by the death of Mr. J. Lawson.

Mr. G. Marconi has been appointed managing director of the Marconi Wireless Telegraph Company, Ltd., and of the Marconi International Marine Communication Company, Ltd., in succession to Mr. H. Cuthbert Hall, who has vacated these appointments.

Mr. Edison's Health.—The latest reports state that Mr. Edison's condition is now much improved, and that his complete recovery is now regarded as assured.

Underground Telephone Wires in London.—An application has been made by the National Telephone Company for the consent of the L.C.C. to the laying of short lengths of underground wires from main routes to distribution points. The company has on seven previous occasions, from 1897, onwards, applied to the Council for consent to the laying of underground works in London, and on June 1st, 1897 (pp. 618-9), provisional consent was given to the laying of underground cables subject to certain conditions which the company were unable to accept. In 1900, it being discovered that the company had executed a considerable amount of underground work without having in the first place obtained a licence from the Postmaster-General, and without having obtained the consent of the Council, proceedings were taken against the company with the result that they consented to an injunction restraining them from proceeding further with underground works without first obtaining the authority of the Postmaster-General and the consent of the Council. The company now point out that the telephone policy has been definitely settled by Parliament, and it having been decided that the telephone service of the whole country shall pass into the hands of the Postmaster-General upon the expiry of the company's licence the position of affairs is different from what it was when the Council and the company were last in negotiation. Moreover, in the agreement which was entered into in 1901 under which the Postmaster-General is to purchase the plant of the company in London on the expiry of the licence, and in the agreement which was entered into in 1905 dealing similarly with the rest of the country, the Postmaster-General is under obligation during the remaining period of the company's licence, to put down underground wires for the company in London and elsewhere, and there would be no point in the company doing this work itself, and therefore requiring the consent of the County Council, but for the element of delay which comes in. The Public Control Committee presented a report to the Council on Tuesday, saying that, as the removal of this delay would "accelerate," and consequently increase, the company's revenue, some portion of the benefit should be secured to the public. They recommended, therefore, that consent should be granted subject to the payment by the company of a sum of 2s. 6d. in respect of each station added in the London area. A number of restrictions as to the method of carrying out the work were also recommended in the report. One of these is that, in any streets where the Council anticipates constructing tramways, the cables shall be laid at least 3 ft. 6 in. below the roadway, and another that where cables are laid anywhere near tramways or other works of the Council, they shall be laid under the supervision of the Council, and the cost of such supervision shall be paid by the company. No boxes whatever are to be built without the express consent of the Council, which, if given, will only be given on full particulars and drawings being supplied showing the position of such box, and the size and construction thereof, and such consent shall be subject to such modification as to position, size, and mode of construction as the Council may require. The Council approved the recommendations in the report at their meeting on Tuesday.

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CORRESPONDENCE

JANDUS ENCLOSED FLAME LAMP.

To the Editor of ELECTRICAL ENGINEERING.

SIR.—In your Editorial Note, on page 298 of your last issue, on the Jandus Regenerative Flame Lamp, comparison is drawn between this and a previous patent. The essence of the patent referred to is a large globe, in which the circulation of gases is limited to a very small portion of the space. Every endeavour is made by means of depositing chambers, filtering devices, and combining chemicals, to secure a thorough elimination of the fumes before they again re-enter the globe.

The principle of the Jandus Regenerative Flame Lamp is exactly opposed to this. In this lamp the endeavour has been to keep the fumes in active circulation, and lead them again and again through the arc. The strong upward current, caused by the peculiar arrangement of circulating tubes, sweeps the sides of the enclosing globe, and keeps it clean, allowing a small inner globe to be used (an essential condition in enclosed lamps to ensure long burning hours).

So far as we are aware, no lamps have been made under the Blondel patent to which you refer. The lamp illustrated in ELECTRICAL ENGINEERING, Vol. II., page 853, is an open arc. In my early experiments I realised that an enclosed long burning flame lamp would be of little advantage unless a large economy was effected in the amount of chemicals used. The consumption of the positive carbon in the Jandus lamp is about 0·06 in. per hour; only a very minute amount of fresh chemicals can therefore be given off by the carbons, and the arc must depend largely for its supply of chemicals upon previously emitted chemicals.

From recent experiments I have proved that the regenerative principle plays a very large part indeed in giving the high light efficiency of the lamp. The arc is, in fact, constantly burning within a thick white mist of chemical fumes.

Yours very truly,

A. DENMAN JONES,
Works Manager,
The Jandus Arc Lamp & Electric Co., Ltd.

Holloway, March 3rd, 1908.

MISCELLANEOUS CITY NOTES

BRUCE PEEBLES & CO.—The following relating to the liquidatorship of Messrs. Bruce Peebles & Co. is given in the *Financial Times*:—Our Edinburgh correspondent telegraphs that in the First Division of the Edinburgh Court of Sessions yesterday answers were lodged for Messrs. A. Krauss & Sons, Bristol, to the petition of Bruce Peebles & Co., Ltd., for a winding-up order. The respondents state that they are creditors for £4,666, the balance of an amount agreed in October last in settlement of an action brought by Messrs. Krauss against the petitioners in connection with a contract. The petitioners, who accepted bills in favour of the respondents, object to the company being wound up voluntarily and to the appointment of Mr. Tait as liquidator, he being a director and having interests which conflict with the interests of the creditors. They also object to the appointment of Mr. Robertson, Durham, he being the nominee of the shareholders, and they desire the appointment by the Court of a neutral person as liquidator. They also ask for an order that the company should be wound up by the Court, and that the Court should appoint one official liquidator or a joint liquidator with Mr. Robertson Durham other than Mr. Tait. The answers were allowed to be received, and a note was also presented for Messrs Andrew Wilson Tait and James A. Robertson Durham to be appointed liquidators of the company with a supervision order. They state that it is expedient in the interest of the company that the liquidation should be placed forthwith under the supervision of the Court, and ask that their appointment be confirmed. The Dean of Faculty stated that the liquidation was a very large and important one, and it would be very much in the interests of all concerned if their lordships would grant an early hearing. This the Court agreed to do.

CALLENDER'S CABLE & CONSTRUCTION CO.—Mr. John Varley, of 11 Stanley Gardens, W., has been appointed a director of this company, to fill the vacancy caused by the death of the late Sir D. Evans.

CITY OF LONDON ELECTRIC LIGHTING CO.—The transfer books and register of members will be closed until March 18th.

GLOBE TELEGRAPH & TRUST.—A quarterly dividend of 3s. per share on the preference shares and 2s. per share on the ordinary shares has been declared.

INTERBOROUGH RAPID TRANSIT CO.—It is announced that if the flotation is assured, the company will issue twenty million dollars five per cent. mortgage bonds.

LIVERPOOL DISTRICT LIGHTING CO.—A dividend of 5 per cent. per annum for the half-year ended December 31st last, less income tax, is announced, making 5 per cent for the year.

MESSRS. VICKERS, SONS & MAXIM.—The directors recommend a final dividend of 2s. per share on the ordinary capital, making 15 per cent. for the year.

METROPOLITAN ELECTRIC TRAMWAYS, LTD.—Subscriptions have been invited during the week for a further issue of £173,800 4½ per cent. debenture stock at 96. The stock is redeemable at £105 in the event of liquidation or at the company's option after December 31st, 1930, at six months' notice.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION.—The petition to the High Courts for confirming the resolution reducing the capital of the South London Electric Supply Corporation from £325,000 in £5 shares, to £250,000 in £4 shares, will be heard before Mr. Justice Nevill on March 14th.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO.—The warrants in respect of the ordinary and preference share dividends for the year 1907 and half-year ended December 31st, 1907, respectively have been posted.

NEW PUBLICATIONS

"Stationary Steam Engines." By William H. Fowler. (Manchester: The Scientific Publishing Co.) 12s. 6d.

Transactions of the North-East Coast Institution of Engineers and Shipbuilders. February. (London: Andrew Reid & Co.)

"The Steam Turbine." By Robert M. Neilson. Fourth Edition. (London: Longmans Green & Co.) 15s.

Journal of the Institution of Electrical Engineers, No. 187, Vol. 40. (London: The Institution.) 5s.

Chilean Railway Electrification.—The American Consul at Valparaiso, reports that the Chilean Government has commissioned an American electrical engineer to study the feasibility of changing the first and second sections of the State railways for the use of electrical instead of steam power. It seems that the project might be very practical, as there are several good streams crossed by the railway lines that have their sources in the regions of perpetual snow along the Cordilleras that must have ample fall for limitless power possibilities. The first section connects Valparaiso with Santiago, and is about 100 miles long, and the second section extends from Santiago to Conception, and is about 350 miles in length. Double track is being laid on the first section. At present the coal bills for the State railways are heavy, since a large proportion of the coal used is imported at a high cost.

The Junior Institution of Engineers.—On Saturday, February 22nd, a visit was paid to King's College, London, for an inspection of the experimental apparatus, &c., in the engineering laboratory, the Siemens Electrical Engineering Laboratory, and the Wheatstone Laboratory, through arrangements kindly made by Professors D. S. Capper, H. Wilson, Ernest Wilson, and Waynforth. The apparatus includes various machines for testing materials; for thermodynamic work there are a 60 i.h.p. Marshall experimental compound engine; 20 kw. Belliss Siemens direct-driven set, Parsons steam turbine and direct-driven dynamo, Davey Paxman and Babcock-Wilcox boilers, Dowson suction gas plant, Crossley high-speed gas engine, condensing plant, various calorimeters, apparatus for flue and exhaust gas analysis, &c. Appliances are also provided for the determination of the cutting power of tools, and efficiency of machine tools, and belts and pulleys, and apparatus for determining the effect of blows on springs, and the resisting power of asphalte. The Siemens Laboratory is equipped with very complete and modern apparatus suitable for the practical instruction of students in every branch of electrical engineering. Direct current is obtained from the supply company's public mains, from a battery of Chloride cells, and from a Siemens 50 kw. generator of 500 to 550 volts. Alternating current is supplied from a Siemens 100 kw. eight-pole revolving field type of alternator arranged to give 1-, 2-, or 3-phase currents at frequencies ranging from 50 to 25; also from two Siemens generators, each of 10 kw. output, with a special coupling, which allows the phase displacement of the armatures to be altered. A complete tramcar equipment is provided, fitted with two 35 h.p. motors, with arrangements for testing draw-bar pulls, efficiencies, &c. In the Wheatstone Laboratory were shown the dark room for optical experiments, workshops for repairs, the celebrated George III. and Wheatstone collections, which include the Lodestone which belonged to Daniell, and was used by Faraday in his classic experiments on the induction of currents; the coils of insulated copper strip used by Henry in his experiments; the rotating mirror which Wheatstone employed in his experiments on the velocity of electricity along wires; the original Wheatstone bridge and resistance boxes, and Clerk Maxwell's dynamical model to illustrate the induction of electric currents.

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COMPANIES' MEETINGS AND REPORTS

ABERDEEN SUBURBAN TRAMWAYS.—At the half-yearly meeting, Mr. G. J. Walker, chairman, in moving the adoption of the report for the half-year ended January 31st, said the free revenue amounted to £887, a sum that was, with one exception, the largest that had yet been earned by the Company in any half-year since its inception. The total amount at the credit of profit and loss account was £1,587, which the Directors proposed to carry forward meantime. Being now entirely within the Aberdeen Corporation's area of electric supply, the Company was entitled to demand a supply of electricity from the Corporation at the same rates as paid by other consumers for power purposes. If not, the Company would have to consider whether it would be cheaper to establish generating plant for the Company's own use. The report was unanimously adopted.

ASCOT DISTRICT GAS & ELECTRICITY.—The report for the half-year ended December 31st, 1907, shows a profit on the gas account of £2,225 8s. 5d., and a small loss of £14 on the electricity account. After providing for every charge against the half-year's working and interest on mortgage debenture stock, there remains a balance of £2,711 at the credit of profit and loss account, out of which the directors recommend the payment of a dividend at the rate of 5½ per cent. per annum on the share capital of the company, that the sum of £183 be set aside as a reserve for renewal of plant, and that the balance, amounting to £780, be carried forward. The electricity works were completed and opened by Sir Walter Palmer, Bart., on October 22nd, 1907, and since then consumers have been connected to the extent of 2,184 equivalent 8 c.p. lamps, and new applications are continually being made.

At the annual general meeting in London on Wednesday last week, Mr. J. Manwaring stated that the directors were well satisfied with the progress of the electrical portion of their undertaking up to date, and although customers had been somewhat slow in coming forward at the beginning, there were now connected to the mains the equivalent of 2,184 eight c.p. lamps, with other orders in hand. The company had been the first gas company to exercise electric lighting powers.

BLACKPOOL-FLEETWOOD TRAMROAD.—The report and accounts, given in our issue for February 6th, were adopted at the meeting on Thursday. The burden of the chairman's speech was the rating problem. He stated that their undertaking was the heaviest rated of all passenger-carrying undertakings in the United Kingdom, and everybody seemed to be against the company, even the Chancellor of the Exchequer. It was not the Blackpool rates that were increasing so much as those of the smaller councils outside, and the Thornton Council had threatened to take the question of the assessment of the company's undertaking to the House of Lords. A satisfactory feature of the year's working, the chairman pointed out, was that their working expenses were only 44 per cent. of the gross earnings, a lower figure than that achieved by any other tramway company in the country.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY.—The annual report for the year ended December 31st, 1907, states that the revenue account shows a credit balance of £31,718, which, with the balance of £9,146 brought forward, and £409 5s. balance of interest received, makes a total of £41,273. After deducting £1,726 11s. 8d. for interim dividend on the 7 per cent. cumulative preference shares, and £6,779 19s. 10d. interim dividend at the rate of 9 per cent. per annum for the half-year to June 30th on the ordinary shares, the directors recommend that the sum remaining, viz., £32,766 19s. 3d., be dealt with as follows:—To credit of depreciation account, £8,000; to payment of dividend on the preference shares for half-year ended December 31st, £1,716; to payment of dividend on the ordinary shares for half-year ended December 31st, at the rate of 11 per cent. per annum, making 10 per cent. for the year, £8,302; to credit of reserve fund account, £4,000; to directors' additional remuneration, £613; leaving, to be carried forward, a balance of £10,136. The death is recorded of Mr. William Page, who served the company as a director from its earliest years. Mr. Stanley Beeton has been appointed to fill the vacancy.

BRUSH ELECTRICAL ENGINEERING. The poll demanded at the meeting of the debenture holders (ELECTRICAL ENGINEERING, February 20th, p. 290), was taken on Thursday, when it was announced that voting to the amount of £21,371 had been given in favour of the proposed rearrangement of the debenture stock, and £16,256 against. As a clear three-fourths majority was necessary to carry the scheme, it was accordingly declared lost. A feature of the result is the very small number of debenture holders who voted.

CAMBRIDGE ELECTRIC SUPPLY.—The report and accounts for the year ended December 31st show that during the year there have been connected the equivalent of 2,269 8-c.p. lamps, making a total to date of 55,648. The number of units supplied has been 655,743, an increase of more than 59,000 units. A water softening plant and a new fuel economiser have been installed. An additional transformer substation has been built, and the supply mains have been extended in several directions. The accounts of the company show a total profit for the year of £8,292, to which is added £674 brought forward from 1906. After deducting debenture and other interest, £1,529, placing £1,500 to depreciation fund account, which will bring up the total placed to the credit of that account to £11,500, and writing £250 off suspense account, there remains a balance of £5,686. An interim dividend of 2½ per cent., absorbing £2,120, has already been paid, and the directors recommend the payment of a further dividend of 3½ per cent., making 6 per cent. for the year. This will absorb £2,968, leaving a balance to carry forward of about £598. The report was adopted at the meeting last Tuesday.

CHARING CROSS, WEST END, & CITY ELECTRICITY SUPPLY.—At the ordinary meeting held on Tuesday the report, already given in our last issue, was adopted. The Chairman, Mr. W. F. Fladgate, in speaking of the Electric Supply Bills now before Parliament, regretted that in the Bill to combine all the electric lighting companies they had not been able to include the Westminster Co. and four other West End companies, who had applied to Parliament for a Bill of their own. At a special meeting held subsequently the Bill referred to was agreed to. An article analysing the company's accounts appears on page 347.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION.—The report to be submitted at the ordinary general meeting, to be held on March 10th, states that the profits of the year, together with the balance of £1,934 5s. 4d. brought forward from 1906, amount to £24,946, from which must be deducted interest on loans and debenture stock, £2,356, and interim dividend of 2½ per cent. on the preference shares paid in October last, £6,250, leaving an available balance of £16,341, which the directors recommend should be appropriated as follows:—In payment of a further dividend of 2½ per cent. on the preference shares, making a total dividend at the rate of 5 per cent. for the year, and of a dividend at the rate of 2 per cent. per annum on the amount called up on the ordinary shares, £10,958; in transferring to depreciation and reserve account, £5,000; in carrying forward to next year, £383. The total connections to the company's system at the end of the year, including the connections of its associated Parliamentary Company, the County of Durham Electric Power Supply Company, amount to 20,757 h.p., which, compared with the previous year's figure of 13,200 h.p., show an increase of 7,557 h.p. Of this increase about 4,000 h.p. were connected during the last months of the year, and have therefore been revenue earning only for a short period. The extensions to the general distribution system, referred to in the last report as having been delayed, became revenue-earning during the summer, and the revenue of the company has increased from £34,096 10s. 8d. in 1906 to £49,089 1s. 8d. in 1907, an increase of 44 per cent., which is satisfactory. The profits, however, which have resulted from this additional revenue have been considerably less, through the working costs being higher than were anticipated, by reason of the heavy rise in the price of coal. The directors report a satisfactory increase in the colliery demand for electrical energy, which the company is now able to take full advantage of, their power transmission mains being practically completed throughout the county. With the increase of connections, which still continue, the directors look forward to a material addition to the profits of the current year. The expenditure on capital extensions during the year has been £194,003, of which £173,933 represents the outlay on the company's account, and £20,070 the outlay on behalf of the Parliamentary Company, for which this company receives shares. Of this expenditure a large part only becomes productive during the current year. The balance of the ordinary share capital was paid up early in the year, making the whole of the authorised share capital fully paid up. To meet the developments of the company, an issue of £250,000 first mortgage debenture stock was made by the directors in December, and was over-subscribed. In consideration of the expenses of this issue, and in order to provide for depreciation, the directors have set aside a sum of £5,000 to depreciation and reserve.

THE MACKAY COMPANIES.—The annual report states that the receipts for the year amounted to $5,830,390, this income having been derived from investments in other companies amounting to $92,075,593. Disbursements were $3,655,216, dividends to shareholders, and $22,250 expenses, leaving a balance to be carried forward of $152,923. A surplus over liabilities of $880,470 is shown. Mackay Companies own the whole or part of the stock of 102 prosperous cable, telegraph, and telephone companies in the United States, Canada, and Europe, including the entire capital stock of the Commercial Cable Co., and the various companies constituting the land line system of the Postal Telegraph Co.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904).—The report for the year ending December 31st, 1907, states that the annuity payable by the Anglo-Argentine Tramways Co., Ltd., has been received. The net revenue for the year has amounted to £65,744; interim dividends have been paid for the nine months ending September 30th, 1907, absorbing £46,500, leaving a balance of £19,244. The directors recommend that the balance be disposed of as follows:—The payment of a balance

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dividend of 1s. 3d. per share (making 5s. per share) for the year ending December 31st, 1907, absorbing £15,500; £3,600 be transferred to general amortisation fund, and the balance of £144 7s. 5d. carried forward. The amortisation fund for the debenture capital, with accrued interest to date, amounts to the sum of £12,705 4s. 8d. The general amortisation fund for the redemption of the share capital now amounts to £17,903, included therein being a further sum of £130, the proceeds of sale during the year of a small strip of land in Buenos Ayres for railway development. The directors regret to have to announce the loss, by death, of two of their colleagues during the past year, Mr. Wells Hutchinson having died on June 21st, and Mr. Simpson Rostron on November 7th.

CITY OF CARLISLE ELECTRIC TRAMWAYS.—The report for 1907 shows a surplus of £1,784, being a decrease of £117 as compared with the previous year, and the balance of profit and loss account, after providing for debenture stock interest and debenture stock trustees' remuneration, is £632, which the directors recommend shall be carried forward.

CROSSLEY BROS.—The report for the year ended December 31st, 1907, stated that the amount at the disposal of the directors is £177,677, from which has been deducted a 5 per cent. dividend on the preference shares, and a 10 per cent. on the ordinary shares to June 30th, amounted to £38,600, leaving £79,077 for depreciation. The directors propose a further dividend for the half-year to December 31st at the rate of 12 per cent. per annum on the ordinary shares, making 11 per cent. for the year, carrying forward £34,773.

FIFE ELECTRIC POWER.—The annual general meeting was held last Saturday, in Edinburgh, Mr. Robert Russell, the chairman, presiding. The report showed that during the year there had been a steady increase of the company's business, and it was stated that the prospects of further business were most encouraging. The retiring directors were re-elected.

O. C. HAWKES.—The report for the year ended December 31st, 1907, shows that after allowing for bad and doubtful debts, and charging cost and replacements and repairs to the extent of £504, the net profit amounts to £13,149, including the balance brought forward from last account. Deducting directors' fees and balance and income tax, the net sum available for distribution is £12,048. An interim dividend of 5 per cent. on the preference shares has been paid. The directors now recommend a dividend of 5 per cent. per annum for the December half year, and on the ordinary shares, making 5 per cent. for the year (the dividend on the 5 per cent. preference shares for the December half year has already been paid), the balance to be carried forward is £3,548.

W. T. HENLEY'S TELEGRAPH WORKS.—The report for the year 1907 shows a net profit of £65,302. After payment of directors' and auditors' fees, and debenture interest, and making allowance for depreciation of buildings, plant, machinery, &c., there remains £50,330, making, with £22,320 brought forward from last year, a total of £72,650. The directors have transferred £10,000 to the reserve account, and recommend the payment of a dividend on the ordinary shares of 15 per cent. (less income-tax), of which an interim dividend of 5 per cent. was paid on September 2nd last. These payments will, together with the preference dividend for the year, amount to £49,000, leaving a balance of £23,650 to be carried forward.

HOVE ELECTRIC LIGHTING.—The report for the year ended December 31st, 1907, shows a net profit of £12,693, compared with £12,673 in 1906. The gross revenue shows an increase of £1,696, but the working expenses have increased by £1,676, due to the excess cost of coal and the additional outlay found necessary on repairs and maintenance. After payment of the final dividend for 1906, and setting aside an amount for renewals and depreciation account, there was a balance brought forward to the present year of £526, which, when added to the net profits from the present year, £12,693, makes an available balance of £13,219. After deducting debenture interest, the interim dividend at the rate of 8 per cent., paid in October last, and income tax, there remains a surplus of £8,055. The directors propose to place £4,000 to the renewals and depreciation account; to pay the accrued dividend and interest on the preference shares up to December 31st; to declare a final dividend, payable on April 15th next, at the rate of 9 per cent. per annum, making 8½ per cent. for the year; and to carry the balance, £780 10s., forward. The expenditure on capital account during the year has amounted to £2,893. With a view of replacing the capital expenditure taken from reserve fund, and investing this to provide for the future, 5,000 £5 preference shares were offered to the shareholders in November last, and 2,559 shares were applied for and allotted. The investments on account of the reserve fund now amount to £11,481. The meeting will be held on March 12th.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING.—At the ordinary general meeting, held last Friday, the chairman, Col. R. E. B. Crompton, dealt at some length with the effect of the introduction of metallic filament lamps of much higher efficiency than the carbon filament lamp. For some time to come this might have an adverse effect on the consumption of electricity, but he said advisedly "for some time" because he felt that the saving would enhance the use of electricity as an illuminant, and the chances were that users would be more wasteful in the future than they had been in the past. Electric light was becoming more and more of a necessity and less of a luxury, and the companies should reap the advantage. He complained of the growth of rates and taxes, and said that if the sum which this company had to pay of £6,500 per annum could only be reduced by one-third, the directors would be able to pay a bonus of 2 per cent. upon the ordinary dividend. They had suffered in common with other electric lighting companies in regard to the increased cost of coal. In all the difficult circumstances of the past year he felt that the results presented would be regarded as satisfactory, for they were able to maintain the amount of dividend which they had paid to the ordinary shareholders for some years past, viz., at the rate of 10 per cent. per annum. He then dealt with the question of the bulk supply of electricity and the Bill which was jointly promoted by this and other West End electric lighting companies in the present session of Parliament, and which would be of benefit to all concerned. The report was adopted, and at a special meeting afterwards held the Bill was unanimously confirmed.

LANCASHIRE UNITED TRAMWAYS.—At the annual meeting, Mr. J. M. Henderson, who presided, said the profit for the year amounted to £12,789, and after payment of the debenture stock interest there was a balance of £289. This amount, with the credit balance brought forward from last year, had been written off the loss on the sale of motor-omnibuses. The receipts from the various tramways (other than St. Helens) comprised in the company's system, were £69,349, and the working expenses £56,499. The receipts per mile were higher than had been attained in any previous year. The working of the new St. Helens and District Tramways Co. had resulted in a profit, but it was not possible to distribute any of it in dividend, owing to the adverse balance of previous years. The report was adopted, and Messrs. Joseph Beecham and Robert Watson were re-elected directors.

LONDON ELECTRIC SUPPLY.—The annual meeting was held in London on Thursday. Explaining the cause for the dividend of 2½ per cent. instead of the 4½ per cent. declared last year, Mr. R. Benson, who presided, said that in addition to the increased price of coal, the revenue under the contract with the London County Council was very much less than had been anticipated. At the same time they hoped to counterbalance this by the supply to the London, Brighton and South Coast Railway, which would commence this year. The outlook for 1908 was much brighter, for they already had an increase in the receipts up to date. The total number of units sold since the beginning of the year amounted to 2,441,000, an increase of 20 per cent. over the same period of last year, and this, it should be remembered, was before the Brighton railway contract came into force. The gradual decline in the revenue which began in 1906, and which continued in 1907, seemed now to have ended, and, generally speaking, it must be admitted that the result has been less severe than might have been anticipated. During the present year it will be necessary to spend on capital account about £40,000, in order to complete works already sanctioned, but they had unused capital powers of £150,000 debentures, £100,000 preference shares, and £267,000 ordinary shares. With the Money Market in much easier condition, there should not be any difficulty in raising the necessary money. Dealing with the power supply problem in London, the Chairman stated he was convinced that the true solution lay in the combination and co-ordination, under some public control, limiting, for instance, the companies' dividends, similar to those of the gas companies, and giving in return some security against waste of capital or loss. It was partly with this object that the company had joined with others in depositing a Bill in Parliament this Session. The report and accounts, given in our issue for February 20th, were adopted, and at a subsequent special meeting the Bill mentioned above was approved.

MATHER & PLATT.—At the annual general meeting on Thursday, the report and accounts, given in our last issue, were adopted. Sir William Mather, who presided, said that their profits were the largest recorded in the history of the company, and it was satisfactory to be able to state that their foreign trade had expanded very considerably. The extra capital required to meet the increasing business had been provided out of a reserve, which was ample testimony to the wisdom of placing large sums to this fund, which now stood at £340,000. The directors recommended the appropriation of £5,000 to the employees' benefit fund, and also £1,000 to the Salford Royal Hospital, a principle which Sir William Mather said he heartily approved of.

METROPOLITAN ELECTRIC SUPPLY.—The report for the year ended December 31st, 1907, states that the capital expenditure, which at the end of 1906 amounted to £1,802,383, has now reached a total of £1,840,876, being an increase during the year of £38,493. The gross revenue for the year amounted to £178,684, as compared with £175,636 in 1906, being an increase of £3,048. As the revenue for 1906 included £5,178 for the remainder of the Marylebone business transferred on March 31st in that year, the total increase of revenue in the Company's areas during the year 1907 was £8,226. The working expenses, which in 1906 were £82,938, amounted in 1907 to £85,333, being an increase of £395. The Bill which was promoted last Session

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by the London County Council for a bulk supply in and around London was jointly opposed by all the London supply companies, and was thrown out by a Select Committee of the House of Commons. The Bill deposited jointly by these companies was withdrawn. In the present Session of Parliament a Bill for bulk supply and other purposes has been deposited by certain persons seeking to be incorporated as the London and District Electricity Supply Company, against which this company has petitioned. The Company has also joined with certain other of the London Supply Companies in promoting a Bill for establishing a Statutory Joint Committee to deal with the supply of electricity in London and surrounding districts. This Bill, which contains provisions for the guarantee by the promoting companies of the interest on the capital of the Joint Committee to be authorised under the Bill, will be submitted for the approval of the shareholders at an extraordinary general meeting to be held immediately after the general meeting. The balance at the credit of the revenue account, before providing for depreciation, is £95,350. The directors have set aside £20,000 as an addition to the Depreciation and Reserve Fund, carrying to the credit of the net revenue account the sum of £75,350. This sum, with the balance brought forward from last account and other receipts, makes a total of £88,767. After deducting interest on debenture stocks and loans, dividend on preference shares and other charges, there remains a balance of £44,879. To this the Directors have added £21,000 from the undistributed balance of the Marylebone purchase money which was set aside towards the maintenance of dividends during the development of other business to replace the loss of Marylebone. This increases the balance at the credit of the net revenue account to £65,879. An interim dividend of three shillings per share (being at the rate of 6 per cent. per annum) on the ordinary share capital, amounting to £30,000, was paid on August 6th, and the directors recommend that a further dividend of three shillings and sixpence per share on such shares be now paid, making a total distribution for the year of six shillings and sixpence per share, or 6½ per cent. This will absorb a further sum of £35,000, and leave a balance of £879 to be carried forward to the next account. During the year new connections representing the equivalent of 49,758 8-candle-power lamps were added to the company's system, making a total connection at the end of the year of 755,116 lamps.

NEWCASTLE & DISTRICT ELECTRIC LIGHTING.—At the annual meeting on Wednesday last week, the report and accounts, given in our last issue, were adopted. Reference was made to the death of the late chairman of the company, Sir J. D. Milburn, Bart., and to the fact that the profits had not come up to anticipation, owing to the abnormal price of coal and the slackness of work in certain trades on the Tyne.

NORTHALLERTON ELECTRIC LIGHT & POWER.—At the annual meeting at Northallerton on Wednesday last week, the report and accounts, given in our last issue, were adopted.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER.—At the ordinary general meeting on Thursday, Mr. Henry St. John Winkworth (chairman of the company) presiding, the report and accounts given in our issue of February 20th were adopted. The Chairman stated that the lamp connections at the end of the year amounted to the equivalent of 160,380 8 c.p. lamps, an increase of 15,668. The consumers connected numbered 3,383, and the net revenue increased from £24,118 17s. 6d. to £27,067 19s. 2d., an increase of about 12 per cent. for the year. The units sold increased from 2,381,788 in 1906 to 2,946,607 in 1907, an increase of over 20 per cent. Seeing that the units sold increased more than 20 per cent. and that the net revenue only increased about 12 per cent., the consumers had benefited during the year to a substantial extent by the reduction of the price, whereas the average price for the year 1904 was 4·04d. per unit; it was now 3·23d. On the output for 1907 of 2,946,607 units, this represented a concession to consumers of about £10,000 as compared with the average price of 1904. Some inquiries had been made by shareholders as to the effect upon the business of metallic filament lamps. Although the extension of their use might lead to a temporary loss of revenue from existing consumers, the directors feel that whatever benefits the consumer must ultimately benefit the company. The capital expenditure during the year amounted to £42,281 15s. 8d., and deducting £5,500 placed to the credit of the depreciation account, the net addition to the capital account is £36,781 15s. 8d., which included about £20,000 in respect of the new power house. The increased earnings for the year amounted to £2,949 1s. 6d., a little over 8 per cent. on the capital expenditure for the year. The chairman concluded by saying that the directors have joined other London electric companies in promoting a Bill in the present session of Parliament for the establishment of a joint committee, and to make agreements for mutual assistance, and for the supply of energy in bulk to, and the taking of energy from, one another.

Mr. Henry W. Bowden, managing director, in seconding the motion for the adoption of the accounts, gave a few details of the position and prospects of the company, and an estimate of capital requirements during the next few years. The output for the year under review was 565,000 units more than the previous year, an increase of nearly 24 per cent., notwithstanding the unfavourable returns in the early part of the year. The cost figures, compared with 1906, are as follows:—Coal, 0·558d. compared with 0·542d.; works costs, 0·827d. compared with 0·837d; total costs, 1·32d. compared with 1·42d.; average price obtained, 3·25d. compared with 3·58d.; efficiency of distribution, 72·1 per cent. compared with 77·8 per cent. The latter decrease is partly due to transformer boosting and extra loss on feeders, some of which are fully loaded, more particularly between Lewisham and Catford, so that steps had to be taken to lay down ducts and cables, which could be worked at the existing pressure, but would eventually be utilised for an extra high pressure (10,000 volts) supply. When the work was finished he hoped that it would be the end of those heavy capital outlays which had had to be incurred from time to time. He felt somewhat strongly that the expenditure should be curtailed to the utmost, without absolutely closing the capital account. The cost of the extra high pressure supply is approximately £10,000, and he did not think for the next few years the annual expenditure for the ordinary growth of the business should exceed this figure. In regard to generating plant and costs, he thought it would be admitted that the company had progressed with the times when he stated that from the results already obtained during four months' working a saving had been effected in fuel alone of £700, or at the rate of £2,000 per annum. Considerable difficulty had been, and was still experienced in using Thames River water for condensing purposes owing to the collection of large quantities of vegetable matter, mud and other refuse, necessitating the use of special revolving screens or strainers and various other devices for either preventing the entrance of river refuse to or discharging it from the condensers. These difficulties had so far been successfully overcome at the new power house. The system adopted consists of sinking two iron chambers, which are connected to the river pipes in such a manner that the reversal of the water takes place daily, and this automatically washes out the chambers and keeps the condensers free from rubbish and permits of the full use of the syphon action at all conditions of the tide, thereby reducing the pumping power to a minimum. The efficiency could be observed by noting the vacuum on the turbines, which is invariably 95 to 96 per cent. of the possible or actual barometric pressure. The coal bill had recently been reduced to well under 0·5d. per unit (for a comparatively poor load factor), compared to 0·4d. per unit previously. The maximum demand was 2,550 kw., and they had connected or in hand orders which would bring this figure very nearly up to 3,000 kw. for the ensuing year, without reckoning on any orders which may be obtained for bulk supply.

The report and accounts were adopted after one or two complaints as to the smallness of the dividend upon the ordinary shares.

At a special meeting held subsequently the Bill in Parliament already referred to was approved.

TELEGRAPH CONSTRUCTION & MAINTENANCE.—The report for the year 1907 shows a net profit of £83,571, after charging the interest on the debentures. To this sum is added £104,308 brought forward from last year. From the total amount is deducted the interim dividend of 5 per cent., paid in July, 1907, amounting to £22,410, which leaves £165,470 to be dealt with. The directors propose to distribute a dividend of £1 4s. per share, together with a bonus of 6s. per share, being at the rate of 12½ per cent., and making, with the amount already paid, a total dividend for the year of £2 2s. per share, or 17½ per cent., free of income tax, leaving £109,445 to be carried forward to the next account. The report was adopted at the meeting held on Tuesday.

TORONTO ELECTRIC LIGHT & POWER.—The report for 1907 shows gross receipts of $1,039,716, compared with $899,578 for 1906, whilst expenditure amounted to $651,925, compared with $562,847. After meeting all charges, the net revenue amounted to $387,791, and a dividend of 8 per cent. has been declared. The sum of $150,000 has been transferred to reserve account, which now amounts to $500,000.

WESTMINSTER ELECTRIC SUPPLY CORPORATION.—At the annual meeting last week, Mr. E. Boulnois presiding, the report and accounts, given in our issue for February 20th, were adopted. The Chairman stated that a contract was being entered into for the erection of their new station upon a site given by the London County Council to replace the Millbank Street Station, and arbitration proceedings were about to be commenced as to the amount which was to be paid. One of the reasons that a smaller dividend was paid this year, although the receipts were higher, was that the £15,000 carried forward in 1905 to equalise the dividend through the large increase in the assessment of the company's undertaking by the Westminster City Council has been exhausted. There was also a very large increase in the price of coal.

WIRRAL RAILWAY.—At the half-yearly meeting at Chester on Wednesday last week, Mr. T. H. Jackson, who presided, stated that the sum of £225,000 has been calculated as the cost of converting their lines to electric traction. The company has been carefully watching the result of electric traction upon other railways, but he did not think anyone could say that the results had been satisfactory, especially from the investor's point of view, and therefore before they attempted to raise the sum in question a system involving less capital expenditure and lower working expenses must be devised.

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SUMMARY

The inquiry before Mr. James Swinburne, F.R.S., concerning the proposed Home Office Regulations for the applications of electricity in factories, was continued on Wednesday, Thursday, and Friday last week. Mr. G. S. Ram, Electrical Inspector to the Home Office, went through the whole set of proposed regulations and explained his reasons for advocating them. He was severely cross-examined with regard to the dimensions he gave for switchboard platforms and passage-ways. He admitted that a certain form of construction used by the Newcastle Electric Supply Co. was, if anything, safer than that provided in his regulations, although it was not in accordance with the regulation. He also expressed the opinion that practically none of the switchboards of the London electric lighting companies complied with the regulation, and that the same was the case with a number of municipal stations in the Kingdom. Mr. W. H. Patchell and Mr. J. F. C. Snell, who had been retained on behalf of the Home Office, expressed themselves in favour of this regulation. Mr. C. P. Sparks' principal objection to it was that it would necessitate expensive alterations in low-pressure switchboards. Under the Coal Mines Regulations, existing precautions may be continued until an inspector directs otherwise, and then there is right of appeal. Mr. Sparks thought that a similar rule should apply in the present case. Much discussion was directed throughout to the question whether existing work could be exempted from the proposed Regulations, and the process by which exemptions could be obtained or accorded. Mr. C. H. Merz, who represented Newcastle and Durham companies supplying nearly 150,000 h.p. of motors, and owning 96 sub-stations with a capacity of 100,000 kw., said that they were erecting 30 to 40 new sub-stations a year, and would be severely hampered by this regulation. Some of its provisions were unnecessary, and, on the other hand, important provisions for safety were omitted. Mr. W. W. Lackie said that to comply with the regulation he would have to abandon two sub-stations in Glasgow containing 9,000 kw. of plant at an expenditure of £120,000. Mr. A. A. Campbell Swinton opposed the regulation on behalf of 42 stations, including those of the Edmundsons' group: he had no objection to the rules for new work. Mr. H. Talbot, President of the Incorporated Municipal Association, supported previous objectors in desiring deletion of the dimensions in the rule applying to switchboards, and in desiring the exemption of all existing work. He argued that the passage-ways about a switchboard should be as narrow as possible to prevent their being used unnecessarily. Rule 12, stipulating that starting switches with no-voltage releases should be employed both for alternating-current

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and direct-current motors, was then gone into, the natural objection being that they were quite unnecessary for a.-c. motors. Mr. Ram admitted that he had never seen a no-voltage release for an a.-c. starting switch, although they were obtainable. His suggestion that a no-voltage release for a whole works or group of motors might suffice, was characterised by the objectors as more dangerous than omitting the device altogether. The discussion on this regulation brought out points and examples of great interest to electric power-users, and was of a thoroughly technical character. Mr. Patchell said he used no-voltage releases successfully with large 440-volt and 2,000-volt a.-c. motors, but admitted that for small motors the apparatus would cost as much as the motor itself. Mr. Merz said he had 3,000 to 4,000 h.p. of a.-c. motors connected to his mains, none of which was fitted with no-voltage release. Mr. Merz characterised the Regulations as "stupid" and "dishonest," which raised a vigorous protest from counsel for the Home Office. The inquiry was adjourned until Monday next. (Page 381.)

THE high-tension transmission line and the transformer sub-stations of the Engelberg-Lucerne Power Supply Company are described. The power station was described in a previous issue. Along the edge of the lake of Lucerne the steel lattice poles are supported on brackets extending out from the shore over the surface of the lake, this unusual method of construction having been necessary in order to keep the high-tension wires away from the telegraph and telephone wires previously strung along the edge of the lake. Three sub-stations, for the double purpose of providing a local supply and of dividing up the line into sections, are situated between Obermatt and Lucerne. The chief sub-station is for the light and power supply of Lucerne, and another has been established at Kriens. (Page 389.)

AN apparatus for the electrical sterilisation of water has been put on the market in this country, in which a brush discharge is produced between plates of glass covered with tinfoil, by means of a small transformer. Air is drawn through between the plates and then thoroughly mixed with the water. (Page 392.)

ILLUSTRATIONS are given of the 11,000-volt overhead construction used by the Clyde Valley Electrical Power Co. (Page 393.)

A PAPER by Mr. W. B. PARSONS, read before the Institution of Civil Engineers last week, described the construction of the New York Rapid Transit subway. The greater part of this is of the shallow tunnel type for four tracks. (Page 394.)

THE first of the tunnels of the Hudson and Manhattan Railroad Co. under the Hudson River has been opened for traffic. Twin cast-iron tube construction is used, and the conductor takes the form of a single third rail outside the track. (Page 395.)

IN the report of the Chief Officer of the L.C.C. Fire Brigade, it is stated that the number of fires caused by defective electric circuits has fallen from 100 in 1906 to 88 in 1907. The total number of London fires attributed to electrical causes is given as 95, none of which were fatal, as against 348 due to gas and 329 due to oil and spirit lamps. (Page 396.)

A SUB-COMMITTEE of the Engineering Standards Committee, with Mr. C. H. WORDINGHAM as chairman, is engaged on the question of the standardisation of fuses. Among others who have been asked to carry out certain investigations for them is Prof. ALFRED SCHWARTZ, of the Manchester School of Technology, who, with Mr. W. H. N. JAMES, presented a Paper describing some of his results to the Institution of Engineers. These included determinations of the best length for fuses, and oscillographic records of the current and the rise of pressure at the moment of the circuit being broken. At the discussion in London, Mr. LEONARD ANDREWS and Mr. MORDEY referred to the magnetic blow-out effect of the wires leading to the fuses if they were arranged with this end in view; Mr. W. H. PATCHELL gave his experience of network fuses, and also referred to the difficulty of obtaining blocks that would carry different sized fuses; Mr. H. M. SAYERS advocated copper network fuses, replaced every August and December; and Mr. C. H. WORDINGHAM, chairman of the Fuse Standardisation Sub-Committee of the Engineering Standards Committee, deplored the difficulties of standardisation. Written communications were also received from Dr. GARRARD (who spoke at Manchester), Mr. E. B. SCHATTNER, and Mr. J. H. M. WAKEFIELD. At Manchester, Mr. W. CRAMP cast discredit on the old Preece fuse formula; Mr. C. F. SMITH said that the inductive drop was always more important than the ohmic drop in the case of blowing fuses; and Mr. S. J. WATSON expressed preference for aluminium fuses in section pillars, and objected to semi-enclosed fuses on switchboards. Dr. GARRARD'S remarks dealt mainly with the question of time-element, about which he has submitted a Paper to the Institution of Electrical Engineers. (Page 397.)

IN a Paper read recently before the Institution of Engineers and Shipbuilders in Scotland, Mr. H. A. MAVOR dealt with the advantages which could be obtained in large steam turbine-driven ships by increasing the speed of the turbines and decreasing the speed of the propellers, and described a form of variable-speed electrical transmission by which this could be accomplished. Induction motors are used in this system, which are started by allowing the "stator" to revolve and gradually arresting it by a mechanical brake. (Page 407.)

THE following books are reviewed in this issue:—"Thomas Alva Edison: Sixty Years of an Inventor's Life," by F. A Jones; "Universal Electrical Directory" (J. A. Berly's), 1908; "Local Government Board Annual and Official Directory for 1908." (Page 409.)

IT is pointed out under "Electrochemistry and Electrometallurgy" that the electrolytic refining of gold and silver is now carried out on a large scale in the United States and Germany. In the latter country the refining of silver was commenced so far back as 1881. In America the principal product to be refined is the gold and silver obtained as slimes in the copper refining baths, and the electrolytical method is fast ousting the chemical and metallurgical processes which have before been used. It is stated that an electrolytic plant for the refining of bullion is to be installed in London. The United States Mint at Philadelphia employ an electrolytic process. (Page 409.)

UNDER "Electrical Science," in the British and American Section, is a report of the first of Prof. J. J. THOMSON'S course of six lectures at the Royal Institution on electric discharges through gases, in which he dealt with the conductivity of air at ordinary pressure. In Papers abstracted in the Continental Section, RIGHI announces the discovery of a new type of radiation which he calls "magnetic rays"; NORDMANN proves that red light travels through space faster than blue light; and H. ABRAHAM makes a detailed study of the Ferrié electrolytic detector. (Page 410.)

AMONG the patent specifications published last Thursday is one by J. S. PECK, describing a combined frequency changing and flywheel load-equalising plant for use with slow-speed induction motors on intermittent loads. A further development in the method of fusing metallic filaments to supporting or leading-in wires is patented by the BRITISH THOMSON-HOUSTON Co. Other specifications of interest are those describing respectively the PUNGA multiple-circuit multiple winding for high-speed direct-current machines, and the magnetic wedges patented by the BRITISH THOMSON-HOUSTON Co. for retaining the conductors in the slots of induction motors. The patent by PRESTON &

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Gill for the slipping-belt train-lighting system expires this week. (Page 411.)

Applications have been received by the Brighton Corporation, both from the Brighton Omnibus Company and on behalf of a London company, for permission to run electric omnibuses; the Watch Committee recommended that permission be given to the London company, but this was defeated at the meeting of the Corporation on Thursday. A tariff has been drawn up by the Dover Corporation in connection with the supply of electrical energy for the Admiralty Harbour. A report by the Highways Committee of the London County Council recommends the purchase of the Highgate Hill cable tramways. The Board of Trade has sanctioned a 6,000-volt transmission system in connection with the Stepney Borough Council's new generating station at Blythe's Wharf. The surface-contact system is proposed for the tramways at York. (Page 413.)

300 kw. and 400 kw. turbo-alternators are required by the Aston Manor Corporation; two 2,000 kw. turbo-alternators, with exciter and alternators, are required at Bristol; a surface condenser and cooling tower is required at Dewsbury; Lancashire boiler, generating set, switchboard, &c., are required as extensions to the Heywood Electricity Works. A long report has been presented to the Poplar Borough Council with regard to extensions involving an expenditure of £27,200. The Manchester Corporation require a 6,000 kw. turbo-alternator, and the Glasgow Corporation a 1,000 kw. turbo-alternator, in addition to motor generators, rotary convertors, and extra high-tension and direct-current substation switchgear. (Page 415.)

The contract for three-phase to direct-current converters in connection with the Avonmouth extension scheme of the Bristol Electricity Department, has been awarded to Messrs. Bruce Peebles & Co. at £3,647. The tender of the Lahmeyer Electrical Co., at £4,591, for the new generating plant at Hull, has been accepted. (Page 417.)

The Newcastle Electric Supply Co.'s accounts show a profit for the year of £87,379, and after meeting interest and debenture loans, &c., dividends upon the preference and ordinary shares of 5 per cent. and 8 per cent. respectively, and transferring £5,000 to depreciation, there is a balance of £2,025 carried forward. At the meeting on Tuesday it was stated that £1,000,000 additional capital was being issued through Lloyds' Bank. A new power-house is to be built at Dunston-on-Tyne, with an initial capacity of 30,000 h.p. At the meeting of the Metropolitan Electric Supply Co. on Tuesday, Mr. W. Harrison Cripps referred to the effect of metallic filament lamps upon the revenue, and mentioned an appeal against their assessment, which had resulted in a reduction of £10,000. (Page 418.)

In the House of Commons on Thursday, the London electric power Bills were referred to a Joint Committee of both Houses of Parliament. Mr. Harold Cox proposes on second reading to move the rejection of the Telegraph Construction Bill, for the reason that the House of Commons should be placed in possession of fuller information as to the financial result of the telegraph and telephone systems. (Page 419.)

Judgment in the Brighton sub-station nuisance case has been given in favour of the Corporation. (Page 419.)

We think that Mr. G. S. Ram, the Electrical Inspector to the Home Office, will be the first to admit, as a result of the first steps of the inquiry into his proposed regulations, that the experts who are responsible for the design of generating stations in this country, and the application of electric power in workshops, are even more fully acquainted than himself with the dangers that exist, and the safeguards that are necessary to guard against them. Our report of the proceedings on Wednesday, Thursday, and Friday last week occupies no less than seventeen columns, and is full of technical matter that will be read with interest by all users of electric motors, and from which more information can possibly be derived concerning the best practice in this direction than from the draft regulations themselves. It will be seen that it is the representatives of the "authorised undertakers" whose voices were heard most frequently, and to whose objections most attention has been directed; and that the individual power-user is apparently relying on the Commissioner's assurance at the commencement of the proceedings that his objections will receive consideration, even if he does not cross-examine the Home Office witnesses on the various points, and put in his own witnesses in support of his case. Although we do not desire that the inquiry should be unduly prolonged, we cannot but think that the owners of independent electric power plants, and those also who are only contemplating the adoption of electric driving, would find it to their advantage to press their claims into greater prominence. The authorised undertaker has three lines of defence. In the first place, he claims that no new regulations are necessary at all. Secondly, he maintains that if an interfering Home Office insists on imposing regulations, undertakers who are already obliged to observe the Board of Trade Regulations under the Electric Lighting Acts, should be exempt. If he is beaten back to this point he is separated from his ally, the independent power-user, although he himself may be entrenched in a stronger position. Lastly, he is able to take up his third line of defence, that should be absolutely unassailable, that existing work, whether it comply with the regulations or not, should not be disturbed unless the Home Office can show that it is absolutely dangerous, and under this plea the independent plant and the power-user will also receive some protection, although he may be harder hit than the larger electricity works when it is necessary to extend his installation. The Home Office representatives still say that they would not even be content to allow this very limited and reasonable exemption, and they argue that electricity works, sub-stations, and all works coming under the Factory Act, must alter their installations to conform with the new regulations, unless they can convince the local inspector (who probably will know nothing about electricity other than what he has read in Mr. Ram's regulations), that the existing safeguards are as good as, or better than, those in the regulations. On his inability to convince this gentleman, he is to be "entitled to make a statement in writing for submission to the Electrical Inspector," or, as Lord Robert Cecil sarcastically put it, his attention is called to the existence of the penny post. If the Electrical Inspector is likewise unconvinced, the electric power user or the owner of a generating station or sub-station, as the case may be, may be charged with committing a criminal offence if he neglects to alter his installation or works, even if no accident has happened and no actual danger has been proved. We need only take one example to show the absurdity of this. Mr. Ram has admitted that he has never seen an alternating current no-voltage release; in accordance with his regulations it is to be a criminal offence to use an alternating-current motor without this device; yet thousands have been safely in use without it for many years; it was also ad-

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mitted by one of the Home Office witnesses that in the case of small motors, the cost of fitting the device would be as great as the motor itself. Yet this regulation with regard to the employment of a device still more or less in the experimental stage of construction is to be enforced, unless in every single instance a case for exemption can be made out.

FROM statements made in the discussion on a Paper dealing with "Fuse Phenomena," at the Institution of Electrical Engineers last week, we now know that the Engineering Standards Committee has taken in hand the standardisation of fuses. It may reasonably be asked by whom this standardisation has been requisitioned, and what good purpose it will serve when —if ever—the work is completed. Prof. SCHWARTZ, we were informed, is one of a number of gentlemen entrusted with experimental work for the Sub-Committee, and, if the other investigators are carrying out equally laborious tests and preparing equally voluminous reports, the final issue of standards by the Committee may be long deferred. This must be some satisfaction to those, like ourselves, who regard a general standardisation of fuses as entirely unnecessary. Prof. Schwartz's investigations have been directed to low-tension fuses below 50 amperes, and should, therefore, cover the ordinary house distribution-board fuse, for which at first sight standardisation would be advantageous. The present patterns of carrier-type fuses have very few disadvantages, and probably the only one is that there are differences in the carriers and clips supplied by different makers, so that the replacement of broken carriers may sometimes occasion delay. Standardisation of these might therefore be desirable, but apparently the work is being developed in quite a different direction, namely, the standardisation of a cartridge type of fuse. The extra cost of fuse replacements, which the employment of this pattern occasions in ordinary house-wiring work, is a strong argument against this, especially as, to judge by the tenour of Prof. Schwartz's remarks in introducing his Paper, the German fad of non-interchangeable fuses of different sizes which has been copied by some American makers is likely to be regarded as desirable practice. In ordinary house-wiring, the current for each way of the local distributing boards is 3 amperes on 200 to 250-volt circuits, and 5 amperes on 100 or 110-volt circuits. The Institution of Electrical Engineers' wiring rules as revised last year specify fuses to blow at 200 per cent. overload on these circuits; the previous Institution rules, to which a large number of buildings have been and are still being wired, prescribe 100 per cent overload; the Phœnix rules call for fuses blowing at 50 per cent. overload. Some local wiring rules issued by electricity undertakers have specified only 25 per cent., but this must not be seriously considered. We have thus no less than six sizes of fuse wires—to blow at 9, 6, 4½ amperes at 200 volts, and at 15, 10, and 7½ amperes at 100 volts. Of course, it will not be seriously suggested that non-interchangeable cartridge fuses with fuse-clips at different gauges or of different sizes are to be employed for all these six sizes, but this is sufficient to indicate the difficulties that will have to be encountered if the German method be followed, and the large and unnecessary cost that would be incurred in fuse-board alterations in the event of a change of voltage. If the fuses for house distribution-boards are to be absolutely standardised at, say, 6 amperes for 200-volt circuits and 10 amperes for 100-volt circuits, there may be something to say in favour of cartridge fuses of a standard size for this purpose, if they can be obtained of good and lasting quality at a cheap price, but more information is necessary with regard to these before we can consent to an official scrapping of the ordinary carrier fuse, which is still doing good service. If Prof. Schwartz had devoted the same energy which he has applied in the oscillographic study of fuses to a test as to the correctness of the rating of the various makes of cartridge fuse on the market, and the rapidity of ageing of these when run at 50 per cent. of their fusing current, he would have done still more useful and practical work. The cartridge fuse is still something in the nature of a surprise packet. When we come to the question of larger circuits, the non-interchangeable fuse and fuse-holder present more serious disadvantages. The main switchboards of public buildings would present a remarkable appearance if fitted with rows of cartridge fuses all of different outside dimensions, and the number of spare cartridges to be stocked would be an extra item of expenditure which would have to be considered. The use of these, moreover, would make it necessary to alter the fuse-clips on the board as extensions to the load on any circuit were made. A similar argument applies in the case of sub-stations and small generating stations in which magnetic cut-outs are not employed. We acknowledge that Prof. Schwartz has done work that intrinsically is valuable and interesting, but if we are to regard his Paper as a prelude to an academic and dogmatic standardisation of fuses which would add an additional burden to the long-suffering electrical contractor, we cannot bid it welcome.

ARRANGEMENTS FOR THE WEEK

THURSDAY, MARCH 12TH.

Institution of Electrical Engineers.

8 p.m Ordinary General Meeting at 25 Great George Street, Westminster. Lecture by Sir William Preece, K.C.B., F.R.S., on "America Revisited, 1907."

Electrical Contractors' Association: London Section.

8. p.m. Meeting at Restaurant Frascati, Oxford Street. Paper to be read :—"On the Comparison of Carbon and Metallic Filament Incandescent Lamps," by L. Gaster.

Rugby Engineering Society.

8 p.m. Ordinary Meeting. Paper to be read :—"The Systematic Design of Lines of Direct-current Machines, in Relation to the Use of Commutating Poles," by H. O. Eurich and F. P. Whitaker.

FRIDAY, MARCH 13TH.

Physical Society.

8 p.m. Meeting at the Royal College of Science, Imperial Institute Road, South Kensington. Among the Papers to be read is one by S. Russ on "The Distribution in Electric Fields of the Active Deposits of Thorium and Actinium."

Junior Institution of Engineers.

8 p.m. Meeting at the Royal United Service Institution, Whitehall. Paper to be read :—"Automatic Fire Extinction as Applied to Factories," by G. T. Bullock.

Royal Institution.

9 p.m. Evening Discourse by Signor G. Marconi on "Transatlantic Wireless Telegraphy."

SATURDAY, MARCH 14TH.

Royal Institution.

3 p.m. Afternoon Lecture II., by Prof. J. J. Thomson, F.R.S., on "Electric Discharges through Gases."

Birmingham and District Electric Club.

7 p.m. Meeting at the Colonnade Hotel, New Street, Birmingham. A discussion will take place, opened by Mr. R. Borlase Matthews, on "The Possibilities of Electrical Developments."

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THE PROPOSED HOME OFFICE REGULATIONS

(Special Report. Strictly Copyright)

WEDNESDAY, MARCH 4TH.—SECOND DAY.

As stated in our last issue, Mr. Swinburne, the Commissioner appointed by the Home Office to hear the objections made to the proposed regulations for the use of electricity in factories (including generating stations and sub-stations), decided that he could not present an interim report on the questions of general principle that had been raised.

Mr. J. H. GRAY, counsel on behalf of the Home Office, said he desired to point out that the regulations proposed, really only defined what was already law under the Factory Acts, and which the Home Office could enforce at any time it thought fit. Therefore the regulations did not hamper the electrical industry in any way. It was not desired to make law what was not law before. As things were at present nobody was in a position to say whether they were complying with the law or not.

Mr. VESEY KNOX, K.C., counsel for the Newcastle Electric Supply Co. and the Cleveland & Durham Electric Power Co., said that the Home Office seemed to be under an entire legal misapprehension as to the effect of the regulations. If the Home Office view was the right one, then all that was proposed could be done equally well by memorandum.

Lord ROBERT CECIL, K.C., M.P., on behalf of the City of London Electric Lighting Co. and other companies, said that to suggest the regulations did not impose further restrictions was absurd. Dealing with the Board of Trade regulation A1 (reprinted in our last issue), he asked for some formal communication from the Board of Trade stating their intention to relinquish this. His view was that they could not relinquish it altogether.

Mr. GRAY said that no official communication had been received from the Board of Trade, but they had been assured that regulation A1 *quâ* factories would be abandoned.

Mr. G. S. RAM, Electrical Inspector of Factories, was then recalled, and went through the regulations in detail. We give his reasons for their adoption after each regulation below.

Mr. RAM first dealt with the definitions. These, he said, had been drafted in accordance with the general use of the terms, and he had kept as near as possible to existing definitions, for example, those adopted by the Board of Trade, but for obvious reasons the exact wording of the Board of Trade regulations could not be taken. With regard to the definition of "system," one objector wanted "pressure" instead of electromotive force; he agreed to this. With regard to the definition of "sub-station," it had been asked that single transformers up to 50 kw. should not come within the definition. The definition was based upon the definition of "electrical stations" in the Factory Acts, and therefore could not be altered. The definition of "switchboard" was regarded by some objectors as being too wide, and it was suggested that it might include a group of two or three lighting switches. He agreed that this might be the case, but it was immaterial because the definition was only used for the purpose of the regulation concerning switchboards. Similarly "switchboard passage way" had been objected to, it being stated that it should be limited to space in front or behind the switchboard. The suggestion had been made that in its present wording the definition could include telephone boxes, but the regulations did not refer to them, and therefore could not apply. With regard to the definition of "danger," there was no definition of this in the Board of Trade rules, and objections had been taken to the Home Office definition as being too wide.

Dealing with the exemptions, Mr. Ram said he had no comment to make upon exemption 1.

Exemption 2 reads that "Nothing in regulations 7, 8, 9, and 10 shall apply in electrical stations to any circuit, conductor, or cable used for conveying electrical energy for public supply." Mr. Ram now added regulation 28 in this exemption, and after the word "supply" the words "or tramway under licence or other statutory powers."

We give below the exemptions as altered and added to by the Home Office:—

Exemptions.

(*a*) Nothing in these regulations shall apply to any system the normal working pressure of which does not exceed 130 volts continuous or 65 volts alternating.

(*b*) Nothing in Regulations 7, 8, 9, 10, and 28 shall apply in electrical stations to any circuit, conductor, or cable used for conveying electrical energy for public supply or traction under statutory powers.

(*c*) Nothing in Regulation 12 shall apply to any motor of a motor-generator, or to any motor forming part of any electrical converter, regulator, or similar apparatus.

(*d*) Nothing in these Regulations shall apply on the premises of an occupier, being the consumer of an authorised electricity supply undertaking, to any service cables and apparatus belonging to or under the control of the authorised undertaker.

(*e*) If the occupier can show with regard to any requirement of these Regulations that the special conditions in his premises are such as to prevent danger not less adequately than if the said requirement were observed, that requirement shall be deemed to be satisfied.

The regulations were then gone through seriatim.

The Proposed Regulations.

Regulation 1.—All apparatus and conductors shall be sufficient in size and power for the work they may be called upon to do, and so constructed, installed, protected, worked, and maintained as to prevent danger.

This is based on regulation No. 1A of the Coal Mines Regulations, and is intended to cover various matters not separately dealt with. For instance, there is nothing in the Home Office Regulations as to the size of cables and wires to be used under different circumstances, nor for the protection of resistance frames and other things about a factory; these are intended to be covered by Regulation 1.

Regulation 2.—All cables shall be covered with insulating material, and further efficiently protected where necessary to prevent danger; or they shall be so placed and safeguarded as to prevent danger.

Mr. RAM pointed out that many objectors were under the impression that this regulation required all cables to be covered by insulating materials, but this was quite a mistake, because they had an alternative in the last line. The regulation did not prevent bare wires being used under proper conditions. The Institution of Electrical Engineers' Wiring Rule No. 12 (1905) provided that where the pressure exceeded 250 volts, the conductors must be completely enclosed in strong metal, sheathing or tubing, and no alternative or exception was allowed. Similarly, the Board of Trade Regulation A1, section (*a*)2 and B1, set up the same standard, but without any alternative. Board of Trade Regulation A1 (*c*)1 also provided that wires shall be enclosed in strong metal casing, and there was no alternative. Therefore, Regulation 2 was less stringent.

Regulation 3.—Every switch, circuit-breaker, and isolating link shall be:—(*a*) so constructed, placed, or protected as to prevent danger; (*b*) so constructed and adjusted as accurately to make and to maintain good contact; (*c*) provided with an efficient handle or other means of working, insulated from the system; (*d*) so constructed or arranged that it cannot accidentally fall or move into contact when left out of contact.

Section (*a*) is intended as a general protection, so that persons could not accidentally knock against a switch in a passage. Section (*b*) was, said Mr. Ram, obviously necessary to prevent overheating, and so that there should not be an arc in making contact. With regard to Section (*c*), it had been suggested by the Institution of Electrical Engineers, that there should be added the words "and so arranged that the hand cannot touch live metal." He had no objection to this. Section (*d*) was necessary especially in regard to isolating links. He had seen isolating links hinged at the top instead of at the bottom, the links being held up by the friction of the hinge, there being nothing to prevent them dropping. There were several objections to this section.

Regulation 4.—Every switch and circuit-breaker shall be so constructed as to be incapable of remaining in partial contact, or of maintaining an arc on breaking circuit.

Considerable modification was suggested in this to meet points raised by objectors. As an instance, however, of why the regulation appeared as it did, Mr. Ram mentioned one accident which he had had to investigate. There was an arc lamp circuit at 200 volts alternating current. While the lamp was burning, the lamp-man switched off the current, lowered the lamp, took hold of it, and got killed by shock. Examination showed that although the switch was off (it was a link switch, *i.e.*, two single switches connected by a link) the man had only broken the circuit on one pole; the other contact had either come off and gone back, or had never come quite off. At the time the regulation was drafted the Institution of Electrical Engineers' Rules of 1903 were in force, and rule 45 (*c*) appeared to fit this case so exactly that he had practically adopted it. Now, however, it was pointed out by some objectors that it was going too far to say that *all* switches should be incapable of remaining in partial contact. He was inclined to agree with this, and proposed an alteration as follows:—

"Every switch and circuit-breaker shall be so constructed that it cannot be inadvertently left in partial contact." The second part he was willing to alter as follows:—

"Every switch and circuit-breaker shall be so constructed that an arc cannot be inadvertently maintained."

Regulation 5.—Every fuse, and automatic circuit-breaker used instead thereof, shall be so constructed and arranged as effectively to interrupt the current before it so exceeds the working rate as to involve danger. It shall be of such construction or be so guarded or placed as to prevent danger from overheating, or from arcing or the scattering of hot metal or other substance when it comes into operation. Every fuse shall be of

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such construction or be so protected by a switch that the fusible metal may be readily renewed without danger.

Some objectors suggested that it should be definitely stated what overloads are to be allowed, but he thought this very undesirable. With regard to the last sentence, there were still many old-fashioned double-pole fuses in use with a positive and negative fuse quite close together. When it was necessary to change a fuse, a man frequently made a short-circuit with his screw-driver, and was liable to injury. Such a fuse under these regulations would only be allowed if it were protected by a switch.

Regulation 6.—Every electrical joint and connection shall be of proper construction as regards conductivity, insulation, mechanical strength, and protection.

Mr. Ram had no comment to make upon this.

Regulation 7.—Efficient means, suitably located, shall be provided for cutting off all pressure from every circuit.

The main object of this regulation is that it shall be possible to make any part of an installation dead in case any work has to be done upon it. The regulation, said Mr. Ram, did not say that efficient means should be provided for cutting off all pressure from every circuit separately. It was conceivable in case of small installations that one main switch would serve the purpose. In case of larger installations, however, it would not be practicable to shut down the whole works, if any small thing was wanted to be done on one circuit; therefore some efficient means must be provided apart from the main switch for cutting off parts of the installation. The Institution of Electrical Engineers' rule 100 (of the 1907 edition) dealt with this point, and Mr. Ram thought this showed that the necessity for this regulation was recognised. The two regulations were not quite identical, however, the present one going a little further and stipulating that efficient means, suitably located, should be provided for disconnecting such circuits from the supply. These last two matters were not dealt with in the Institution of Electrical Engineers' rules.

Regulation 8.—Every circuit shall be efficiently protected from excess of current, and every circuit arranged to carry more than 750 watts shall be separately so protected.

This is based on Institution rule No. 21 (1907), and also on the Coal Mines Regulation No. 9, but it is claimed to be more clearly and concisely expressed in the present draft.

Regulation 9.—Where one point of a system is connected to earth, no single-pole switch other than a link for testing purposes shall be placed in any cable connected thereto.

This regulation is based on Institution Rule No. 16 (1907); the link for testing purposes is based on Institution Rule No. 17.

Regulation 10.—Where one of the main conductors of a system is uninsulated and bare, such as a bare return of a concentric system, no switch, fuse, or circuit-breaker shall be placed in that conductor, or in any conductor connected thereto, and the said conductor shall be earthed.

This is identical with Institution Rule No. 18 (1907). It was pointed out that the system referred to was not often met with, and Mr. Ram said he believed it was never allowed in an installation supplied from public supply mains, but there were instances with factory premises having their own generating stations. The danger was that the outer conductor might become charged to the full pressure of the circuit.

Regulation 11.—Every motor, converter and transformer shall be protected by a switch or switches, suitably placed, and so connected that all pressure may thereby be cut off therefrom and from any apparatus in connection therewith.

So far as motors are concerned, this regulation is based on the Board of Trade regulation A.1., sub-section (*a*) 3. The Home Office has added "converters and transformers." The corresponding Institution Rule (1907 edition) as regards motors is 91 (*e*), and it is also in Mines Regulations No. 34. The object of the regulation is that if any of these pieces of apparatus has to be attended to, it shall be possible to make it dead. An objection is made by the Coventry Corporation which Mr. Ram thought could be met. The objector in this case has a two-phase supply. The motors on consumers' premises are supplied with two-pole switches, and although the system was what might be called a three-wire system, the switch of the motor was only on the two poles, and it was pointed out that this was all that was necessary. Mr. Ram thought he could agree to this, provided the other wire was connected to earth at the generating station or sub-station, whichever it was, and he proposed to add these words:—"Provided, however, that where one point of the system is connected to earth, there shall be no obligation to disconnect on that side of the system which is connected to earth."

Regulation 12.—Every electrical motor shall be controlled by an efficient switch or switches for starting and stopping, so placed as to be easily worked by the person in charge of the motor. Every electrical motor rated at more than one-third of a horse-power shall be further protected by a release that will automatically break the circuit if the current is interrupted, unless the motor is incapable of re-starting automatically on the current being restored. In every place in which machinery is being driven by any electrical motor, there shall be means at hand for quickly stopping the motor.

No objection is made to the first point of this rule.

With regard to the second sentence, dealing with automatic circuit-breakers, Mr. Ram explained that this was really a mechanical requirement. It was not an electrical danger at the motor which was in view. Take the case of a motor driving machinery located on a different floor of the building. If the motor stopped and then went on again suddenly without warning, persons engaged at the machinery in every room might easily be injured. By means of an automatic circuit-breaker, if the current stopped from any cause, the circuit was broken, and even if the current came on again suddenly, the motor did not start. He proposed to add after the word "restored" the words "or no danger is involved by the automatic restarting of the motor."

With regard to the third sentence, this is intended to apply to places where there is a motor in the basement driving machinery on different floors, so that in a case of urgency, such as an accident in one room, for instance, it would be possible to stop the motor from that room. In some places Mr. Ram said he had seen motors locked up in a sort of hut or enclosure, and the man in charge away with the key in his pocket. In order, however, to obviate the necessity for stopping a motor, which might be inconvenient at times, he proposed to add at the end of the third section the words, "or the machinery."

Regulation 13.—Every flexible cable for portable apparatus shall be connected to the system either by efficient permanent joints or connections, or by a properly constructed connector. Every portable apparatus and its flexible cable shall be independently controlled by a switch conveniently placed. Adequate precautions shall be taken against shock, due to leakage or other cause, in all places where the person handling the portable apparatus is not insulated from earth. In such places, and in any place where the pressure exceeds low pressure, the switch shall be so constructed as to break the circuit on each pole.

In respect of this regulation the Institution of Electrical Engineers suggested that the words, "by efficient permanent joints or connections," should be deleted. They thought that a connector should be used on all occasions. Mr. Ram did not think he could accept this, because there were cases where a permanent joint was desirable. As an example he took the case of a tramway car repair shop, which would come under the Factory Act, where there was a 500-volt system with one pole earthed. He had seen several cases of portable lamps connected with flexible wires protected by flexible metallic tubes. This latter was permanently attached at each end, and connected to earth, and he thought in a case like that it should be permanently attached, because supposing the earth connection was at any time broken the flexible tubing would in itself constitute a great danger. If it could not be disconnected it was more likely to remain safe than if it could be disconnected.

Dealing with the second sentence referring to portable apparatus, Mr. Ram said this corresponds with the Institution Rule No. 76 (1907). The Institution and some other objectors made a suggestion that it should read "Every connector or group of connectors." He thought he could agree to that. Therefore instead of the words, "portable apparatus and its flexible cable," he proposed to substitute "connector, or group of connectors, for circuits not exceeding 750 watts in the aggregate." Also after the word "controlled," he proposed to add "on the live side."

The last part of the regulation, Mr. Ram explained, is aimed at the danger from shock from portable apparatus which may be leaky.

Regulation 14.—The general arrangement of switchboards shall, so far as reasonably practicable, be such that: (*a*) all parts which may have to be adjusted or handled are readily accessible; (*b*) the course of every cable may be readily traced; (*c*) conductors connected to different systems are kept apart and can be readily distinguished; (*d*) all bare conductors are so placed or protected as to prevent danger from accidental short-circuit.

One objector in regard to this section had suggested the addition of the word "well" after the word "kept." He thought this was a good suggestion.

Regulation 15.—Every switchboard having conductors normally so exposed that they may be touched shall be located in an area or areas set apart for the purposes thereof and suitably fenced or enclosed. No person except an authorised person, or a person acting under his immediate supervision, shall have access to any part of such area.

He proposed to add in the last line of the first part, before the word "suitably," the words "where necessary to that end." This meant that the switchboard need not necessarily be fenced, but it must be fenced if it could only be set apart by being fenced.

Regulation 16.—All apparatus appertaining to a switchboard and requiring handling shall so far as practicable be so placed or arranged as to be operated from the working platform of the switchboard, and all measuring instruments and indicators connected therewith shall so far as practicable be so placed as to be observed from the working platform. If such apparatus be worked or observed from any other place, adequate precautions shall be taken to prevent danger.

This was an endeavour to deal with the practice in some places of putting fuses and switches behind the boards. He

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had known cases where rather than extend the board, switches, fuses, and instruments had been added at the back, and this was a most undesirable arrangement.

Regulation 17.—At the working platform of every switchboard and in every switchboard passage-way, if there be bare conductors exposed, or arranged to be exposed when live so that they may be touched, there shall be a clear and unobstructed passage of ample width and height with a firm and even floor. For low pressure and medium pressure the clear height shall not be less than 7 ft. and the clear width not less than 3 ft., and for high pressure and extra-high pressure 8 ft. and 4 ft. respectively. Bare conductors shall not be exposed on both sides of a switchboard passage-way unless either the clear width of the passage is double that otherwise required, or the conductors on one side are so guarded that they cannot be accidentally touched. Adequate means of access, free from danger, shall be provided for every switchboard passage-way.

The dimensions had been put into this regulation as a result of an examination of a large number of switchboards. He had seen switchboards with much less space and some with more space, and he thought that the regulation drew reasonable limits. The dimension of 7 ft. in height for medium pressure boards allowed a man to walk to the back of the switchboard upright, and even with his hat on. The width of 3 ft. clear did not appear to him to be excessive; it gave room for a man to walk along, and, if necessary, to work on the board. The distance of 4 ft. in width for high pressure boards was originally suggested by the report of the Dangerous Trades Committee about ten years ago. 8 ft. for height was given as being out of the reach of an ordinary man.

The latter part, dealing with bare conductors, was framed because with bare conductors on both side a man was liable to forget, and in this way was liable to touch the bare conductors and so get injured.

Regulation 18.—In every switchboard for high pressure or extra-high pressure :—(*a*) Every conductor within reach from the working platform, or in any switchboard passage-way, shall be so placed or protected as to prevent danger. (*b*) The metal cases of all instruments shall be either earthed or completely enclosed with insulating covers. (*c*) all metal switch-handles, and all metal rods connecting them with the switches, shall be earthed. (*d*) Every switchboard in continuous use shall be so arranged that the conductors thereof can be made dead in sections, and no work shall be done at any section unless that section be (*a*) made dead, and (*b*) so separated by permanent or removable divisions or screens, from all adjoining sections of which the conductors are live, that the work may be carried out without danger.

It had been pointed out in regard to section (*b*), that, although they might have a high pressure or extra-high pressure switchboard, the instruments nevertheless might be at low pressure if worked on transformers, and it was feared that the regulation would mean that such instruments would have to be protected whether they were at high pressure or not. Similar objections had been raised in regard to section (*c*). He proposed therefore to strike out the whole of section (*c*), and to substitute the following :—

"All metal handles of high pressure, or extra-high pressure switches, and, where necessary to prevent danger, all metal gear for working switches shall be earthed."

Paragraph (*d*) he regarded as a very important provision, and in a very large number of modern high-pressure and extra-high pressure switchboards, this requirement was already carried out.

Regulation 19.—All fixed coils, conductors, or terminals of generators, motors, transformers, or other apparatus, at high pressure or extra-high pressure, and within reach from any position in which any person employed may require to be, shall be so protected as to prevent danger.

Coal Mines Regulation No. 22 already covered part of this ground. One of the dangers often met with, and with which this regulation would deal, was with extra-high pressure motors and generators where the stator coils were not protected, leaving anybody to touch them.

Regulation 20.—Where a high-pressure or extra-high pressure supply is transformed for use at a lower pressure, adequate means shall be provided to prevent the lower pressure system from being accidentally charged above its normal pressure by leakage or contact from the higher pressure system.

This is based on Board of Trade Regulation A9. It had been suggested that this regulation should have been adopted entirely, but he could not do this, as the Board of Trade wording was restricted to the case of public electricity supply. The Home Office regulation applied to factory installations, and hence the difference. Instead of the Board of Trade words, "suitable automatic and quick acting means," they had the far more general expression, "adequate." It had been suggested by the Institution of Electrical Engineers that an alteration might be made in the wording, and that instead of the words "adequate means shall be provided to prevent," they should have "suitable provision shall be made to guard against," and that instead of the words "from being" substitute the word "becoming." He agreed to adopt this latter suggestion.

Regulation 21.—Adequate precautions shall be taken to prevent any metal other than the conductors from becoming electrically charged, and such metal shall be earthed where necessary to prevent danger.

This was framed in rather general terms. Other codes provided for the earthing of certain definite apparatus; thus the Board of Trade Regulation A1, sub-section (*a*)1 required the frames of motors of medium pressure to be connected to earth; sub-section (*a*)2, (*b*)1, and (*c*)1 of the same regulation required all metal cases for wires to be connected to earth, and that in the case of medium pressure, the metal cases of switch lamp-holders shall be connected to earth. Board of Trade Regulation A10 required that metal portions of transformers other than the conductors, shall be connected to earth, whilst Regulation A16 required that metal conduit pipes and casings containing any high-pressure electric lines, shall be connected to earth. Coal Mines Regulation 1c required the earthing of all metal coverings, armourings, and frames of generators, transformers, motors, &c., where the pressure is above low pressure. Coal Mines Regulation 47 required that metallic pipes for wiring, whatever the pressure, be connected to earth, and Institution Rule No. 24 required all metal sheathing or tubing to be earthed for low pressure. The Home Office Regulation, instead of specifying all these pieces of apparatus, was general in its application.

Regulation 2.—Adequate means shall be provided and used for preventing any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon.

These provisions were very generally made in supply stations, sometimes by means of an actual locking switch, and sometimes by hanging up a notice. In other cases more elaborate precautions were taken.

Regulation 23.—Where necessary to prevent danger, insulating stands or screens shall be provided and kept permanently in position and shall be maintained in sound condition.

The Dangerous Trade Committee in 1897 made a recommendation in regard to the use of insulating mats for pressures about 350 volts alternating current, or 700 volts continuous current. Coal Mines Regulation No. 21 requires insulating floors or mats at medium-pressure switchboards, both in front and back. The words "stands or screens" did not mean that one was the alternative to the other. Whichever was required must be used, and if necessary both.

Regulation 24.—Portable insulating stands and screens, boots, and gloves, shall be provided and used when necessary to prevent danger, and shall be periodically examined by an authorised person.

The Dangerous Trades Committee recommendation No. 9 requires the use of gloves by persons working on live mains; gloves, mats, or shoes are also required for use above low pressure. The Institution of Electrical Engineers and others had suggested that the words "and gloves" be deleted. Whilst, on the one hand, engineers held that gloves should not be used in any circumstances, *i.e.*, that apparatus should be so safe that gloves are not necessary, others maintained that gloves are in certain circumstances necessary. He quite believed that there were conditions under which gloves should be used, and the regulation only required them to be used when necessary to prevent danger.

Regulation 25.—Adequate working space and means of access, free from danger, shall be provided for all apparatus that has to be worked or attended to by any person.

As examples for the need of this regulation, Mr. Ram mentioned that he had found the switches for working a motor placed behind a running belt; he had also found them placed on a wall, between which and the main operating the motor was a space having a drop of 12 or 15 ft., so that if the man in operating a switch received a shock, he would probably fall into this pit.

Regulation 26.—All those parts of premises in which apparatus is placed shall be adequately lighted to prevent danger.

Some objectors rather thought it necessary to have a light burning all the time. He quite agreed that this was unnecessary, but light should be available if it was wanted.

Regulation 27.—All conductors and apparatus exposed to the weather, wet, corrosion, or to inflammable surroundings or explosive atmosphere, or used in any process or for any special purpose other than for lighting or power, shall be so constructed or protected, and such special precautions shall be taken as may be necessary to prevent danger in view of that exposure or use.

Among the special apparatus under this regulation, Mr. Ram said he would include testing operations in a manufacturing works. He did not make any definite regulation, but merely stated that whatever precautions were necessary for safety should be taken.

Regulation 28.—Adequate periodical tests shall be made by an authorised person to ensure (*a*) that the insulation of all conductors and apparatus is duly maintained; (*b*) that no metal part of any apparatus, other than the conductors thereof, is electrically charged so that there is danger; and (*c*) that all earth connections are in order. Adequate periodical examinations shall also be made by an authorised person to detect any other defects from which danger may arise.

Bearing on this regulation, reference was made to Institution Rules 97 and 98 of the 1907 Edition, which provided for the

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testing of installations before being put to work. Institution Rule 99 emphasised, in no unnecessary manner, the necessity for frequent systematic inspection and testing. It had been suggested by objectors that Board of Trade Regulation A6 should be substituted. This Board of Trade regulation provided that the leakage on the electric supply system shall not exceed one-thousandth part of the maximum supply current, but this rule was not applicable to individual installations. The limit of one-thousandth in many cases was not stringent enough. The Institution Wiring Rules allowed less than one-tenth of this amount; Coal Mines Regulation No. 6 was similar to the Board of Trade rule in allowing one-thousandth, but the case of mines was rather different. It was more difficult to keep down leakage in mines on account of water. He did not agree with the suggestion that the Home Office should adopt Board of Trade Regulation A6. The second paragraph of this Board of Trade regulation required a test once a week, which was much more frequent than he should presume to ask, but they would accept it if the objectors wished for it. The third paragraph of the Board of Trade regulation in question gave total exemption to the greater number of electricity supply undertakings, as most distribution from public mains was by the 3-wire system, having the neutral conductor earthed. If, therefore, the Home Office accepted the Board of Trade regulation, thousands of installations would never be tested at all. This regulation was one which he had that morning suggested should be added to the second exemption attached to the rules, so that it should not apply to any circuits in electricity works which conveyed electrical energy into the street and beyond.

Regulation 29.—No person except an authorised person, or a person acting under his immediate supervision, shall undertake any work where technical knowledge or experience is required in order to avoid danger.

It had been suggested by the Institution of Electrical Engineers that the contractor should be allowed to appoint the authorised person in certain cases. He thought the appointment of the authorised person should be considered in regard to the control of the danger. In the case of electrical sub-stations, accidents had occurred to contractors' workmen where he thought blame was attached to the occupier. He did not think it was fair, for instance, that supposing in an electrical sub-station a contractor was called in to do some work a man should be allowed to work without any supervision, in a dangerous place, merely because he was a contractor's man. In the case of an occupier having a factory or mill where he did not employ a competent person, but only a man for starting and stopping the motors, if anything went wrong assistance was obtained from an outside contractor, but the occupier should not be made responsible for the contractor's man being competent. In this case he thought it was the contractor who should appoint the competent person. He considered that the person who controlled the danger should be the person responsible for the safety of the workmen, and he thought that this difficulty might be got over by adopting the Institution suggestion with regard to the definition of "authorised person." They might make an addition to the definition of "authorised person," after the word "occupier" by adding, "or by a contractor or contractors for the time being under contract with the occupier." This addition, however, should be subject to an addition at the end of Regulation 29 as follows:—

"Where the contractor is employed and the danger to be avoided is under his control, the contractor shall appoint an authorised person, but if the danger to be avoided is under the control of the occupier, the occupier shall appoint an authorised person."

MR. GRAY, on behalf of the Home Office, pointed out that he did not think this would quite meet the objection, but no doubt something better could be suggested during the cross-examination.

Regulation 30.—Instructions as to the treatment of persons suffering from electric shock shall be affixed in all premises where electrical energy is used, other than for incandescent lighting at low pressure, and in all premises in which electrical energy is generated or transformed.

MR. RAM pointed out that this regulation was proposed by the Dangerous Trades Committee as regards electrical sub-stations for 350 volts alternating, and 750 volts continuous current, with the addition that all persons engaged in the works shall be practically instructed in methods of artificial respiration, &c. Coal Mines Regulation No. 13 required instructions to be posted in every transforming, generating, and motor house. The objectors to this regulation seemed to think that needless alarm would be caused by the display of instructions in the case of consumers connected to their mains. Personally he did not think this would be the case. At present, he pointed out, the Board of Trade required that under every motor a notice should be posted saying that no unauthorised person was to touch the motor. That was for medium pressure. The Home Office regulations did not require that instructions should be placed on every motor or about the place; one on the premises would comply. Such a notice might be placed at the entrance to the works where the Factory Act notice was usually placed.

Regulation 31. Every sub-station shall be of ample dimensions and substantially constructed of fire-resisting material; and shall be so arranged that no person can obtain access thereto otherwise than by the proper entrance, or can interfere with the apparatus or conductors therein from outside; and shall be provided with efficient means of ventilation and be kept dry.

The question of substantial construction was important. He had seen sub-stations for extra high pressure where it was possible to knock down the wall by leaning against it. With regard to access other than by the proper entrance, he had in mind a sub-station where the door was carefully locked, but the windows, three feet from the ground, were left open. The portion of the regulation with regard to interfering with the apparatus from the outside did not mean that they should not handle the switches from the outside. It was merely framed to prevent unauthorised interference. It had also been objected that the last provision, "shall be kept dry," could not in many cases be observed, and that it was impossible to keep some sub-stations dry, especially if they were underground, and that the words "as far as practicable" should be added. He did not, however, think that this was necessary or even desirable. While admitting that some sub-stations could not be kept dry, there was an alternative in the fourth exemption, namely, that if the sub-stations could not be kept dry they should take whatever precautions might be necessary. This might involve the use of gloves for handling the apparatus.

Regulation 32.—Every sub-station shall be under the control of an authorised person, and none but an authorised person or a person acting under his immediate supervision shall enter any part thereof where there may be danger.

Mr. Ram said there were many cases in which electrical supply authorities have similar regulations of their own.

Regulation 33.—Every underground sub-station shall be provided with adequate means of access by a door or trapdoor, with a staircase or ladder securely fixed, and so placed that no switchboard or bare conductor shall be within reach of a person thereon: Provided, however, that the means of access shall be by a doorway and staircase if (*a*) any person is regularly employed therein, other than for inspection and cleaning; or if (*b*) there is moving machinery therein, other than ventilating fans; or if (*c*) there is extra-high pressure therein.

An amendment had been suggested in regard to the first sentence, which he was willing to adopt, viz., that between the words "no" and "switchboard," the words "live part of should be put in.

At the close of Mr. Ram's examination-in-chief, it was decided that cross-examination should be first directed only to Regulation 17.

MR. VESEY KNOX, K.C., on behalf of the Newcastle Electric Supply Co., put a large number of questions tending to prove that the sub-stations of this company in the past was of a much more satisfactory and safe nature than any constructed under the proposed regulations of the Home Office would be. A plan of a sub-station built by this company was placed before Mr. Ram, in which it was shown that there were brick partitions and a hand-rail for the protection of the workmen, but in consequence of this the width of the passage way was reduced below the four feet for extra high pressure boards referred to in the regulation. Mr. Ram admitted that this form of construction was, if anything, safer than that provided for in the regulation, but refused to admit that the effect of enforcing the regulation would be to develop a design of switchboard which would be less safe than that now in vogue, and yet at the same time to enable the electrical supply authority to escape conviction. Asked as to his attitude towards such a sub-station built in the future, Mr. Ram said that he would consider it on its merits, and would probably agree to it. To his questions as to why, therefore, Mr. Ram wished to impose Regulation 17 upon the Newcastle Electric Supply Co., Mr. Vesey Knox could obtain no satisfactory reply. Mr. Vesey Knox therefore suggested that the regulation in question should stop at the word "floor," leaving out the prescribed limits. On the question of as to what is the best form of switchboard in practice, Mr. Ram said he preferred brick-chambers and expanded metal doors, with arrangements to isolate switches to enable the current to be cut off before the door could be opened. He believed such an arrangement as this had been installed in the sub-stations of Messrs. Armstrong, Whitworth & Co., in the Newcastle district.

Lord ROBERT CECIL, K.C., M.P., on behalf of the London electric supply companies, elicited the expression of opinion from Mr. Ram, that in the case of practically all existing London stations, none complied with Regulation 17, and counsel suggested, as a very good way out of the difficulty, the exemption of all these stations from the clause.

Further questions were put to Mr. Ram on behalf of the municipalities owning electricity works, to the effect that the same condition of affairs applied, and photographs of a switchboard at Glasgow were shown to illustrate this. In this case Mr. Ram said that he would require additions to protect men from accidental contact with the conductors in the passage-way. He admitted that, by the regulation all high-tension sub-stations would have to be a minimum of 8 ft. in height, and that this was not obtainable in many sub-stations. He realised a difficulty in this matter.

MR. SYDNEY MORSE, who represents a large number of supply companies, also asked that the figures and dimensions should

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be omitted from Regulation 17, and that the undertakers should be left to provide "ample" passage-way. He also suggested the addition of the words "so far as is reasonably practicable," at the head of the whole set of regulations, making it apply to everyone. As an example of the difficulties which would be encountered under Regulation 17, as at present drafted, Mr. Morse instanced the generating station of the North London Railway Co., the switchboard of which backs on to the retaining wall of a public road, thus making alterations to the width of the passage-way on the switchboard impossible.

Dr. OLIVER, F.R.C.P., was called to give evidence in support of the fixing of the voltage limits at 130 volts continuous, and 75 volts alternating. He said he was the editor of a book on "Dangerous Trades," and had been a member of one of the Home Office committees which dealt with dangerous trades. His view was that there was considerable danger, both from the point of view of life and limb, between the voltages mentioned in the regulation and the pressure of 250 volts preferred by the objectors, although several factors were responsible for the degree of danger, such as the contact between the person and the current, and the condition of health of the person. He had seen rabbits and dogs killed by quite low pressures. In his judgment, the voltages selected by the Home Office were the best. Cross-examined by Lord Robert Cecil, witness stated he had never seen a case of human death by electric shock, and, although one or two cases of burning had come under his notice, he was unaware of the conditions. He thought it possible, by prolonged contact, that the pressures proposed in the Regulations might be dangerous.

THURSDAY, MARCH 5TH. THIRD DAY.

Mr. GRAY, referring to Exemption (*b*), said that in reference to the addition of the words: "or traction under statutory powers," which satisfied the objection of tramway companies, it had been represented to him that there were certain railway companies who generated electricity for the purposes of traction, who would not be covered by these words. He therefore proposed to add after the word "powers," "or for railway purposes." They had not had sufficient time to consider the point thoroughly, and it was quite possible that some modification of this might be necessary to meet the case.

Mr. F. W. FIRTH, electrical engineer to the Great Eastern Railway Co., asked whether this condition only related to traction purposes, and not to lighting and applications of power generally on railway premises.

Mr. GRAY said the intention was to apply the words to every application of electrical power by railway companies, but on the suggestion of Mr. Swinburne the exact wording of the alteration was adjourned.

Mr. RAM'S cross-examination was then continued by

Mr. A. M. SILLAR, representing a number of small electric lighting companies, asked that Exemption (*e*) should include the large number of small switchboards in existence, which were only sufficiently away from the wall to allow the terminals to be got at. Under the definition, these small spaces would become passage-ways, although they were never used as such in fact. In common with other objectors, Mr. Sillar asked that all reference to dimensions in Regulation 17 should be deleted. Mr. Ram replied that this question of dimensions had been very carefully discussed since yesterday, and he could say no more at the present moment than he had already indicated. At the same time he promised to consider the question further in the light of the cross-examination.

Mr. W. B. WOODHOUSE, for the Yorkshire Electric Power Co. and others, put the case to Mr. Ram of a two-storey sub-station on a consumer's premises, with the transformers on one floor and the meters, &c., on the other floor. The sub-station was locked up, and nobody entered it with the exception of the company's servants. Did the floor which contained the apparatus come within the definition of sub-station, and receive the benefit of Exemption (*e*)?

Mr. RAM thought the portion of the building in question would certainly be regarded as part of the sub-station.

Mr. COZENS-HARDY, who appeared for a number of factory owners, asked for an alteration in the definition of passage-way in the case of small boards, so that the small space usually available for a man to put his arm behind to get at the terminals should not come within the definition.

Questions were next asked on behalf of the WESTMINSTER CITY COUNCIL with regard to the evidence and accidents upon which the regulations were based, and also for a statement of what electrical accidents had been dealt with in the past by the Board of Trade, and those dealt with by the Home Office.

Mr. GRAY, on behalf of the Home Office, replied that he did not intend to rely upon the frequency or scarcity of accidents in relation to the formation of these regulations, and his advisers were not desirous to give them, as they felt it would only tend to lengthen the inquiry without assisting the Commissioner in any way.

Continuing, Mr. GRAY gave some particulars with regard to the dimensions specified in some foreign regulations. The French regulations, he said, prescribed that for high pressure the width of the switchboard passage-ways shall be one metre, and the height two metres, and that there shall be a locked door. No dimensions were given for low pressure. These regulations were published in July, 1907.

In the German regulations, the width was fixed at one metre and the height at two metres. If the wall had naked conductors the passage must be two metres wide, and the space must be divided by a railing.

The Swiss high-presure regulations stipulated that the height should be two metres 20 centimetres, when there were conductors on the ceiling, and two metres when there were no conductors there. The width for high pressure was one metre, and for low pressure 80 centimetres. When no conductors were on the wall, the width for high pressure was one metre 50 centimetres, and for low pressure one metre 20 centimetres.

The advisers of the Home Office, continued Mr. GRAY, regarded these dimensions as too small, but nevertheless it was thought that this information should be in the hands of the objectors. All the regulations referred to were Government regulations, and low pressure was defined as 600 volts continuous current, or 150 volts alternating current, high pressure being all pressures above these.

Mr. RAM, re-examined, said he had based his figures in Regulation 17 upon the report of the Dangerous Trades Committee, and also upon examples of switchboards which he had seen. Existing works were sufficiently safeguarded by the exemptions, but it was necessary that there should be uniformity of practice with regard to future works, and the dimensions given in his opinion would ensure safety from danger so far as this can be done by spaces. The Newcastle sub-station referred to on the previous day would come under Exemption *e*, but he could conceive cases in which such a form of sub-station might not. With regard to the sub-station mentioned belonging to the Glasgow Corporation, this would not come within the exemption without additions, but these would not be impossible to make, nor would they involve a great deal of expense.

Mr. SWINBURNE asked for a definition of the legal position with regard to Regulation 17. For instance, suppose a switchboard put up by the Newcastle company, in the manner indicated, which was apparently safe, but did not conform with the regulations. Had the person putting it up to write to the Home Office and get sanction, or had he to wait until some criminal proceedings were taken? If he had to write to the Home Office and get sanction, was the Home Office going to have a number of people to deal with these matters? If the occupier did not write to the Home Office, he apparently would work the switchboard not complying with the regulations at his own peril. There were two cases in which an occupier might be prosecuted by the Home Office. First, if an accident happened, and again if the switchboard did not comply with the regulations. What would the position of the occupier be if an accident occurred in a case, first, where the occupier had sent to the Home Office, and came under Exemption (*e*), and, secondly, in the case where the occupier might come under Exemption (*e*), but had not referred to the Home Office for sanction?

Mr. GRAY said that the Home Office had discussed the whole of this question, and he would like to state what the practice would be. A factory inspector visited all works periodically, and the practice in this case would be that if the inspector thought the switchboard did not comply with the rules, he would tell the occupier that it must. The occupier would appeal to the electrical inspector, and if it was possible, the electrical inspector would give a certificate that the works came within the Exemption. But supposing it was impossible for the electrical inspector to give a certificate to this effect, notice would be given to the occupier to make such alterations as were necessary to bring it within the exemption, and if this were not complied with, whether the prosecution was as the result of an accident, or by reason of non-compliance, the person being prosecuted would have every opportunity at the criminal proceedings of satisfying the magistrate that whereas he did not, as a matter of fact, comply with Regulation 17, he had taken such precautions as, in his opinion, created a condition of things less dangerous than if he had complied with the regulation.

Lord ROBERT CECIL said he was not satisfied with an explanation of what the practice would be, but preferred to know exactly the legal position of an inspector under the circumstances in question.

Mr. SWINBURNE suggested that the matter might be left over for the present. He wanted to know what the law was, and what was the exact position with regard to responsibility of the man who put up a switchboard in the manner mentioned.

Lord ROBERT CECIL proposed that a statement with regard to the law on this point should be made so that the objectors and the Home Office could agree. He complained that the rules gave very great powers to the Home Office, and the objectors were asked to believe that the practice of the Home Office would not be so stringent as their regulations.

Mr. GUTTRIDGE, on behalf of the London County Council, said that the question of civil action in relation to accidents in works in consequence of the existence of Regulation 17 must also be taken into account.

Mr. W. H. PATCHELL was then called in support of Regulation 17. He said he had been a member of the Committee

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appointed by the Home Office in 1903 to consider the application of electricity in mines, and the same difficulty with regard to fixing definite spaces for switchboards had been encountered. Definite distances had, however, been set down, and in practice he was not aware that it had given very much trouble. They certainly caused him some anxiety at the first in a case where the switchboard was absolutely enclosed, and he did not know what construction to place upon the rule in regard to how the distance was to be measured, namely, from the live metal to the side of the passageway or from the door in front of the compartment. It was decided, however, that the measurement should be taken from the live metal inside. Generally speaking, he thought it would be a very great assistance to have definite dimensions in the regulation, although he recognised the difficulty with regard to existing works. He thought the owners of such works could fall back upon the exemption.

Cross-examined by Lord ROBERT CECIL, who asked for the words "as far as reasonably practicable" to be made applicable to all the regulations, witness expressed the opinion that the exemptions would have the same effect. He agreed that the Coal Mines Regulations left all existing apparatus untouched until an inspector directed a change to be made, and in these circumstances the owner was given the right to appeal to arbitration. This regulation had been dratted in view of the fact that there were at that time very few installations in mines. He could not see that this was an unreasonable provision in respect of central station switchboards.

Mr. VESEY KNOX reminded Mr. Patchell that under the Coal Mines Regulations an exemption from the Secretary of State was a bar to prosecution. Mr. Patchell also agreed that the mining rules were also drawn up mainly from the point of view that the persons in charge of electrical machinery in mines had not had very great experience, a condition which did not apply to ordinary central stations.

In reply to Mr. PRITCHARD, on behalf of the municipalities, Mr. Patchell agreed that there was no exception in the Mines Regulations as to bare conductors on both sides of the switchboard, but the conditions were somewhat different in the mine. He thought the dimensions in the regulations were reasonable for new work. A suggested alteration to the definition of "passage way," namely, "Way intended for passage of persons engaged in the operation or control of the switchboards," Mr. Patchell saw no objection to.

Mr. ALEXANDER SIEMENS, for the Institution of Electrical Engineers, suggested an alteration in the definition of "passage way," by adding, "unless the same is made inaccessible by a wall or a door which can only be opened when the board is dead, except by an authorised person."

Mr. COZENS-HARDY suggested an addition to this definition which would make it not applicable to low or medium pressure boards. Mr. Patchell disagreed with this.

Mr. W. B. WOODHOUSE asked if it were not possible that, in trying to follow these rules, the design of switchgear might be made more dangerous. He put a specific case of a certain kind of switchgear, in which all live parts behind a panel, which was two or three feet wide, were made live through fuses at the top about six feet high, there being live metal behind and a handle in front. This was in a mine, and the inspector under the Coal Mines Regulations insisted that either the panel, which was three feet wide, should be moved a distance to allow a three feet passage way, or that each end of the panel should be protected by a door which could be opened on the inside without a key. Very considerable expense was thus incurred without additional safeguard, and the result was that all live metal was removed to the front of the board, the fuses were placed within 2 ft. of the ground, and the operator had to operate a switch with live metal within a few inches of his hand, not protected by a slate panel as before.

In answer to further questions, Mr. Patchell agreed that so far as he was concerned, a memorandum from the Home Office indicating what should be done would be sufficient, but he did not think it safe to rely upon this method for all cases.

Mr. H. M. SAYERS, for the Tramways and Light Railways Association, pointed out that these rules would, when they came into operation, be applicable to coal mines, and would presumably supersede the Coal Mine Regulations now in force. Asked as to whether he thought this would be an advance, Mr. Patchell said he did not know.

Mr. J. F. C. SNELL, called on behalf of the Home Office, said he entirely agreed with Rule 17. While recognising the difficulty of fixing definite figures, he considered a high standard of work was set by these regulations. He had come across several low-pressure boards where at the back there were resistance frames, or cables on the floor, all of which had formed obstructions which were undesirable, and which were not indicative of good design. With extra high pressure boards, it was not unusual to find transformers placed in a position where they formed an obstruction to the passage way. He entirely supported Mr. Ram's conclusion that the passage way should be clear and unobstructed. If any works could not be made to comply with the regulations, they should be reconstructed, but he thought such cases would be very few. In two cases, recently, of electrical design with which he was concerned he had adopted very nearly these dimensions before the regulation was drafted.

In answer to Lord ROBERT CECIL, Mr. Snell stated that one of these cases was a high-pressure board, in which, although the bus-bars and all live parts were contained in cubicles and further protected by iron doors, he allowed 4 ft. 6 in. between the wall and the iron plate forming the cover of the cubicle. So far as he was concerned, he saw no objection to the introduction into the regulations of the Coal Mines regulation which stipulates that existing apparatus shall be left unless an inspector otherwise directs.

In answer to Mr. Vesey Knox, Mr. Snell stated that he did not think any of the sub-stations designed by himself during the past three years would not comply with the dimensions in the regulations.

Mr. A. SIEMENS, on behalf of the Institution of Electrical Engineers, suggested an alteration in the wording of Regulation 17, to provide for switchboards which are fitted with doors or other devices which cannot be opened whilst the switchboard is live, except by an authorised person. Mr. Snell thought Exemption *e* provided for such cases, and if they were to put every specific case into the regulations, then it would make them too long and burdensome.

This closed the case for the Home Office in regard to Regulation 17.

It may be pointed out that the comparatively small amount of cross-examination is due to an intimation from the Commissioner that the fact of an objector not having cross-examined, will not tell against him, as the cross-examination that has taken place will be considered in favour of every objector who had lodged objections. This course has been adopted owing to the large number of similar points covered by different objectors.

The case for the opposition to Regulation 17 was opened by Lord Robert Cecil, on behalf of the London Electric Lighting Cos.

Mr. C. P. SPARKS, Chief Engineer to the County of London Electric Supply Co., said that his principal objection to Regulation 17 was that its application would necessitate expensive alterations from the low-pressure point of view. He was quite certain that it would make structural alterations necessary, which it would be physically impossible to comply with. With high pressure and extra high pressure the difficulties might not be so great. As an instance of his objections, Mr. Sparks produced a section of the sub-station belonging to the Richmond (Surrey) Electric Light & Power Co., which supplies direct current upon the three-wire system at 110 and 220 volts, and power at 220 and 440 volts. The distance from the back of the switchboard to the wall was 3 ft., but taking into consideration the bus-bars the clear space was 2 ft. 4½ in., and between the bus-bars and the brick buttress there was only 2 ft. clear space. It was physically impossible to increase these measurements. There had been no accident on this board, and in his opinion it involved no danger. The station had been in existence for 17 or 18 years; the width of the engine-room was 22 ft. 9 in., and the distance from the front of the board to the pedestal of the machinery was 4 ft.; thus it was impossible to bring the board further out, and to set it further back would involve the reconstruction of the buildings, as the boiler-house adjoined. They had no powers to acquire land compulsorily, so that if these regulations were enforced upon them, they would have to do so by agreement with owners of the adjoining property, in which case a very prohibitive price would have to be paid. He did not agree that the occupier was sufficiently protected by the exemption, and he did not think he personally could bring his stations within Exemption (*e*). The ordinary factory inspector took a very narrow view of things, and naturally would not take the responsibility of giving the owner the benefit of the exemption. He was of opinion that the Coal Mines Regulation, to the effect that the existing precautions might be continued until an inspector directs otherwise, ought to be put into these regulations. His opinion was that a coal mine inspector was a very much more specialised individual and of a far higher calibre than an ordinary factory inspector, and seeing that an appeal was allowed in mines, he thought the case for an appeal in the case of the present regulations was much stronger.

Cross-examined by Mr. GRAY, he stated that he saw little to object to with regard to the dimensions in the regulations in their application to new work. Concerning existing work, he could not accept the assumption that the regulations would be administered reasonably from his point of view, as he could not conceive a sufficiently broad-minded inspector to take the responsibility of giving him the benefit of the exemption. He believed it would be practically impossible to convince an inspector that a station could be made equally safe even if it did not comply with the regulations. He was quite convinced that if the regulation came into force the board at Richmond would have to be reconstructed. The only way in which the board could be made to comply with the regulation was to have a remote control switchboard, for medium pressures, which would be too expensive.

Mr. C. H. MERZ, for the Newcastle Electric Supply Co. and the two Durham power companies, said that by enabling electrical engineers to design switchboards upon certain lines, it was possible to supply electricity economically at very low prices, but if restrictions were to be placed upon them in relation to their design, the cost of these boards would be increased and all the advantages of cheap electricity would disappear. The companies which he represented supplied about 130,000 to 150,000 h.p. of motors, and the capacity of their ninety-six sub-stations

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was about 100,000 kw. New sub-stations were being erected at the rate of 30 or 40 a year, and he regarded the setting up of dimensions, as proposed, a backward step. If Mr. Ram meant that a space of 4 ft. from the wall of a cubicle on a switchboard with isolating switches and a door would comply with the regulations he thought that would get rid of many objections, but it was not in the regulation. The Home Office had suggested that nobody but themselves cared for the safety of the workmen. As a matter of fact, all designs were looked at from the point of view of safety to workmen, although more or less linked up with this was the question of security of supply. If the Home Office wanted the greatest safety, then they had specified the wrong thing in these regulations. If there was one thing necessary in extra-high tension work, it was that each panel should be entirely separate. This was far more important than that any passage should be 2 or 4 ft. wide. Personally he would specify absolute clear sub-division of panels, and clear means of indicating which panel a workman was at work on. The design of sub-stations was developing and improving, and the fixing of specific dimensions was the wrong way for getting safety. Mr. Ram had expressed a preference for iron sheets under isolating switches. The Newcastle Co. had, as a matter of fact, abandoned this method because they considered it was more a source of danger than the reverse. Another important point not mentioned in the regulations was the space between poles. These things were much better discussed whilst looking at the actual boards, and he would therefore like the Commissioner, if it were possible, to pay a visit to some of the Newcastle sub-stations. A special objection related to the electrochemical industry, namely, whether these regulations were necessary below 250 volts. The Castner Kellner Alkali Co., which took current from the Newcastle Co., used a great many bare wires which they were afraid might be claimed as part of the switchboard, and in that case the limit of low pressure was too high to exclude them from the regulations. He thought it would be only fair to say that electrochemical works below 250 or 500 volts should be excluded.

In cross-examination, Mr. Gray pointed out that Mr. Merz, on the point of separate panels, had overlooked Regulation 18 (*d*), which provided for these. Mr. Merz replied that this regulation did not go far enough, which emphasised his point as to the objection to regulations upon specific details. To deal properly with this point alone, would require a four-page specification. The only reason he could give for wishing to have the dimensions in was that it made the regulations intelligible to the inspector. He agreed that 3 ft. was a safe width for a passage-way, if the switchboard was properly designed in other respects.

Mr. W. W. LACKIE, Chief Electrical Engineer to the Glasgow Corporation, gave particulars of one of his boards, in which the total space from the back of the switchboard to the machines was only 4 ft. 6 in., whereas to carry out the regulations there should be 17 ft. under the conditions prevailing. The present arrangements had been in existence for some years, and had been perfectly safe. He had made an estimate of what it would cost to absolutely comply with the regulations, and it would involve the abandonment of two sub-stations containing 9,000 kw. of plant at an expenditure of £120,000. He agreed with the previous evidence that it was unnecessary to define dimensions.

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Mr. LACKIE handed in further photographs of the Waterloo Street and St. Andrew's Cross sub-stations, the switchboard conditions in both of which he said would not comply with Regulation 17.

In cross-examination, Mr. Lackie stated that the floors of the switchboard galleries were made of glass, and there were a number of holes about one foot square through which the 250-volt bus-bars passed. He regarded these conditions as absolutely safe, although a man would get a shock if he put his foot on the metal work of the board, and touched one of the bus-bars at the same time. He thought the boards were safer than they would be if constructed under Regulation 17.

Mr. GRAY: Then you would come within the exemption?—But I do not come within the rule.

Discussion took place between Counsel and the witness as to what alterations could be made in the event of an inspector certifying that these boards did not comply with the regulation. Mr. Gray suggested the arrangement of the bus-bars in the same plane along the passage instead of across it. Mr. Lackie objected to this on the ground that where the bus-bars came under the board, they would have to be crossed, which would introduce an element of danger in cleaning, quite apart from the question of expense. Objection was also taken to Mr. Gray's suggestion that the bus-bars and other live metal could be covered, on the ground that this would interfere with efficient cleaning. Of course, said Mr. Lackie, if the bus-bars were covered with insulation, they might be made safe in that way.

The question was then discussed of making rheostat contacts safe by protection. Mr. Lackie argued that any form of covering would hide the contacts from the operator, thus preventing him from knowing when they were working properly.

So far as getting over the difficulty of bare conductors was concerned, of course, a glass plate could be placed over the rheostat. Various suggestions by Mr. Gray as to guarding the machinery in the sub-stations, which are very close to the switchboards, were agreed to by Mr. Lackie in so far as they were possible, but he would not accept the suggestion that the degree of security afforded by these methods would be commensurate with the expense involved. A suggestion by Mr. Gray that the St. Andrew's Cross sub-station switchboard could be raised, and so made to comply with the regulation, was met with the answer that this would necessitate an alteration in the position of the travelling crane. In many cases Mr. Lackie agreed that, whilst the covering up of the bare conductors might make things safer from the point of view of workmen, there was a strong possibility of introducing extra risks of fire.

Mr. SYDNEY MORSE here suggested that Rule 55 of the Coal Mines Regulations should be adopted by the Home Office; such an action would, he said, considerably shorten things from his point of view, and possibly from others. This rule read as follows:—

"Notwithstanding anything contained in these rules, any electrical plant or apparatus installed or in use before the coming into force of these rules may be continued in use unless an inspector shall otherwise direct, or subject to any conditions affecting safety that he may prescribe.

"In case any difference of opinion shall arise between an inspector and an owner under this rule, the same shall be settled as provided in Section 42 of the Coal Mines Regulation Act, 1887."

Mr. SWINBURNE said that it appeared the objectors were running two cases against Rule 17. First, that there should be no dimensions, and, secondly, that it did not include an exemption for existing work. He suggested that some addition might be submitted by the objectors, which would definitely lay down when an existing station was complying with the regulation without having recourse to the inspector.

Mr. A. A. CAMPBELL SWINTON, by agreement, gave evidence at this stage, in the interests of 42 stations supplying electrical energy under Provisional Orders, including the whole of the Edmundsons' group. Regulation 17, he said, affected small concerns much more than larger ones, on account of the very unsatisfactory financial position of such undertakings. The question of safety, he said, was a comparative one, and personally he preferred to have bare live metal about a station, with strict instructions to the workmen as to the nature of the place in which they were working. He had a 10,000-volt battery in his own office, and no precautions were taken in the way suggested by these rules. In reply to Mr. Gray, Mr. Swinton said he had no objection to the rules for new work.

Mr. H. TALBOT, President of the Incorporated Municipal Electrical Association, and Chief Electrical Engineer to the Nottingham Corporation, supported the previous evidence as to deleting the dimensions from Rule 17, and asked for a complete exemption for existing work. He preferred to have the passage-ways about a switchboard as narrow as possible, so that they would not be used by the workmen except for the purposes of their work. When these passage-ways were made too wide, the workmen frequently made use of them as a short cut for leaving their work at night, and so on.

Mr. GUTTRIDGE, on behalf of the London County Council, expressed his intention of not calling evidence, but of relying on the view already expressed by other witnesses.

Mr. W. B. WOODHOUSE, for the Yorkshire Electric Power Co., did not call evidence, but drew attention to a type of switchboard not already mentioned, namely, remote control extra high tension switchgear. On these boards they had direct current, and two alternating-current systems in close conjunction with each other. The point that he wanted to make was that the standard voltage for alternating-current instruments transformed from extra high tension would bring that type of board under Section 17. It would be difficult to make such a board conform with Rule 14 (c) or 18 (d). Further, some types of remote board were almost horizontal, and it was difficult to see how this type of board was going to be treated under Section 17.

Mr. RAM was then cross-examined with regard to Rule 12.

In reply to Mr. Vesey Knox, he stated that he was informed that no-voltage releases for alternating-current motors were on the market, and that several were in use.

Mr. VESEY KNOX stated he was instructed that there was no standardised article to be obtained commercially which would comply with the requirements of this rule in the case of a single-phase motor.

In the course of further questions, Mr. Vesey Knox put the case of a three-motor crane used in dock work, with a competent man constantly in charge. Was it not sufficient if this man had means ready at hand to turn off the current in case of need? Mr. Ram thought the man might forget to do so.

Asked as to accidents which had led him to draft this rule, Mr. Ram mentioned the case of a printing machine motor in which the current failed, and the machine stopped. Whilst the electrician on the premises was putting in new fuses, the machine operator thought he would take the opportunity of getting into the machine to oil the bearings, or something of that sort. He had forgotten to turn off his switch, and the man replacing the fuses, which were in another room, gave no warning that he had done so. The result was that the motor

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started, and the operator was caught in the printing machine and killed. He had formed no estimate as to what the cost of fitting such a device on motors would be, but it might vary, according to the size of the motor, from 10s. to £10. With continuous-current machines it would not add 10s. to the cost of the starting switch. He admitted that he had never seen a no-voltage release for alternating currents, but he had been invited to see several in operation.

Mr. VESEY KNOX pointed out that the rule would make failure to use this piece of apparatus, which Mr. Ram had never seen, a criminal offence.

Further cross-examination elicited the information that the regulation did not necessarily mean that every motor should have such a release. One might do for several motors, and certainly, in the case of a three-motor crane, one would do. In fact, he saw no reason, according to circumstances, why one release should not do for all the motors in one room.

As a further justification for enforcing this rule, Mr. Ram referred to the Institution of Electrical Engineers' Wiring Rules 91*f* and 91*h*, of the 1907 edition, which require automatic releases on both alternating- and continuous-current motors.

Mr. VESEY KNOX pointed out that this was not a compulsory rule, but was merely a suggestion for guidance, and there was a permanent committee which made alterations from time to time. The Home Office Regulation was one which could not be altered except under a procedure involving an inquiry if there was opposition.

Mr. SYDNEY MORSE raised the question as to whether the size of the motor should be one-third horse-power as the minimum. He thought this was much too low, but was prepared to leave this to the Commissioner.

Mr. ALEXANDER SIEMENS asked Mr. Ram if he could not accept the suggestion of the Institution of Electrical Engineers, namely, to add "unless the motor is automatically prevented from re-starting."

Mr. RAM thought it possible that this might be accepted.

Mr. SIEMENS, in the course of a few further questions, indicated that in his opinion to put a no-voltage release into the circuit was the same as putting in another fuse, and taking Mr. Ram's instance of the printing machine fatality, he argued that if the man who had put in the fuses had replaced the automatic cut-out, also without warning, the accident would have happened all the same.

Mr. COZENS-HARDY pointed out that there was a very distinct objection to having a no-voltage release on a lift.

Mr. RAM thought a sufficient case could be made out in regard to lifts to secure an exemption. A suggestion by Mr. Cozens-Hardy that the automatic no-voltage release might be on the distribution board ten minutes away from the lift-man, was not assented to.

Mr. RAM gave, as an example of why this rule would be useful for cranes, the case of a man operating an overhead travelling crane. The current came off, and not knowing what was the matter, he got out of his cage and began to crawl along the gangway to get down to ascertain the cause of the stoppage. In the meantime the current came on again, and having forgotten to leave his controller in the "off" position, the crane started, caught him up, and crushed him. Had there been a no-voltage release, that would not have happened.

As an instance of the saving of time which the use of no-voltage releases would effect, Mr. Ram mentioned that one power company in this country, which did occasionally have an interruption of supply, had made it a rule that their consumers, in the case of interruptions, should not expect the supply to be resumed in less than eight minutes, as it took that time to go round and pull off the switches. If automatic switches were used a considerable saving in time, and consequently in money, would be made.

A series of questions were put by Mr. Cozens-Hardy with regard to what might happen if Mr. Ram's suggestion that one release would do, in the case of small factories, for the whole of the installation were adopted. He contended that the danger would be as great, if not greater, than if there was no automatic release at all. The point he wished to make was that Mr. Ram's argument that the expenses would not be great did not hold, for the reason that in his view, to carry out the regulation an automatic release must be put at every switch, otherwise the regulation was useless. Mr. Ram said a warning would have to be given when the no-voltage releases were replaced.

Mr. W. B. WOODHOUSE suggested that the extra cost of motors, in consequence of this regulation, would tend to prevent the use of electricity. In other words, the keen competition between various forms of power would turn the balance against electricity by the extra capital cost of the motors. Taking the instance mentioned by Mr. Ram of the printing machine, he argued that this was really a case for fencing the machinery to prevent the man from getting into it. Mr. Ram refused to admit this contention for the reason that, in his view, the no-voltage release would have acted, and the operator would have been given warning when the current was on again. That was the object of the regulation.

Mr. WOODHOUSE next took the case of textile mills with a steam engine driving long lines of shafting fitted with fast and loose pulleys for operating the various machines. He said that no regulation had been made to prevent injury to the work-people by the sudden stopping of the steam engine, and it frequently happened that the engine stopped and was started again without any warning. The only rule was that whenever the main shaft stopped, the operators were to put their belts on to the loose pulley. From this he argued there was similarly no need for the operator of an electric motor to be further protected in a case of stoppage of current, than being instructed to put his switch in the "off" position. In fact, he said, this was a machinery trouble, and not an electrical one. Continuing, Mr. Woodhouse stated that in the case of a shunt motor, these devices had been fitted as a precaution to the motor itself, not to the workmen, and therefore to say that because they were fitted to continuous current motors they should be fitted to all motors, was not a good argument.

As a result of further discussion, Mr. Ram said that in the case of the cranes which he had mentioned, he believed that a system had now been adopted by which the man could not leave the cage of the crane except by opening a door, and this door opened the switch. Such a device, he said, would get the benefit of the exemption.

Mr. WOODHOUSE, as a further illustration of the hardship of enforcing this regulation in all cases, mentioned a pump filling a tank in which a float at a certain level of the water operated a switch which shut off the motor. He saw no reason whatever for putting upon them expense of this no-voltage release in such instances.

Mr. A. M. SILLAR asked that the rule should not be made to comply to such classes of machinery as capstans, cranes, &c. In the case of a capstan, no possible harm could be done, as the moment the operator took his foot off the treadle, the motor stopped. So far as cranes were concerned, he thought they were much more safe without no-voltage releases.

Mr. RAM: Then if you satisfy the inspector on this point, you come under the exemption?

Mr. SILLAR: Yes, but who is to determine this point?

In re-examination, Mr. Ram proposed that the rule should be altered to read "either switch off the motor, or stop the machinery." This alteration was made to prevent the interpretation of the rule that in the case of machinery which had large momentum and would continue to revolve after the current was shut off, the owners should not provide a brake.

Mr. VESEY KNOX, reverting to the point that the rule need not necessarily mean that one release should be fitted to each motor, said that the view of his advisers was that there should be either one to each motor or none at all, and that in the former event the cost would be prohibitive.

Mr. W. H. PATCHELL was then called with regard to the use of no-voltage releases for alternating current. He had used them on 440 volts and 2,000 volts in each case successfully, but not for very small motors. The expense was certainly an item, and a bar to their use with regard to small motors. This, therefore, would be met by grouping the motors, which he understood the Home Office would accept; otherwise the apparatus would cost as much as, if not more than, the motor which it was to control. Such a piece of apparatus was quite commercial, and he had tried several kinds from various makers. There was a German one sold in England by the Union Electric Co., which had been very successful, although others made in England had not been so satisfactory.

Cross-examined by Mr. Vesey Knox on the question of cost, Mr. Patchell said he could not state definitely because he had always had them combined with a maximum switch, but he thought that £6 or £7 would be substantially correct for large motors, but it was not commercial to supply them with small motors. Asked as to an instance in which a no-voltage release would have prevented danger, Mr. Patchell said he could call to mind no others than those mentioned by Mr. Ram.

Mr. WOODHOUSE pointed out that no provision for the use of these apparatus in mines had been made in the Coal Mines Regulations, and to this Mr. Patchell assented, but he said the fact that such a rule was necessary was proved by a case recently, in which a man had been caught in a coal-cutter through the current coming on suddenly.

Evidence was then heard against Regulation 12.

Mr. C. H. MERZ said he had 3,000 or 4,000 h.p. of motors connected to his mains, not one of which was fitted with the automatic release. He did not know of one in use anywhere in the world; he had never seen such an article, although he had been through America, Germany, and factories in many other places. Some ingenious person might have invented one, but the thing did not exist as a commercial article. The curse of the electrical industry was that so many fakes could be made. The industry had gone on very well in the past without these things, and seeing that the tendency now was towards fewer interruptions of supply than formerly, he failed to see the need for enforcing such a regulation now. It was quite clear that in such a factory as, for instance, a shipyard or marine engine works the grouping of motors and fitting of automatic releases would be absurd. There were in such factories sometimes mere momentary interruptions due to the local man in the switch-room manipulating his switches. With automatic releases fitted, there would be interruptions from this cause with the same effect as if there was an interruption of supply at the power

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station. Further, according to the regulations these releases would have to be fitted to motor-generators, which was very undesirable. If the appliance was to be fitted at all, it should be fitted to every motor, but this would be a serious matter financially, and would only introduce another possible source of breakdown. The feature of the alternating-current motor was that it was a machine, and not a piece of electrical apparatus, and that was why it was being so largely adopted. The great advantage of power supply was in the use of induction motors without slip rings.

Mr. Merz then made a few comments upon Regulation 4. Even as redrafted, he said, this might apply to isolating links which would be absolutely useless for breaking the circuit. If they omitted the words "intended to be used for breaking the circuit," this would meet his point.

Mr. Gray pointed out that it was the intention of the rule not to include isolating links.

Mr. Merz, continuing, thought that the rule should not apply to apparatus below 250 volts, and that the power should be limited to 100 h.p., or something of that sort. In a great many cases, switches upon switchboards were practically nothing more than isolating links, and they were quite satisfactory for small powers.

With regard to Rule 7, he thought this was not practicable. Having regard to the Board of Trade definition of the word "circuit," one lamp would mean a circuit. He asked that the regulation should end at the word "apparatus." For instance, winches in a shipbuilding yard would be compelled to have a separate switch for each circuit.

With regard to Regulation 8, the same argument applied. It might be right in small shops, because 750 watts was a very small power, but it was really not quite practicable in big shipyards.

With regard to Regulation 12, he objected to the second paragraph, and regarded it as almost unmeaning. Plugs were usually used upon the circuits in shipyards and the limit was too small. Great care was taken with disconnectors and plugs in shipyards on the Tyne, and there had been no trouble in using the switches.

Cross-examined by Mr. Gray with regard to Rule 12, Mr. Merz stated that the desirable thing for a man to do when operating a motor and the current failed was to put his switch off. So far as the manufacturing centres on the Tyne were concerned, it was not a very common thing for a man to walk into his machine when the power went off the motor. For instance, a man would not walk into the gear of a punching machine. He thought it was just as essential to have automatic means for putting the belts of individual machines on to the loose pulley if the gas engine or steam engine stopped, as it was to have an automatic switch on a motor. In the case of very complicated machinery, it might be necessary to have a no-voltage release, but as these only represented about 5 per cent. of the machines driven by motors, he thought it unfair to make rules for 5 per cent., and to which the other 95 per cent. not concerned had to conform. He thought that 5 per cent. was an excessive allowance as the number of alternating-current motors in use which ought to have such devices.

Mr. Gray: But up to what size do you allow induction motors to be set on to the mains without special starting devices?—We do not make any special regulations; we do not believe in hindering the use of electricity by regulations, and we therefore make none. What starting devices are used, are provided by the consumers themselves to prevent excessive rushes of current.

In reply to further questions, Mr. Merz stated that to have a no-voltage release on a long circuit as well as fuses, would be quite wrong practice; if they were going to have regulations that were stupid, let them be as little stupid as possible.

Mr. Gray: All this refers to your own works in which supply is very constant?—Yes.

But in other factories there are more frequent interruptions, for instance, where there is a private generating plant. Do not you think that in those cases automatic releases should be used?—Ninety-nine per cent. of the users of these motors have been using them for eight years in England and fifteen years in America, and in a sense you are putting upon us the onus to prove that they are not dangerous. I consider the rule is dishonest in its drafting for that reason.

Mr. Gray: You have been using some strong expressions, Mr. Merz; you first say that these rules are stupid, and then dishonest. Do you suggest that any of these regulations are put forward in any but a *bonâ-fide* manner?

Mr. Merz: I do not wish to use too strong expressions, but I think you know what I mean.

Mr. Gray: I am bound to say I do not. With all respect, you ought not to use such expressions with regard to any of these regulations.

Mr. Swinburne: Supposing, Mr. Merz, you have a motor of 50 or 100 h.p., and you have a choking coil in series for starting as usual. Supposing there is a stoppage due to the power station, when you start up again do you give them full volts at full frequency right off, or do you go up gradually from the low frequency to the high?

Mr. Merz: I should say that they would switch straight on as the only practical thing to do, and in the case of a large motor, unless it were driving a pump, probably the fuse would go, so that you really have a device equivalent to a no-voltage release. The bigger motors generally start with the load off.

The inquiry was then adjourned until Monday, March 15th.

THE ENGELBERG-LUCERNE 25,000-VOLT OVERHEAD TRANSMISSION

In a previous issue (*see* Electrical Engineering, Vol. II., p. 439) we gave a full description of the hydraulic works and power station recently established between Obermatt and Engelberg by the Lucerne-Engelberg Electricity Works Co., for the supply of power and lighting to Lucerne and the surrounding district. The following is a description of the high-tension transmission lines and sub-stations belonging to this company.

The main overhead line, which consists of nine copper conductors supported on a single line of steel lattice poles, runs from the power station near Obermatt to a sub-station at Steghof in Lucerne, and is 16·7 miles long. The nine conductors are utilised as follows: Three form a single three-phase circuit from the power house to Steghof for the power supply in Lucerne; another three form a three-phase circuit from the power house to the sub-station at Stansstad for the lighting and power supply in the Nid- and Obwalden districts, but are continued on to Steghof as a reserve circuit; two of the remaining three conductors are used for the single-phase lighting supply in Lucerne, and the remaining conductor is a reserve, and can be used in any circuit. The line is intercepted at three points—namely, at Wolfenschiessen, Stansstad, and Hergiswyl—for the double purpose of taking off power for the supply of the surrounding districts and for interposing section switches. At these three points all nine conductors are carried into massive stone towers which contain the section switchgear and the transformers for the local supply. From the station at Stansstad a branch three-phase line supplies the sub-station in the town of Stans, and another line which goes out from the station at Steghof supplies the sub-station at Kriens.

The main line crosses the Stansstad-Engelberg railway four times, and the Brünig railway four times. The general character of the overhead construction and the steel lattice poles themselves can be seen from Fig. 1, which shows a portion of the line in the neighbourhood of Steghof. The lattice poles here shown are embedded in the concrete foundations, and are spaced about 180 ft. apart. The cross-arms, which are of steel, support two vertical beams of impregnated oak, to which are fixed the iron pins of the insulators. The conductors are 40 in. apart. There are 469 lattice poles between Obermatt and Lucerne. The weight of each pole is about 1,750 lb., and the cost about £11. The cost of erecting the poles, inclusive of the material for the foundations, works out at about £12 per pole; this figure includes the additional expenditure due to the special construction along the base of the Lopperberg. The poles are earthed in the following manner: Every pole is electrically connected with a copper wire

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of 0·2 in. diameter which runs the whole length of the line, and every tenth pole is electrically connected to a copper plate, with a total surface of 10 square feet, which is buried at the foot of the pole. The telephone wires connecting the power station at Obermatt with the various sub-stations are also carried on these steel poles, and in order to avoid any disturbances, the two wires, which are of bronze and 0·12 in. in diameter, are crossed every 300 yards. These telephone wires can also be put in connection with the public telephone system, although it does not seem that any special precautions are taken to prevent accidental contact between the high-tension wires and the telephone wires.

Between the Stansstad sub-station and that at Hergiswyl the line runs along the side of the road at the edge of the Lake of Lucerne. On the one side of the road the rocky slope of the Lopperberg rises steeply, and on the other side is the edge of the lake, which rapidly deepens. The special construction shown in Fig. 2 was therefore resorted to. The lattice pole is fixed to a steel bracket, the end of which is embedded in a massive block of concrete, as shown in the diagram. The wall built over this block is to protect the pole from the boulders which occasionally roll down the side of the Lopperberg. The poles would have been placed at the edge of the road, but there was already a line of telegraph and telephone wires which could not be moved. In order to reduce the number of poles along this portion of the route, the average span was doubled, *i.e.*, 360 instead of 180 ft.

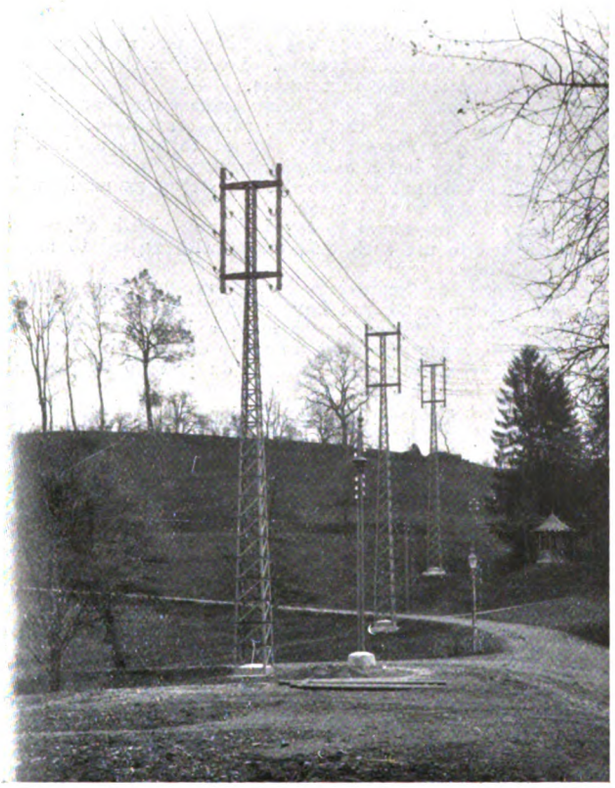


Fig. 1.—The Overhead Line near Steghof.

The transformer sub-stations at Wolfenschiessen, Stansstad, and Hergiswyl contain each one oil-cooled three-phase transformer with a capacity of 30 kw. These transformers transform down from the line pressure of 25,000 volts to a pressure of 350 volts. The secondaries are star connected, and the neutral point is earthed. Lighting is done between one phase and the neutral conductor, *i.e.*, about 200 volts across the lamps. The transformers are well protected against lightning, &c., and all the high-tension switchgear is arranged, as was described in the case of the switchgear in the power station, in fireproof cells.

The lightning arresters, which are of the horn type, are connected to earth through water resistances. The water is mixed with a little glycerine to prevent it from freezing in winter. The sub-station at Stansstad is larger than the other two, and contains, besides the small three-phase transformer for the local supply at 350 volts, two 250-kva. transformers which transform down from 25,000 volts to 5,000 volts. These last supply power, over the three-conductor line already mentioned, to the town of Stans. The town of Kerns also receives a supply at this pressure.

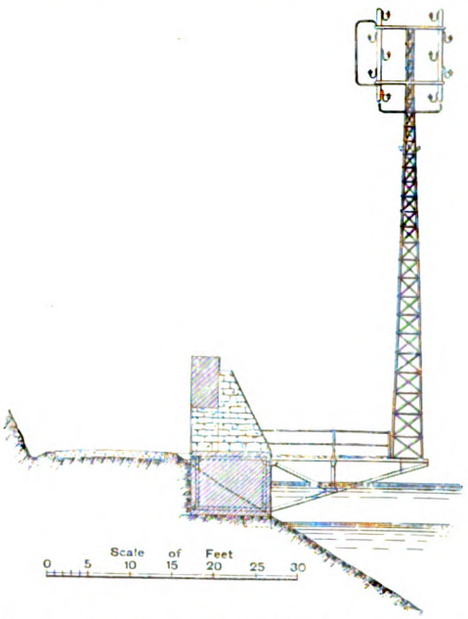


Fig. 2.—Lattice Poles and Bracket Construction along the edge of the Lake.

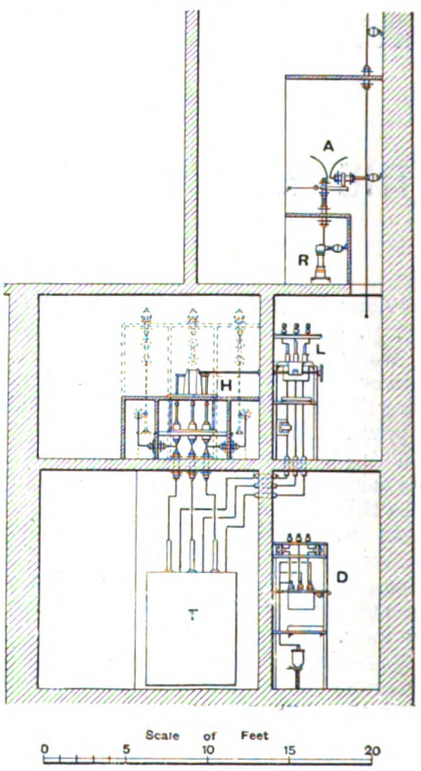


Fig. 3.—Section through the Transformer Sub-station at Kriens.

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The sub-station at Steghof for Lucerne is an extension of the old power station for the Lucerne tramways. This station contains the three-phase transformer plant for the power supply, the single-phase transformer plant for the lighting supply, and the motor-generator plant for the tramway supply. This sub-station contains, as do all the others, lightning arresters and other protective devices, also automatic oil-switches and other necessary switchgear. The transformers and switchgear are arranged in a similar manner to that at the power station at Obermatt. The pressure is transformed down from 25,000 volts to 2,650 volts, which is the pressure of the outgoing lighting and power supply cables. The lighting transformer plant consists of three 700-kva. single-phase units, exactly the same, as regards construction and method of cooling, as those described in the previous article (*see* Electrical Engineering, Vol. II., p. 445). The power transformer plant consists of three groups of three 300-kva. units arranged in mesh connection. The frequency of the supply is 50 cycles per second.

Room is provided for three motor-generator sets for the tramway supply, but only two are installed at present. The asynchronous three-phase motors are rated at 340 kw., 2,650 volts, 490 r.p.m., and are direct-coupled to continuous-current generators rated at 300 kw., 575 volts. A battery of accumulators situated in the old power station is used in parallel with these motor-generators.

As has been already mentioned, a high-pressure line, consisting of three conductors, connects the sub-station at Steghof with a sub-station at Kriens. This station

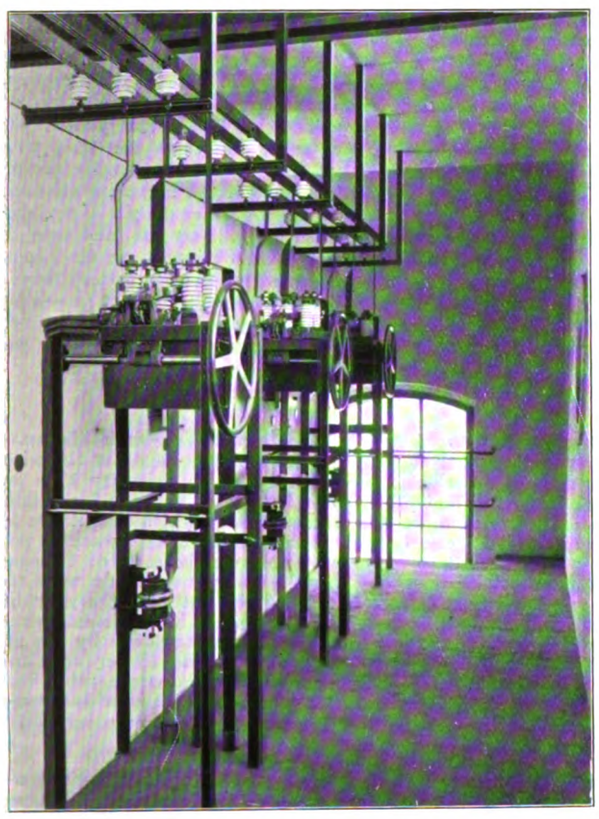


Fig. 4.—Low-tension Transformer Switchgear in Kriens Sub-station.

contains three oil-cooled three-phase transformers, rated at 450 kva. each, and transforming down from 25,000 volts to 500 volts. This sub-station is chiefly for the supply of a large silk factory, which takes about 1,000 kw. Fig. 3 is a section through this sub-station, and shows the arrangement of the switchgear. The high-pressure wires are brought in at the top of the tower, and immediately below on the top floor are the lightning arresters, *A*, and the water-resistances, *R*. On the first floor are situated the high-pressure oil-break switches, *H*, and on the same floor, but on the other side of a substantial wall, the low-pressure transformer switches, *L*. On the ground floor, immediately below the high-pressure switches, are the transformers, *T*, and the remaining compartment contains the distribution board, *D*. Fig. 4 shows the corridor containing the low-pressure transformer switches, and Fig. 5 is a view of the distribution board in the corridor on the ground floor. The signal lamps, the current

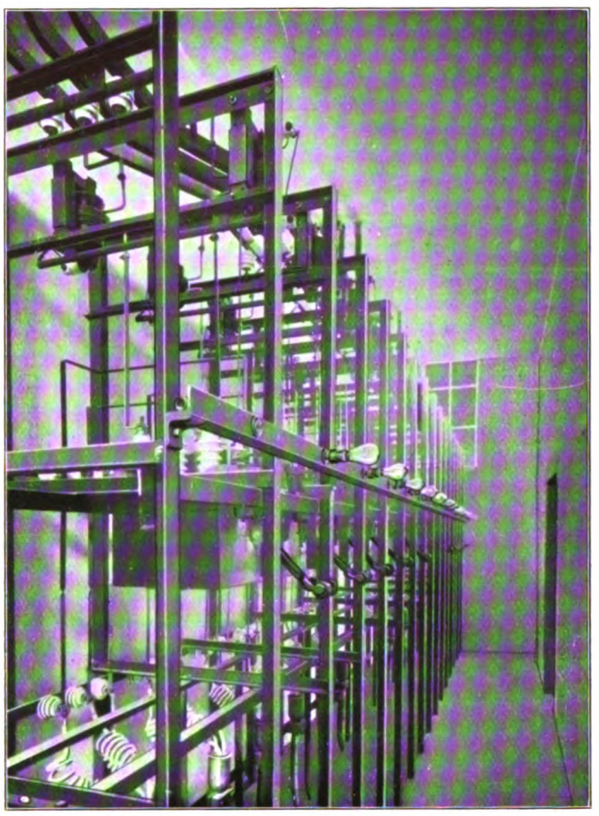


Fig. 5.—Distribution Board in Kriens Sub-station.

transformers, and the ends of the outgoing three-phase feeder cables are conspicuous in this last view.

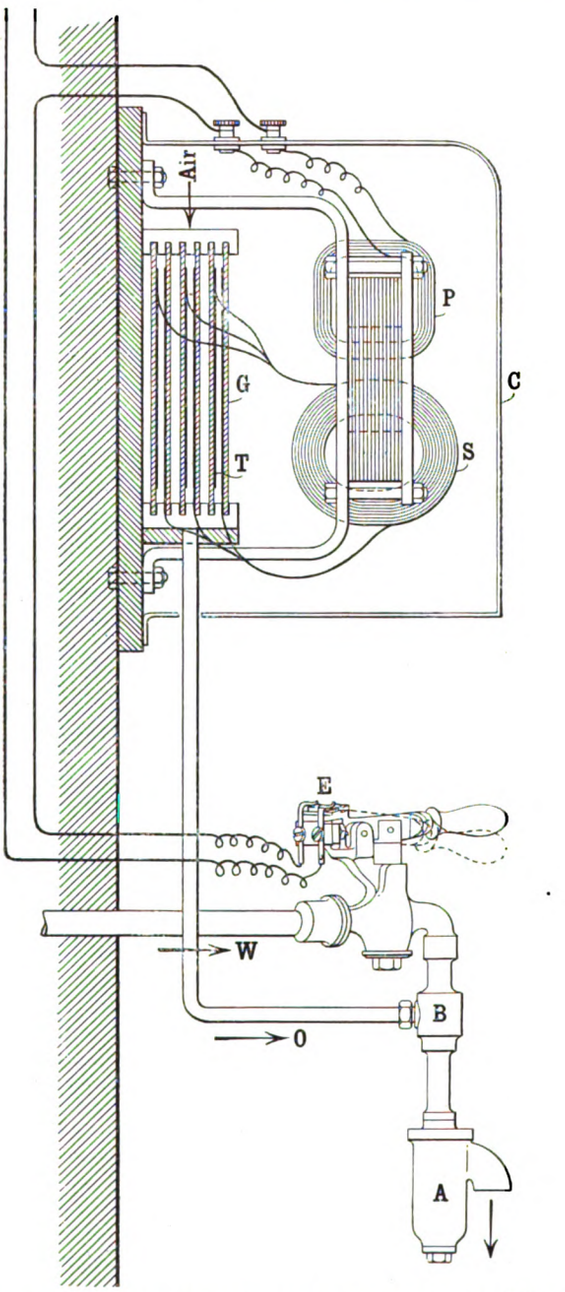
With the exception of the high-pressure line itself, all the electrical equipment was supplied by the Oerlikon Co. On November 1st, 1904, the instalment of the electrical equipment was commenced, and on July 2nd, 1905, power was transmitted from Obermatt to Engelberg. On July 27th the tramway system in Lucerne was supplied from Obermatt, and on September 1st, 1905, the regular supply of both light and power to Lucerne exclusively from the power station at Obermatt was taken over. During the two years of working since that date no troubles worthy of mention have been experienced, in spite of the fact that many heavy storms were experienced in the district in the summer months.

The Batti-Wallah's Society.—The third annual dinner of the P. & O. Batti-Wallah's Society was held on March 7th at the Holborn Restaurant. An excellent musical programme was arranged. The President (Mr. Walter Riggs), replying to the toast of the President and Committee, reported on the gradually increasing membership, and said he hoped that the new clause qualifying electricians and electrical engineers who were not necessarily sea-going, or connected with the P. & O. Company, to associate membership, would result in a substantial swelling of their ranks. A number of new members were enrolled during the evening, and the announcement was made that a branch was to be inaugurated at Birmingham.

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ELECTRICAL STERILISATION OF WATER

ELECTRICAL apparatus for the production of ozone has been on the market for some few years, but ozone as a means of sterilising water has not generally been known from a commercial point of view. The Lahmeyer Electrical Co. have on view at their offices in Oxford Street, a piece of apparatus which they have placed on the market, and which goes by the name of the "Otto Ozoniser." The apparatus on view is of the type used for installation in private houses for treating the drinking water instead of filters, and consists of a small transformer and ozoniser enclosed in a case a little over a foot square. A special tap and emulser, in which the ozone is mixed with the water, are also provided. If the supply is continuous-



Diagrammatic Sketch showing the principle of the "Otto" Ozoniser.

current, a small rotary converter, four or five inches in diameter, must be used to convert to alternating current. The principle of the ozoniser is best explained with the aid of the diagrammatic sketch shown above.

In the upper part of the sketch are shown the transformer and ozoniser in the metal case *C*. *P* is the primary winding of the transformer, which is supplied with current at from 100 to 250 volts according to the voltage of the supply mains or the converter. *S* is the secondary winding of very fine wire, which supplies current to the ozoniser plates at a pressure of about 15,000 volts. The ozoniser proper consists of six or more glass plates (*G*), supported on a grooved bracket at the bottom, and by grooved slips at the top and sides. Three pairs of plates are shown in the sketch. The inner sides are each provided with a coating of tinfoil (*T*), the opposing coatings being connected in parallel with the secondary winding of the transformer. The distance between the coatings is about one millimetre, and the layer of air is broken down, so that a continuous brush discharge takes place between the coatings. The oxygen in the air passing between the coatings is converted by the action of the brush discharge into ozone. The air enters at the top and sides of the battery of plates, and is sucked down through the opening provided in the lower bracket into the ozone pipe by the action of the water at the junction *B*. The water carries the ozone down with it into the emulser *A*, in which the two are mixed together, and the water thoroughly sterilised. As the transformer need be working only when water is being drawn, the primary switch is interconnected with the water tap as shown at *E* in the sketch. When the water is turned on, the primary winding, or in the case of a continuous supply the converter, is connected to the supply mains, and in a few seconds thoroughly sterilised water is issuing out of the emulser, at the rate of 60 gallons per hour. As the apparatus requires little more power than that corresponding to the no-load losses of the transformer, the consumption of energy is very low.

When first drawn, the water smells strongly of ozone, but in a few seconds the ozone has gone, leaving the water fresh and pure. According to the pamphlet issued by the Lahmeyer Co., the apparatus supplies some 8 to 10 grains of ozone per cubic metre of air, although much less would be sufficient to perfectly sterilise the water with which it is brought in contact.

Bacteriological analyses of samples of water treated in this way have shown excellent results, and we are informed that several municipalities, particularly in France, are adopting this system of putting down large and complete installations to deal with the whole town supply. The town of Nice has decided to instal the "Otto" system, and to electrically sterilise the water for the whole population, at present about 100,000 inhabitants. The city of Paris has also put down an installation to deal with a portion of the city's supply of water. The plant at Bon Voyage has batteries of ozoniser plates taking 2·4 kw. for each battery, and these are supplied from transformers, which transform up from 220 volts to 20,000 volts. In the larger plants, the ozone is pumped into mixing tanks, and these are filled with pebbles in order to ensure that the water is thoroughly broken up, and mixed with the ozone. Some of the larger installations deal with several millions of gallons of water daily. A portable sterilising plant has been designed for military use, and consists of a small petrol engine driving a water pump, an air pump, and a small alternator, a transformer, an ozoniser battery, and a mixing tank. Two filters are provided for filtering out suspended matter. The whole plant is mounted on a carriage, and is very compact. The capacity of the plant is about 500 gallons per hour.

The Fire at the Eiffel Tower Wireless Telegraph Station.—Some further particulars of the fire which occurred at the wireless telegraph station at the Eiffel Tower on February 17th are given in *La Lumière Electrique*. It appears that the fire originated in the condensers, the oil dielectric of which caught fire by some means not clearly understood. Experiments were in progress with regard to communication with the coast of Senegal, but it is not thought that these had anything to do with the cause of the fire, as at the time of the outbreak the sparking apparatus was not actually in operation. The statement which went the round of the Press that the damage done by the fire had interrupted all communication with the *Kléber* at Casablanca is contradicted, as it was only apparatus connected with the special experiments mentioned above which was destroyed, so that the service from the ordinary station was not interrupted.

Banquet of the American Institute of Electrical Engineers.—The American Institute of Electrical Engineers held a banquet at the Waldorf Astoria Hotel on February 19th. The gathering was called the "Public Service" banquet, from the fact that the control of public service corporations by the State is a topic now being much discussed in the United States, and that the speakers were asked to discuss themes connected with this subject. Mr. Stott, President of the Institute, was in the chair. Mr. W. C. Kerr, of Messrs. Westinghouse, Church, Kerr & Co., responded to the toast of "The Ethics of Public Service." Mr. F. W. Stevens, chairman of the second district Commune of New York, spoke on "State Control of Public Service Corporations." Mr. C. R. Huntley, of the Buffalo General Electric Co., also dealt with the same subject, and Mr. T. C. Martin, editor of our contemporary, the *Electrical World*, spoke on "The Technical Press and the Public."

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11,000-VOLT OVERHEAD CONSTRUCTION

THE two illustrations below show the construction adopted by the Clyde Valley Electrical Power Co. for the 11,000-volt overhead lines that have been

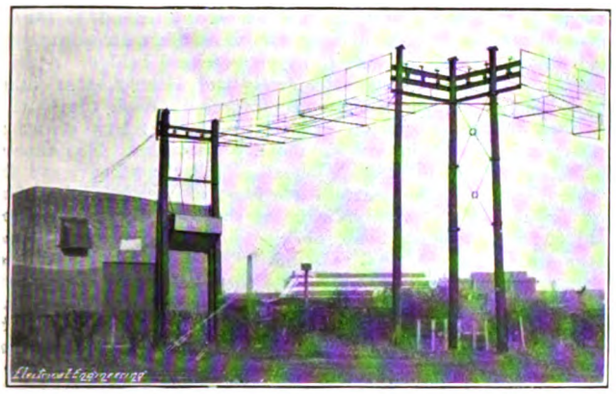


FIG. 1.—GENERAL VIEW OF 11,000-VOLT LINE, SHOWING GUARD-NET AND TURNING POLES.

they also supply and distribute to lighting loads in Clydebank and a number of districts in the Lanark

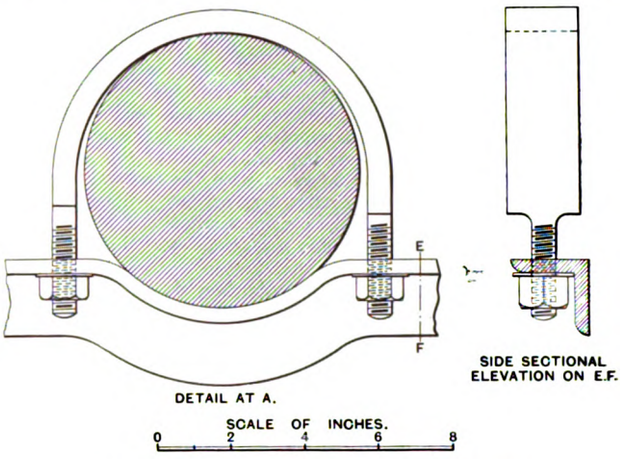


FIG. 2.—DETAIL OF SUPPORT FOR CROSS-ARMS.

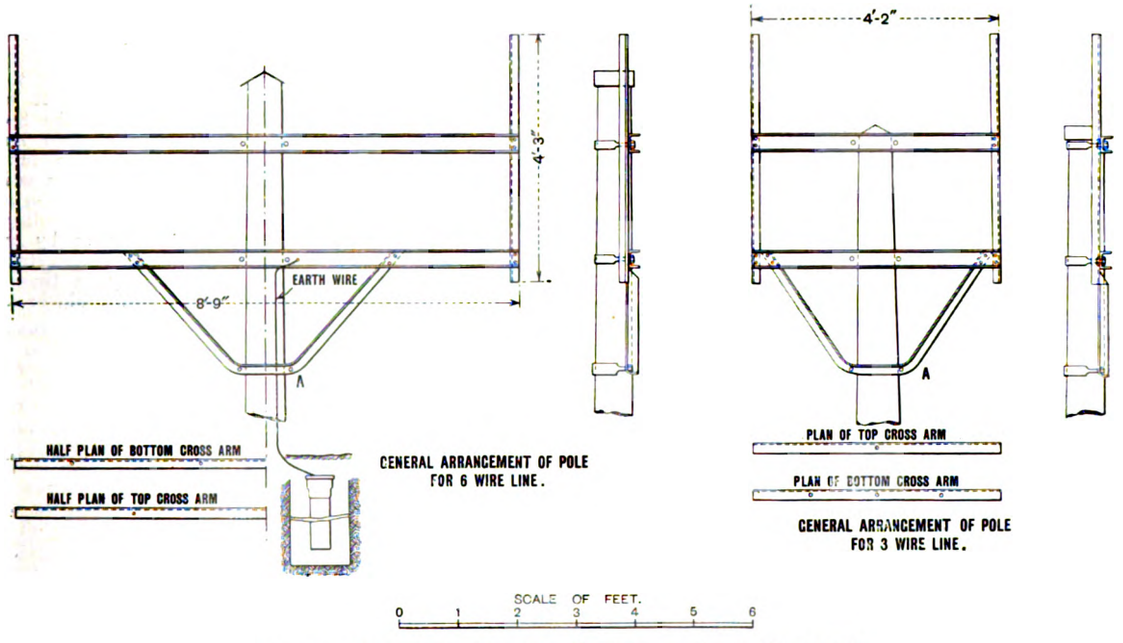


FIG. 3.—ELEVATIONS SHOWING DETAILS OF STEEL CROSS-ARMS.

permitted in their district. Fig. 1 is a photographic view of the turning poles which lead the lines into a sub-station, and shows the guard-net which is fixed in positions where the line crosses roads or paths. Figs. 2 and 3 are drawings showing the details of the steel cross-arms, &c. These cross-arms are connected by an earth-wire to a 6 ft. length of R.W. pipe embedded in coke breeze close to the base of the pole. The construction is employed for the line supplying the Motherwell Iron & Steel Works, described in our issue of February 27th. During 1907 the Clyde Valley Electric Power Co. have increased their output from 100,000 units per week to 11,000,000 units per annum, and their mains and distributors aggregate nearly 150 miles. Six shipyards, three steelworks, five rolling mills, eleven collieries, two foundries, and a large number of miscellaneous works are now connected to their power mains; and County Council district, and "in bulk" to the Corporation of Wishaw.

The Kelvin Lectureship.—At the meeting of the Institution of Electrical Engineers on Thursday, Colonel Crompton, the president, announced that the Council of the Institution have decided that the first Kelvin lecturer will be Professor Silvanus P. Thompson, F.R.S., and that the first Kelvin lecture will be delivered on "Lord Kelvin: His Life and Works," on April 30th, at the Institution of Civil Engineers, at 8 p.m.

The Under-running Third Rail System.—It is announced that the Belgian Government will adopt the under-running third-rail for its electric line at the Parc de Laeken, near Brussels. This decision was made upon the recommendation of Mr. Em. Uytborck, Electrical Engineer of the Government railways, who some months ago visited the United States and spent considerable time investigating heavy electric traction conditions here. Licence has been taken on behalf of the Belgian Government to use the Wilgus-Sprague type of protected third-rail, and orders for much of the necessary material, it is stated, have already been placed in America.

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THE NEW YORK RAPID TRANSIT SUBWAY

A PAPER on the above subject was read by Mr. W. B. Parsons on Tuesday, February 25th, before the Institution of Civil Engineers.

The population of the city of New York is about 4,150,000, distributed among five boroughs. The railway described in this Paper is confined chiefly to the borough and island of Manhattan, the most important district of the city. The railway has been constructed by and at the expense of the Municipality, under the jurisdiction of the Rapid Transit Commission, through two contracts with one company. These contracts provided that the company should construct the railways for a lump sum in each case, payable in cash by the city as the work progressed; that it should furnish all equipment, to be taken over by the city on an appraised value at the termination of the leases, and to operate the railways for 50 years with the renewal period of 25 years. The rental during the first period is the interest on the city's bonds issued for the construction, plus 1 per cent. per annum for a sinking fund. For the second period the rental is to be fixed by arbitration.

The route begins at one of the suburban stations of the Long Island Railroad, in the borough of Brooklyn, passes under streets in that borough for 1½ mile, and thence in tubes under the East River, whose width at the point of crossing is nearly one mile; it then follows a central route under streets in Manhattan for about eight miles, where the line forks, one branch continuing north, the other north-east to the upper part of the city in the borough of the Bronx, giving a total length of route of 25·7 miles. It was in 1894 that the Rapid Transit Commission was appointed and the work projected; but for various reasons the latter was not begun until 1900. The author, as chief engineer to the Commission, after a study of the tubes in operation and under construction in London, advised that the converse extreme principle in design be adopted, and that so far as possible the railway be of "subway" rather than tube type, and be kept as close to the surface as local conditions permitted.

In New York, the demand for additional transportation, especially for long distances, was so great that the two tracks were recognised as being too few to carry the traffic, and especially to give the required high speed. It was therefore decided to construct four tracks, parallel, and usually on the same level, over the central section, where the traffic would be the heaviest, on which trains could run all day in both directions. The outer tracks were to serve the local traffic, with about four stations to the mile, while the inner tracks were to carry the fast service, with stations at intervals averaging 1½ mile. On the sections where traffic would be less heavy, three tracks were projected, the central one to give an express service in the direction of maximum demand; that is, towards the commercial district in the morning, and from it in the evening. Of the total route, 10·2 miles have two tracks; 7·6 miles, three tracks; 7·6 miles, four or five tracks; 0·2 mile, eight tracks, a storage yard; and 0·1 mile, one track, a terminal loop.

To support the street roadway, a flat roof was adopted, consisting of transverse beams set at 5-ft. spacing. From the surface of the paving to the top of the roof the minimum distance is 30 in., governed by the yokes of the surface electric tramway. The height in the clear from rail-level to underside of roof is 13 ft., and the width per track is 12 ft. 6 in. The internal diameter of a tube of corresponding capacity would be 15 ft. 6 in. This accommodates a car similar to the one in use on the New York elevated system, and much larger than any car in the London tubes, except the Great Northern and City. The minimum depth from street to rail-level is 17 ft., and to platform about 13 ft. Every effort was made to attain this last dimension at stations. In order to keep the subway dry, an envelope of waterproofing material was embedded in the concrete of floor, walls, and roof. This material was alternate layers of paper roofing-felt and carefully selected asphalt. This envelope was made continuous, and was protected from subsequent external injury by an external covering of concrete. This was found to work well against even a substantial hydrostatic pressure. Where, however, such pressure became considerable, layers of bricks, dipped in asphalt, were used instead. After the work had begun, a structure of reinforced concrete was designed instead of the beam construction, and has been largely used. The rows of columns between the tracks are retained, and, in order to economise space, such columns are of steel. A longitudinal truss of reinforced concrete connects the columns, while the roof and walls contain rods on the tension side. Wherever below the level of standing water, rods were embedded in the floor. Such construction, in practice, was found to be both cheaper and more expeditious than beam construction. Although the basis of the design is a shallow subway, with a flat roof, and constructed by "cut-and-cover" methods, there was no hesitation to depart from this type if conditions demanded or warranted such a course. There are 14·2 miles of cut-and-cover, of which 13 miles have a flat and 1·2 miles an arched roof, 3·9 miles of masonry-lined tunnels, 2·7 miles of iron tubes, and 6·6 miles in the open or on steel viaduct.

Stations for the local tracks, except in a few instances where island platforms were more convenient, have platforms on the outside with short direct stairways leading to the pavement. There are for each platform usually two exit and two entrance stairs. The express stations are served by island platforms, one between each pair of tracks, connected with each other and with the street pavements by an overhead bridge. At such stations passengers can transfer freely and without extra charge from local to express trains and *vice versâ*. Such transferring is done to an unexpected extent, the local trains acting as gatherers and distributors for the express trains. The express trains are scheduled to make about 30 miles per hour, and the locals 13 miles. There are 58 stations, of which all but four are reached by stairs only, while of the four, three have lifts, and one a moving staircase working in both directions. Junctions are arranged so that opposing tracks pass under and over, there being no level crossing. The sharpest curve where speed is possible has a radius of 458 ft., and the maximum gradient is 1 in 33, or less than 1 in 60 if accelerating is likely. The express tracks are wholly and the local tracks partly protected by automatic block signals, with emergency automatic stops. The permanent way is of the usual American standard with 100-lb. rails.

New Admiralty Wireless Telegraph Station.—It is stated that the Admiralty are about to establish a wireless telegraph station at Easington, in Holderness, the special junction of which will be to keep in touch with the North Sea fleet.

Interference with Wireless Messages.—According to the *Electrical Review* (New York), President Roosevelt transmitted to Congress on February 13th a letter from the Secretary of the Navy, recommending the enactment of laws making it a punishable offence "to originate or transmit a false wireless message purporting to be official, or to break in and interfere with any wireless station while it is transmitting an official message, or to refuse to cease or fail to cease sending a private wireless message when called upon to do so by an operator having an official message to be sent." The restrictions suggested are intended to apply particularly in times of peace. In times of war more rigorous restrictions would be indicated.

Proposed New Australian Electric Railway.—According to the *Australian Mining Standard*, it has been proposed to construct an electric railway between Collingwood and Doncaster (Victoria). The line would be a single one, and about 8¼ miles in length. Mr. M. Kernot, chief engineer for railway construction for the Victorian Railways, estimates that the cost of the line construction will be about £77,500, excluding power-house and rolling-stock. The power-house and plant would cost about £10,200, and the rolling-stock, consisting of ten motor-cars and five trailers, £13,500. This makes the total cost of the electric line amount to £101,000, whereas the estimated cost of the steam line is £166,000. The working costs, including everything, and with electric power supplied from the generating station at 1d. per unit, would come to about £17,950 per annum. On the present population there would be an income of not more than £2,000 a year, consequently the railway would not pay until there was a large increase in the population along the route.

Electric Cab Signalling in Germany.—A few notes on a system of cab signalling which has been introduced on the Prussian State Railways are given in an American Consular report. The purpose of the appliance is simply to give the driver warning at points about 100 yards before a signal. No attempt has been made to repeat the indications of the signals in the cab, as it is held that if he had only to observe signals in the cab, then the attention which it is his duty to devote to the road would greatly diminish. The watching from the locomotive, which is absolutely necessary for the safety of the train, would be gradually left unperformed, and the attention only directed to the little apparatus in the cab. Experiments in purely mechanical systems led to the adoption of an electrical contact apparatus as being the only form suitable for high speeds. At a fixed distance from the signal post two parallel iron bars with a small space between them are mounted along the track for several yards. There is attached to the locomotive an arm which carries a brush made of pliable copper wires. The passage of this brush between the iron bars produces a contact which is intense and free from concussion. An electrical action follows upon the mechanism in the cab, a bell sounds, and a white slide replaces a red. The sign remains plainly visible to the eye until the engineer presses a button. He knows definitely that a signal is to be expected, and if he cannot clearly make out the order intended, will stop the train.

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OPENING OF THE HUDSON RIVER TUNNEL

THE first of the Hudson & Manhattan Railroad Company's tunnels under the Hudson River was formally opened for traffic by President Roosevelt on February 25th. The part of the route now opened consists of a twin-tube tunnel extending from Hoboken, on the New Jersey side, to Sixth Avenue and Nineteenth Street, New York, a distance of nearly three miles. This section is generally designated the Morton Street or "uptown" tube, and forms a part of the complete scheme of about 18 miles of track, the remainder of which is nearing completion. There are eight stations on the portion of the line now open, including the Hoboken station, and seven on the New York side of the river.

The project of building a tunnel under the Hudson River had its inception in 1878, when D. C. Haskins conceived the idea of constructing a brick tunnel from Hoboken to New York, through which he proposed to run railroad trains having a grand railroad terminal in the vicinity of Washington Square. His plan embodied simply a tunnel for the purpose of gaining access to New York for a terminal, and did not contemplate the extensive system of connecting lines now being completed. With much difficulty a company was formed to undertake the great work, and after a large sum of money had been spent, and about 1,200 ft. of tunnel built, the company failed, and in 1880 the undertaking was temporarily abandoned. In 1890 another company was organised with English capital, and the contracting firm of Pearson & Son, now engaged in constructing the East River section of the Pennsylvania tunnels, resumed work where the Haskins company had left it. This company, after adding about 1,800 ft. to the part already built, also failed, and once more the enterprise was checked. The original tunnel was constructed of brick and masonry in the old way, but it appears to have been the first time that compressed air had been used in horizontal work of this sort. In 1901, a company was formed by Mr. W. C. McAdoo to go on with the tunnel. The 3,500 ft. of old tunnel was acquired, and the tube finished with the steel-ring method. Work on the second parallel tube was also completed. These are the tunnels to be opened on February 25th, but to them has been added the extension under Sixth Avenue on the New York side.

The diameter of the tubes is 15 ft. 3 in. in the clear, and the depth of the tunnels below the surface of the Hudson River varies between 60 ft. and 90 ft. Under the river the tubes are about 30 ft. apart for the greater part of the distance. The system of separate tubes for north and south bound travel is maintained under Sixth Avenue and elsewhere in New York, although there the tubes are close together, and at passenger stations are joined so as to afford space for an island platform between the tracks. There are also side platforms as exit and egress platforms are kept separate. The use of separate tubes permits of ventilation by the piston action of the trains, which draws in fresh air from either end and forces the foul air out in front. In addition, the company has installed all along the line apparatus for artificial ventilation, which may at once be put into use if for any reason the tunnels or stations require an additional supply of fresh air. The whole cost of the system when complete will be 72 million dollars.

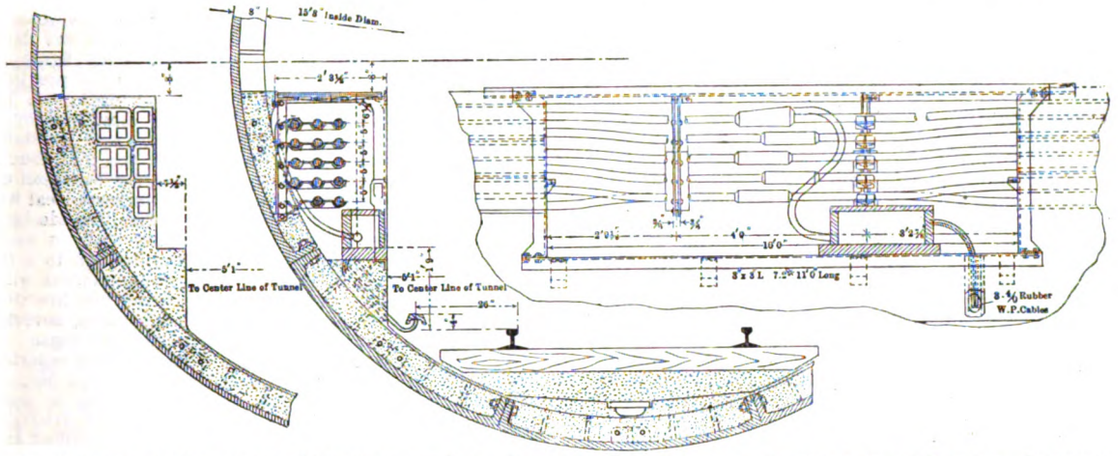


FIG. 1.—SECTION OF TUNNEL AND ELEVATION OF CABLE JUNCTION BOX SHOWING ARRANGEMENT OF FEEDERS, POSITION OF TRACK AND CONDUCTOR RAIL, &c.

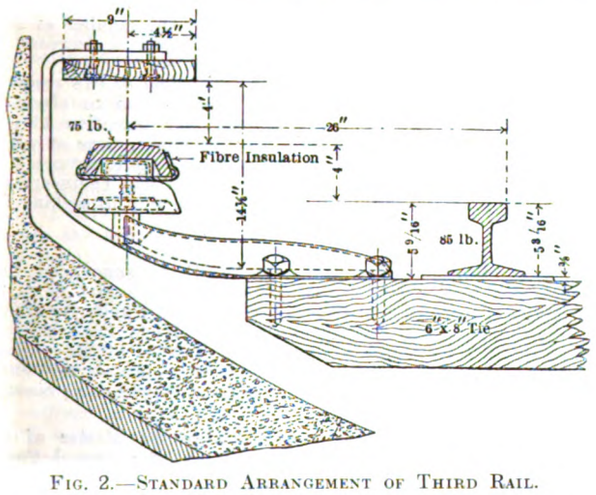


FIG. 2.—STANDARD ARRANGEMENT OF THIRD RAIL.

The arrangement of the third rail, which was designed by Mr H. Hazelton, electrical engineer to the Hudson Companies, and Mr. L. B. Stillwell, consulting engineer, is shown in the accompanying illustrations, which are reproduced from the *Street Railway Journal*, New York. Only one conductor rail is used, and this is placed outside the track. It is of inverted channel section, and is laid in 60-ft. lengths. It weighs 75 lb. per yard, and the composition of the steel is as follows:—Carbon, 0·10; manganese, 0·55; phosphorus, 0·10; sulphur, 0·08; silicon, 0·03. This composition gives a conductivity, as compared to copper, of 1 : 8·5. The third rail is bonded at every joint with two 550,000 circ. mil bonds. These bonds have compression terminals which extend through the head of the rail. After the heads are expanded they are filed down to give a smooth-running surface to the third rail. An angle plate is used at

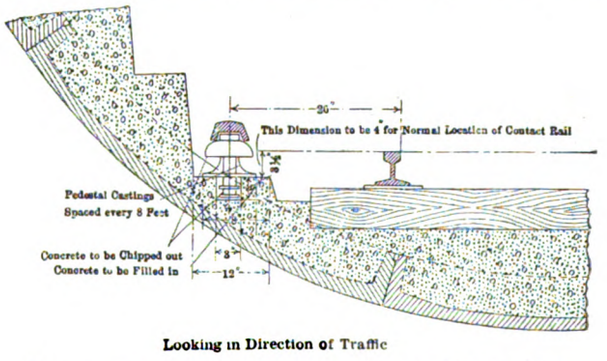


FIG. 3.—ALTERNATIVE ARRANGEMENT OF THIRD RAIL.

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the third-rail joints, consisting of two clips 11½ in. long, clasping the lower part of the channels and held together by two ¾-in. bolts. The third-rail insulator is of porcelain, with double petticoat 7½ in. in diameter and 3½ in. high. It is mounted on a malleable iron pin, and is surmounted by a malleable iron cap on which the third rail rests. The third-rail insulators are spaced 9 ft. apart, and as a rule are supported on a malleable iron bracket which is held to the tie by screw spikes. Where the clearance would not admit of this construction a pedestal casting, illustrated in Fig. 3, is used, sunk into the concrete walls of the tunnel.

The third rail is anchored at its middle point by a special cap of malleable iron, and by a pair of angle plates. Where this cap is used the smaller cap is not employed. The bolts of the angle plate pass through the extension arms of the anchoring cap. A protection board is carried over the third rail, as indicated in the drawings. This protection is made of Jarrah plank, 2 in. by 9 in. by 9 ft., and is supported on brackets on every other tie or at 36-in. centres. The ends of the planks are joined by a special splice plate consisting of 3/16-in. steel, 9 in. wide and 6 in. long, and with a 1 5/6-in. channel bent down on each side to keep the planks in line. This splice plate is bolted over the top of the protection board with ½-in. by 2¾-in. bolts. The track rails are 85-lb. A.S.C.E. section, and are bonded with two 300,000 circ. mil protected bonds. Screw spikes are used for the track rails as well as for the third rail.

As the large power house which the company is constructing in Jersey City has not been completed, and as only a small portion of the system was put in operation February 25th, arrangements have been made for securing all of the power necessary at present from the New York Edison Company. Eight-car trains, electrically propelled, are used in the tunnel. The cars are made entirely of steel, and are constructed upon a plan differing materially from any others now used in the Metropolitan district. They have large sliding side doors in the middle as well as at either end, and the platforms are so arranged at the terminal stations that passengers enter and leave the cars at the same time. The doors are operated by compressed air, and no signal bells are used. When the last door in the train is securely closed, the motorman receives an electric flash signal and starts the train. The automatic adjustment is such that the signal to start cannot be given so long as any door in the train remains open for even a fraction of an inch.

The ventilation of the tubes is automatic, as each train acts as a piston, forcing out the air ahead of it and drawing in a fresh supply from the surface as it proceeds.

Tramway Rating.—In the King's Bench Division of the High Court on Friday, Mr. Justice Darling and Mr. Justice Phillimore, sitting as a Divisional Court, gave their reserved judgment in the motion which they had before them on Friday week, in which Mr. Page, K.C., who had with him Mr. Ryde, moved on behalf of the Guardians and Assessment Committee of the Hendon Union, for a rule *nisi* for a writ of prohibition, calling upon the Justices of Middlesex to abstain from hearing an appeal by the Metropolitan Electric Tramways Company, against their assessment, while certain magistrates, who are members of the Middlesex County Council, were on the bench. We gave full particulars of the action on p. 371 of our last issue. Mr. Justice Darling, in his judgment, said that the Tramway Co. had a tramway which was leased from them by the London County Council, which received 45 per cent. of the net profits. Some of the Justices who were going to hear the appeal were members of the County Council. The question was what would be the effect on the minds of the public as to the fairness of the administration of justice if these magistrates sat, and it was a question of degree. Any person might reasonably, though perhaps wrongly, object to these justices sitting, as what the Council would receive would be greater or less, according as the rates were less or greater. The applicants were therefore entitled to a rule *nisi*. However, the bias of a person was not always in the direction which charitable people assumed. He could imagine that there were people who were the friends of every parish but their own, but still their decision would be biassed. Mr. Justice Phillimore concurred, and the rule was accordingly granted.

Electric Lighting in Austria.—According to *Elektrotechnik und Maschinenbau*, the town of Beraun, in Bohemia, decided last year to have a central station, and a three-wire 2 × 220-volt direct-current system was originally proposed. In consequence of the success of the metallic-filament lamp, however, the generating plant and the distribution network have been installed for three-wire 2 × 120-volt direct current. Both public and private lighting is, with the exception of a few arc lamps, carried out entirely by metallic-filament lamps, the streets being lit by 50 c.p. 120-volt Wolfram lamps. The generating plant consists of two 66 kw. steam generating sets and a 400 ampere-hour accumulator battery.

FIRES IN LONDON DURING 1907

THE report of the Chief Officer of the London Fire Brigade for the year 1907 contains some interesting statistics relating to the fires which have taken place in the metropolis during the year. It is gratifying to note that the total number of fires, which was 3,520, was 523 less than during the previous year. The number classified as serious is, however, slightly in excess, being 70 as against 65. The number of lives lost has declined from 104 to 95. Considerable improvements are being made in the equipment of the brigade, and it may be mentioned that the number of street fire-alarms has been nearly quadrupled in the last eight years, and now stands at 1,285, and that there are now three stations where motor-driven appliances are used exclusively. Owing to the fact that the system of fire-alarms employed is such that the appearance of any defect acts in such a way to give an alarm, there have been no less than 549 false alarms due to this cause—including four from the derangement of automatic alarms—during the year. This figure, however, shows a reduction of 57 over the number in the previous year.

All the telephone exchanges situated within the county of London are now connected with the most appropriate fire-stations for distributing calls received for fire, but these are not necessarily the stations nearest either to the telephone exchange or to the subscriber. In cases of fire delay has been caused by persons asking to be connected with the nearest local fire-station. The best method of calling the London Fire Brigade by exchange telephone is, after getting communication with an exchange, to ask for "Fire Brigade," and on getting through to a fire-station to give the address of the fire, when the appliances will be sent. It is obvious that every fire-station cannot for fire purposes be connected with an exchange, as, in some cases, several stations are in the area covered by one telephone exchange.

A summary of the causes of the 3,520 fires reported during the year gives information regarding all except 343, which are classified as "unknown," and it is interesting to compare the comparative number of fires attributed to electricity and gas. The fires attributed to electrical causes are classified as follows:—Electricians at work, 1; defective electric circuits, 88; "overheat" of electric light, 2; vapour of spirit coming into contact with electric spark, 3; spark from electric arc lamp, 1. As against these 95 "electrical" fires, particulars are given of no less than 348 fires due to gas, classified as follows:—Swinging gas bracket, 13; overheat of gas engine, 1; escape of gas, 95; explosion of gas, 10; gasfitters at work, 13; gas light, 2; gas lighting, 5; clothes coming into contact with gas light, 1; curtains or window blinds coming into contact with gas light, 102; goods coming into contact with gas light, 8; linen coming into contact with gas light, 1; overheat of gas light, 12; spirit coming into contact with gas light, 2; seeking for an escape of gas with a light, 22; gas stoves, 17; clothes coming into contact with gas stove, 5; curtains coming into contact with gas stoves, 7; overheat of gas stove, 14; portable gas stoves, 14; geyser, 1; lighting geyser, 1; overheat of geyser, 1; petrol vapour coming into contact with gas light, 1. The total number due to oil and spirit lamps and stoves is 329. Only one fire is recorded as due to lightning. It should be noted that the number of fires attributed to defective electric circuits shows a decrease of 12 as compared with 1906.

From the table of causes of fires in which loss of life occurred it is seen that no lives were lost at fires due to electrical causes, although four fatal fires owed their inception to gas. Eleven fires took place at electric lighting works, none of which were serious, and six cases are reported of electric tramcars on fire, and eight fires on the premises of electrical engineers are recorded, one of which, curiously enough, is due to seeking for an escape of gas with a light.

Electric Automobiles in Hyde Park.—It is announced that licences and badges will be issued, after March 31st next, by the Commissioners of his Majesty's Works and Public Buildings, for the admission of electric carriages to Hyde Park between the hours of 4 p.m. and 7 p.m., in the months of May, June, and July. Forms of application may be obtained, by letter only, from "The Secretary, H.M. Office of Works, &c., Storey's Gate, Westminster, S.W."

Mersey Railway Contract.—On Saturday the Master of the Rolls and Lord Justice Buckley, sitting in the Appeal Court, heard an appeal by the British Westinghouse Manufacturing Co., Ltd., from the refusal of Mr. Justice Eve to grant an injunction restraining the Mersey Railway Co. from issuing the difference between £249,276 and £275,000 debenture stock at a higher rate of interest than 4 per cent., and from issuing the said difference, or the difference between £620,000 and £705,000 debenture stock, at any price lower than par without previous consent in writing of the plaintiffs in breach of an agreement of July, 1901. Full particulars of the point in dispute were given in our account of the action before Mr. Justive Eve in our issue for February 20, page 282. Their Lordships dismissed the appeal, holding that there was an obligation on the plaintiffs to purchase the £2,500 stock on January 2nd, 1908, which had not been done, and that the defendant company was released from all their obligations under clause four of the Works Contract.

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FUSE PHENOMENA

Proposed Standardisation of Fuses

A PAPER by Prof. Alfred Schwartz and Mr. W. H. N. James was discussed at the Manchester Section of the Institution of Electrical Engineers on March 31st, and in London last Thursday. Although it dealt principally with the selection of a metal for fuses, the Paper was of unusual length, and we are, therefore, only able to publish it in an abbreviated form. From the discussion, it was elicited that the tests described have been made at the request of the Engineering Standards Committee.

Purity of the Metal.

The importance of employing a material which can easily be obtained of standard composition is generally understood; but, notwithstanding this, a very large amount of alloy wire and strip is still used, the composition of which is a very uncertain quantity. It is true that many of these metals have lower melting-points than those of the pure metals in use as fuses, but this does not outweigh the advantage which a pure metal such as copper possesses of constancy of composition.

Melting-point.

Fire Risk.—The fire risk with metals of low melting-point is due to the scattering of molten particles when the fuse blows, or to the persistence of the arc across the terminals. With metals of high melting-point, there is an additional risk due to the fuse becoming red-hot before fusion. The liability of some metals, such as zinc, to burn in air at the temperature of disruption must also be considered; and with enclosed fuses fitted with indicator wires, it must be borne in mind that this wire practically forms an open fuse of small capacity. Experience has shown that the flash from such an indicator is sufficient to ignite combustible material in the vicinity. Further, with enclosed fuses, unless hermetically sealed or provided with special arrangements referred to hereafter for preventing the ejection of molten metal, both flame and molten metal may issue from the ends.

Method of Connecting the Fuse to the Fuse Contacts on the Carrier.—In enclosed cut-outs the fuse is usually soldered to stout copper wires or lugs, which are in turn soldered to the metal end caps of the cartridge, extending inwards inside the cartridge for a considerable distance. With an enclosed cut-out of this character it is impossible to judge of the actual length of break employed, from a consideration of the outside overall length between the end caps or fuse contacts. Secondly, the four soldered joints, if not carefully made, may develop sufficient heat locally to blow the fuse prematurely or to char the jacket if a combustible material, such as red fibre, is employed. With metals of low melting-point this arrangement seems to be adopted to avoid damage to the end caps by the arc, and also to allow of the fuse being soldered to the lugs before being placed in the cartridge.

Jacket Material for Enclosed Fuses.—Fibre is easily worked, but is combustible, absorbs moisture, and deteriorates on heating. It can only be employed with fuse metals of low melting-points; the low melting-point of the metal does not prevent a high temperature being developed by the arc if this holds for any length of time. Fibre is used very largely in the United States, and possesses the advantage of being tough and not easily broken. Frequently the fixing of the end caps to the fibre tube is not substantial enough; where rivets are employed, they are commonly placed too near to the end of the tube, and the end caps are in consequence easily blown off. Glass is not much used for enclosed fuses, as it is not so strong as porcelain. Porcelain would seem to be the most suitable material for jackets; it, however, does not lend itself so easily to connection with the fuse contacts, and is also more expensive than fibre. At first sight the metal tube would appear to offer advantages from the point of view of incombustibility, strength, and cooling; its use, however, is complicated by the necessity of using an internal liner of insulating material. With regard to cooling, the jacket material does not usually play an important part, as this is largely determined by the character and disposition of the filling.

Specific Resistance.

On low-voltage circuits the resistance of the fuse itself forms a considerable portion of the total resistance of the circuit, and therefore plays a not inconsiderable part in limiting the current rush on short circuit. With higher voltages this effect is of less importance.

Liability to Oxidation.

Fuse metals may be grouped under the following three heads with reference to their oxidation:—

(*a*) Non-oxidisable metals and those in which the skin or sheath of oxide is fluid at the temperature of fusion of the metal.
(*b*) Oxidisable metals in which the oxide sheath is sufficiently strong to hold up the molten metal until evaporisation occurs.
(*c*) Oxidisable metals for enclosed fuses in which the oxide sheath is capable of combining with the filling, fluxing the latter and forming a sheath or tube.

Copper and silver may be placed in class (*a*). Copper oxidises slowly at temperatures under red heat, and as, in open-type fuses, copper only becomes red hot when loaded to 75 per cent. of its fusing current, this metal is suited for circuits which will allow of an overload of the order of 75 per cent. or upwards. At the temperature of fusion of copper the oxide sheath is fluid, and, as far as the holding up of the molten metal is concerned, it may therefore be considered as a non-oxidisable metal.

Class (*b*) consists of oxidisable metals, such as aluminium, zinc, cadmium, and tin, which are capable of forming oxide sheaths strong enough to hold up the metal after fusion. This effect is particularly noticeable with small round wires; with the larger wires and strips the mass of metal is usually sufficient to break through the oxide skin.

Class (*c*) includes enclosed fuses with silicious fillings, which are capable of combining with the oxide sheath and of forming a containing tube around the arc. Such tubes at the high temperature at which they are formed would very probably conduct after the manner of Nernst filaments.

Mass of Metal required for a given Service.

Although the quantity of heat in the fuse at disruption may be considered as some criterion for selecting a metal from the fire-risk point of view, yet in the authors' view this consideration is outweighed by others, such as the capacity of the metal for maintaining an arc, the surface tension of the molten metal as influencing the way in which it segregates into globules, the behaviour of the globules of metal after disruption as to whether they burn in air or not. In general, it may be taken that the mass of metal in the fuse should be kept as small as possible for open-type fuses; for enclosed fuses this point has to be considered in connection with the temperature which the jacket material will stand, as the metals with small mass necessarily have a high melting-point, and will attain red heat before fusion. In the screened shunted type of fuse it would seem possible to employ a metal with large mass and low melting-point for the main fuse, as this will melt quite quietly, the break being made on the shunt, which is of high resistance, and is enclosed or protected. For fuses of large capacity this type is worthy of more attention than has hitherto been paid to it.

Capacity of the Metal for Maintaining an Arc.

The authors have studied this condition in three ways: By photographing the fuse itself when blowing; by observing the minimum length of break at which, on short circuit, the character and duration of the arc is such that little or no damage is done to the terminals; by oscillograms of the current rush and inductive pressure-rise on short-circuit.

The Short-circuit Current.—The authors suggest that the drop in volts in the conductors on the generator side of the fuse (expressed as a percentage of the supply voltage), when these conductors are carrying the current which will melt the fuse, should be specified, so that the maximum value of the short-circuit current may be known. Thus a 3 per cent. drop in volts would allow of a short-circuit current equal to thirty-three times the normal fusing current of the fuse under test, a 10 per cent. drop of ten times the normal fusing current, and so on. Three per cent. drop in pressure was found to be representative of the conditions likely to be met with in house services for main and distribution board fuses. The minimum length of break referred to as the "minimum no-arc length" was taken as the least length at which no damage was done to the terminals on short circuit, the resistance of the circuit being such as to give a 3 per cent. drop with the normal fusing current flowing.

Experiments showed that there was a greater tendency for an arc to form across clean, freshly fused surfaces than across dirty surfaces. The authors found that for copper wires of 20 amperes N.F.C. (Normal Fusing Current) and upwards on a 220-volt circuit the minimum no-arc length increases slightly as

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the drop in pressure in the circuit is reduced. The following values are each the result of about twenty experiments with a 27-ampere (No. 25 S.W.G.) open-type copper fuse with large terminals (350 gm.) on a 220 volt circuit :—

Short-circuit current in terms of the normal fusing current.	Minimum no-arc length in inches.
N.F.C. × 33	3·6
N.F.C. × 10	2·9

With the same size of wire, but small terminals, the authors obtained the following results :—

Short-circuit current in terms of the normal fusing current.	Minimum no-arc length in inches.
N.F.C. × 33	4·20
N.F.C. × 10	3·05

On the other hand, for smaller copper wires (Nos. 33 and 29 S.W.G.) in open-type cut-outs the minimum no-arc length seemed to be larger with a short-circuit current of ten times the normal fusing current than with a current thirty-three times the normal fusing current. The size of wire at which transition occurs seemed to be greater the lower the voltage of the circuit is and the more massive the terminals are. With enclosed fuses it was found that the results of short circuits were much more severe with 33×N.F.C. than with 10×N.F.C. This conclusion is based on a large number of visual observations; only a small number of actual determinations of minimum no-arc lengths were made, but these supported the above conclusion.

In all subsequent experiments, unless otherwise stated, 33× N.F.C. has been taken as the standard short-circuit current.

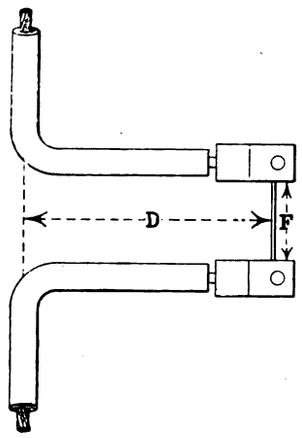


Fig. 1.—Arrangement of Wires to Fuse for Magnetic Blow-out Effect.

D. Distance through which leads are bent up at right angles
F. Fuse length.

Variation of Minimum No-arc Length with the Capacity of the Fuse, for a given Metal.—The minimum no-arc length for both open and enclosed fuses of a given metal increases with the capacity of the fuse, but not strictly proportionally.

Variation of Minimum No-arc Length with the Pressure of the Circuit.—Experiments were carried out at pressures of 110 and 220 volts on open- and enclosed-type fuses. They showed that for open-type fuses the increase in length of the minimum no-arc length is at least in proportion to the increase in the circuit pressure for the ranges given.

Variation of the Minimum No-arc Length with the Character of the Fuse Metal.—Under the same conditions in open-type fuses the minimum no-arc length for zinc is decidedly less than that for copper. Zinc blows fairly cleanly; the molten metal is not scattered far, but occasionally some globules show a tendency to continue to burn in air where they fall. On the whole it is a good material from a short-circuit point of view. Tin in open-type cut-outs with short-circuit currents of ten times the normal fusing current behaves very much like copper with short-circuit currents limited to two or three times the normal fusing current; that is to say, it blows softly and quietly, and it is difficult to state from visual observation when arcing takes place. It may be taken that the damage to terminals with tin in lengths commonly employed is slight with short-circuit currents of ten times the normal fusing current. With 20- or 30-ampere fuses and short-circuit currents of 33×N.F.C. there is, however, a great display of fireworks, accompanied by copious fumes, and with the lengths commonly used severe damage to terminals is likely to ensue. With enclosed fuses the minimum no-arc length was found to be somewhat greater for zinc than for copper; this is due to the greater mass of metal involved for a fuse of a given capacity and to the molten metal being confined by the filling, and possibly also to the metal vapour not being so quickly oxidised as when the fuse is in air.

That the different metals behave in a characteristic manner on fusion with regard to the duration of the current rush on short circuit, the tendency of the arc to persist, and the induc-

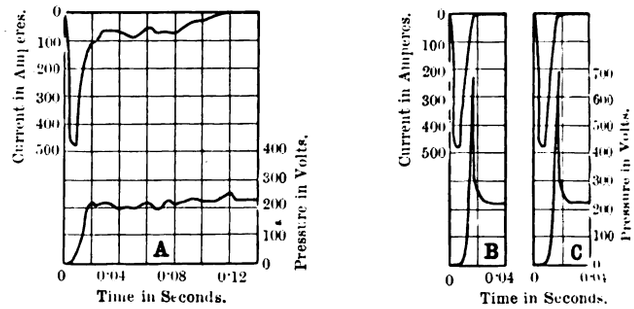


Fig. 2.—Oscillograms of Magnetic Blow-out Effect with Copper Fuses of Open Type on 220-volt Circuit. Fuses placed in a separately excited Field-coil Spool.

A. No magnetic field.
B. Lateral magnetic field.
C. Longitudinal magnetic field.
N.F.C. = 20 amperes.

tive pressure rise on breaking the circuit, was shown by a series of oscillograms.

Variation of the Minimum No-arc Length with the Inductance of the Circuit.—A consideration of these oscillograms showed that inductive pressure rises of as much as four times the circuit pressure may be met with in moderately inductive circuits. On non-inductive circuits the tests showed comparatively small voltage rises, and these were of short duration. Where present, the voltage rise occurs at two definite periods: firstly, when the current commences to fall, and, secondly, when it ceases.

Variation of the Minimum No-arc Length with the Disposition of the Cables to the Fuse Terminals.—In order to test the magnetic blow-out effect obtainable from the circuit conductors, the leads to the fuse terminals were bent through a right angle as shown in Fig. 1. It was found with this arrangement that the minimum no-arc length for open-type fuses could be very considerably reduced. For instance, with a 27-ampere copper fuse on a 220-volt circuit with leads bent up for a distance D = 4 in., the minimum no-arc length was 0·7 in., as against a length of 3·6 in. with the circuit cables entering the terminals in the ordinary way. Short-circuit current = 33 × N.F.C. The length was not materially increased with the bend in the leads reduced to D = 1 in., and even when an arc was formed it was of short duration and little damage was done to the terminals. This magnetic blow-out arrangement might well be taken advantage of in practice, as has already unwittingly been done with some

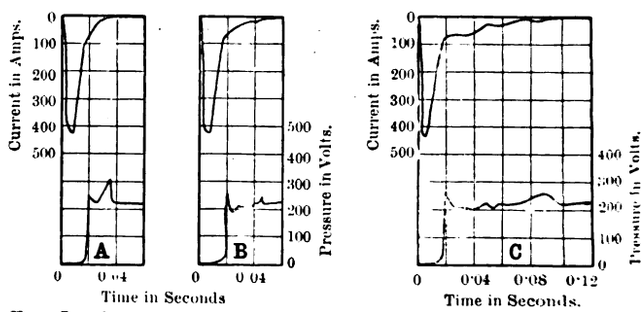


Fig. 3.—Oscillograms of Open-type Copper Fuse on 220-volt Circuit blown in a Longitudinal Magnetic Field, produced by forming the Lead to the Fuse into a Coil, through which the Fuse passed.

A. Coil of 10 turns.
B. Coil of 20 turns.
C. No magnetic field. The 20-turn coil was retained in the circuit, but removed from the fuse.
N.F.C. = 20 amperes.

forms of knife-blade terminals, and terminals in which the cables enter from the back in contradistinction to the sides.

In order to obtain more direct evidence of the magnetic blow-out effect, a number of oscillograms were obtained for open- and enclosed-type fuses when blown in a magnetic field, first, at right angles to the length of the fuse, and then parallel to the length of the fuse. A selection of these is given in Fig. 2, which

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shows the relative effects of these two dispositions for an open-type fuse when blown inside a field-coil spool which was separately excited. A longitudinal field was next produced by winding the lead to the fuse into a coil with a few turns through which the fuse passed; the results are given in Fig. 3. A consideration of this figure shows that the magnetic field is of considerable use in extinguishing the arc. Further experiments were made with the fuse wire doubled back upon itself for an inch, the legs of the loop being lapped with asbestos paper. The oscillograms are given in Fig. 4.

Extending the experiments on the magnetic blow-out effect to enclosed fuses, a small permanent magnet was first employed with but little effect. A solenoid was then arranged in series with the fuse, first, with lateral field, and then with longitudinal field; this resulted in both cases in the quicker rupture of the arc and an increased inductive pressure rise. The results are given in Fig. 5. A separately excited field coil gave similar results with both lateral and horizontal fields.

Variation of No-arc Length with the Mass of the Terminals.—The minimum no-arc length diminishes as the terminals are increased in size, and this effect is greatest with small fuses. This effect is probably not so much due to the cooling of the ends of the fuse by conduction (which for short-circuit currents of 33 × N.F.C. may be considered negligible, for the whole length of wire is almost instantly disrupted), as to the cooling of the arc vapour by the terminals. This cooling, taking place along a transverse section of the arc, introduces at each end a small section of high resistance which breaks down the arc.

Variation of No-arc Length in Enclosed Fuses, with the Character and Disposition of the Filling.—The formation of a slag tube around the fuse on disruption has already been referred to; the formation of such tubes would seem to depend on the

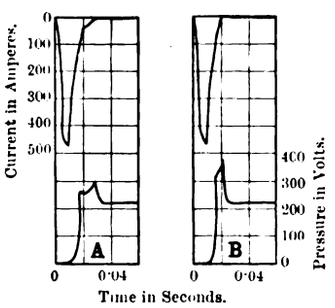


Fig. 4.—Oscillograms of Magnetic Effect obtained by Bending the Fuse Wire.

A. Straight wire.
B. Wire bent back on itself for 1 inch.
N.F.C. = 20 amperes.
In each case the wire was lapped round with asbestos paper and blown on a 220-volt, inductive circuit.

character of the filling employed, and to some extent on the character of the fuse metal. In general, silicious fillings favour the formation of these tubes, whereas cretaceous or chalky fillings do not. Metals with a high melting-point would at first sight seem to favour this formation, but it must be borne in mind that although the melting-point of a metal such as tin is low, yet the temperature of the arc following disruption may be, and probably is, as high as with metals of a higher melting-point.

The results given in Table I. are from experiments with various fillings in use commercially.

Table I.

Filling.	Remarks.
Calais sand	Forms tubes.
Coarse emery	Slight formation of tubes.
Fine emery	" " "
Trent sand	Does not form tubes.
Pumice	Forms tubes.
Chalk	Does not form tubes.
Crushed limestone	Very slight formation of tubes.

Apart from the formation of tubes and the absorption of moisture by the filling, the chief characteristics which differentiate the various materials used for fillings are the degree of fineness of the particles and the degree of tightness of the packing; the specific heat and thermal conductivity of the filling only influence the results indirectly, in that they affect the normal fusing current of the fuse. The normal fusing current for a given fuse is greater when enclosed and surrounded by a filling than when free in air from terminal to terminal. Experiments with a copper wire (N.F.C. in air 20 amperes) illustrating this point are given in Table II.

Table II.

Increase in Normal Fusing Current for Fuses enclosed in a Porcelain Tube ⅜-in. Internal Diameter with various Fillings.

Nature of filling.	Normal fusing current in amperes.
Air (open fuse)	20
Trent sand (loosely packed)	22
" (tightly packed)	25
Calais sand	30

In order to see if the diameter of the enclosing tube and the quantity of filling employed exerted any considerable effect on

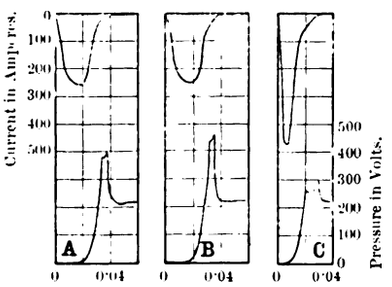


Fig. 5.—Oscillograms of Enclosed-type Fuse blown in a Magnetic Field produced by forming the Lead to the Fuse into a Solenoid.

A. Lateral magnetic field.
B. Longitudinal magnetic field.
C. No magnetic blow-out; extra length of lead forming the solenoid removed from the circuit.
In each case the fuse was of copper. N.F.C. = 20 amperes on a 220-volt circuit. Inductance, 0·023 henry.

the normal fusing current, tubes of ⅜ in., ½ in., and 1 1/16 in. internal diameter were employed, and in each case for a copper wire with a Calais sand filling the fusing current was found to be 30 amperes. These and other experiments indicated that it is only a comparatively thin layer of filling round the fuse which exerts any considerable influence on the fusing current, and that this effect is due chiefly to the conductivity of the filling for heat.

It is probable that with tubes of very small diameter and with a small amount of filling the normal fusing current would not be increased so much as in cases given in the table above. Three experiments with a No. 27 S.W.G. copper wire N.F.C. in air 20 amperes, when passed through a clay tobacco-pipe stem, gave a mean result of N.F.C. = 28 amperes. The same size wire when passed through a braided asbestos tube had an N.F.C. = 22 amperes when the texture of the braiding was open, and 25 amperes when the texture was very close.

The effect of the size of the particles of the filling on the

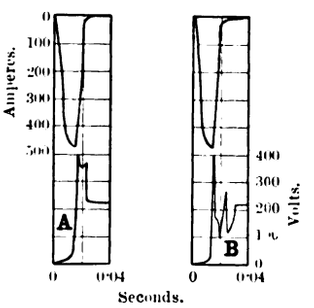


Fig. 6.—Oscillograms showing the Effect of the Size of Particles of the Filling on the Behaviour of an Enclosed Fuse.

A. Powder passed through mesh 50 to the inch.
B. Powder passed through mesh 10 to the inch, retained on mesh 30 to the inch.
No. 27 copper wire on a 220-volt inductive circuit. Crushed limestone filling.

duration of the arc is shown in Fig. 6. It will be seen that the more finely the material of the filling is divided the more quickly is the arc extinguished, and consequently the pressure rise on an inductive circuit would be high. This result is supported by a large number of oscillograms with various powders, both coarse and fine. The fine powders seem to be more effective in repressing the arc than the coarse ones, owing to their interstices being smaller and less air being included. This effect is linked with the degree of tightness with which the filling is packed: in the oscillograph experiments, the results of which are given in Fig. 6, the powders were not packed into the

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tubes, but merely shaken down lightly into position. With the coarse filling the circuit was sometimes opened satisfactorily and sometimes irregularly.

Experiments were carried out with fillings of various degrees of fineness packed both tightly and loosely, and it was found that with fine powders the minimum no-arc length was shorter for both tight and loose packing than with coarse powders. This points to the presence of air spaces in the filling, due to the size of the particles of the filling being large, as having an adverse influence on the minimum no-arc length, since the tightness of

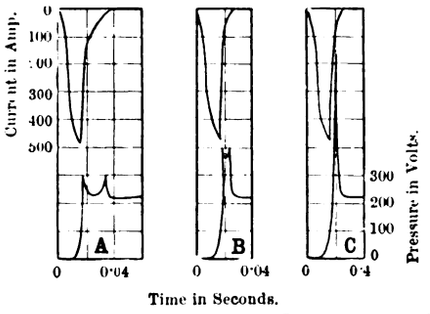


FIG. 7.—OSCILLOGRAMS SHOWING THE INFLUENCE OF TIGHTNESS OF PACKING IN THE FILLINGS FOR ENCLOSED FUSES.

A. Copper wire in bone ash loosely packed.
B. Copper wire in bone a-h tightly packed.
C. Copper wire in Plaster of Paris (equivalent to a very tight packing).
N.F.C. for copper wire in air = 20 amperes. 220-volt inductive circuit (0·023 henry).

the packing has but little influence in reducing the air spaces with coarse powders. Results illustrating this point are given in Table III.

Table III.

Effect of Tight and Loose Packing for Fillings of Enclosed Copper Fuses on 220-volt Inductive Circuit.

N.F.C. of copper fuse in air.	Minimum no-arc length in inches.		
	Calais sand.	Trent sand.	
		Loosely packed.	Tightly packed.
27 amperes... ..	2·0 in.	1·4 in.	0·8 in.
43 „	2 2 „	1·4 „	1·0 „

With fine powders loosely packed there is a good deal of noise on disruption if the jacket is not hermetically sealed, and the filling is much blown about and some of it is compressed by the explosion against the inside of the tube. Loose fillings are therefore not to be recommended; and, further, when used vertically, as is nearly always the case, the filling will gradually settle together more closely, leaving a portion of the wire at the top end of the fuse exposed.

In order further to investigate the influence of tight packing, a series of experiments was carried out with fuse wires set in plaster of Paris. This practically amounts to a fuse with a very tightly packed filling; such fuses give a quick break, with a consequent high inductive pressure rise on inductive circuits.

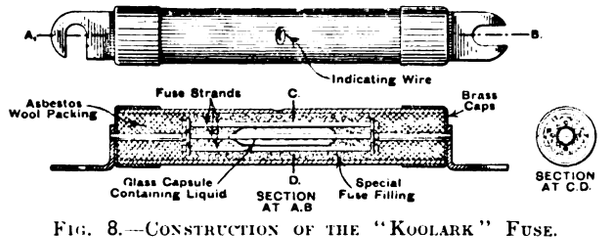


FIG. 8.—CONSTRUCTION OF THE "KOOLARK" FUSE.

Oscillograms on this point are given in Fig. 7. In general, these fuses blow very quietly, provided that the plaster covering does not crack or rupture; when this occurs bad arcing frequently results, and a loud report is produced. It is essential that the whole length of the fuse wire should be embedded in the plaster; this can be effected by soldering the fuse to stout copper connecting wires, one end of the wire being connected to the fuse contacts, while the other is embedded in the plaster. A containing envelope or jacket, even if only of slight mechanical strength, is essential for plaster fillings.

The presence of moisture in the filling may affect the fuse in the following ways:—(*a*) By actual combination with the filling material, causing it to set or otherwise altering its condition, *e.g.*, plaster of Paris; (*b*) a filling which has been moist may on subsequent drying become more or less coherent or caked; (*c*) an absorbent filling or a hygroscopic one will affect the arc disruption by cooling it, but may give rise to considerable pressure due to the generation of steam. It will also give rise to electrolytic corrosion in course of time; (*d*) The filling may be normally dry, the liquid being held in a special vessel or container, and is only liberated on a short circuit taking place when it extinguishes the arc. With enclosed fuses in general the jacket affords considerable protection from moisture, and the filling materials usually employed do not cake or cohere. Moisture in the filling, however, is not unusually present in commercial forms of fuses in red fibre jackets, as it exudes on tests when the fuse becomes hot. The closing of the vent holes of such fuses with a disc of glazed paper does not seem to be a very efficient means of preventing the ingress of moisture in damp situations.

Experiments were made with Calais sand as representing a silicious non-absorptive filling. Oscillograms of a copper fuse on a 220-volt inductive circuit with fillings containing up to 12·8 per cent. of water by weight showed that no very marked effect is produced on the action of the fuse by moderate amounts of moisture in the filling, but that when in excess—with 12·8 per cent. of water the filling was almost "sloppy"—it produces irregularity of action in the fuse.

Experiments were then made with a filling of Trent sand; this is much finer in texture than Calais sand, and absorbs water

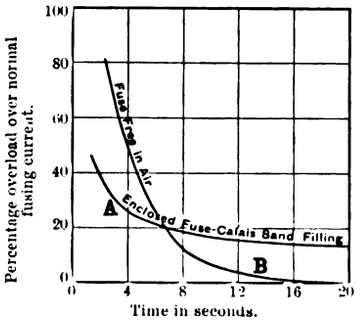


FIG. 9.—RELATIVE TIME ELEMENTS FOR COPPER WIRES WITH APPROXIMATELY THE SAME N.F.C. IN AIR AND IN CALAIS SAND. FUSES INITIALLY COLD.

A. N.F.C. in air = 32 amperes.
B. N.F.C. in Calais sand = 30 amperes.

freely, ultimately forming a mud. As the percentage of moisture in the Trent sand was increased, the action of the fuse became irregular, but with the moderately wet sand tightly packed a quick break and high voltage rise resulted. In this series of oscillograms of fuses in Trent sand, which are not reproduced here, the arc was broken very quickly, due probably to its being cooled by the evaporation of the water. This point is of interest in connection with a type of fuse recently placed upon the market in which a special liquid enclosed in a small glass tube is disseminated throughout the filling when the fuse is subjected to a short circuit. When the fuse blows with a moderate overload the glass tube is not broken and the filling remains dry. The construction of this fuse is shown in Fig. 8.

Although moisture in the filling may not very seriously affect the action of the fuse as far as the suppression of the arc is concerned, its presence in enclosed fuses is not at all desirable, as it would certainly lead to corrosion and electrolytic troubles, particularly if a contact difference of potential exist between the fuse and the wire or lug connecting it to the fuse contacts.

TIME ELEMENT.

Relative Time Element for Open and Enclosed Fuses with the same Normal Fusing Current.—A copper wire in an enclosed cut-out with Calais sand filling was found to have a normal fusing current of 30 amperes. A second copper wire was then taken and drawn down so as to have as nearly as possible this normal fusing current in air. The time elements for these two wires were then found for various overloads, and the results are shown graphically in Fig. 9, where the crossing of the curves owing to the smaller amount of metal in the enclosed fuse is clearly shown.

Temperature Rise for Jackets of Enclosed Fuses.—The chief factor which determines the temperature rise of an enclosed fuse as measured by the external temperature attained by the jacket is the melting point of the metal employed, metals with high melting-points on continuous overloads giving a higher

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external temperature on a jacket of given diameter than those of greater fusibility. Experiments were first made with jackets of red fibre. Copper gives the highest temperature-rise, but when running at 50 per cent. of its normal fusing current (*i.e.*, when rated to blow with 100 per cent. overload) the temperature attained even at full load is not excessive, and when running at the rating given in the Institution Wiring Rules, namely, 200 per cent. overload for fusion—the external temperature of the jacket does not differ very materially from that obtaining with zinc and tin.

In order to determine the effect of the jacket material on the external temperature attained similar tubes of red fibre and of brass were next employed as jackets. The difference in temperature rise with a given load in the two cases was found to be very slight, the external temperature of the metal tube being slightly higher than that of the fibre tube. A short series of experiments were carried out to determine the effect of high temperatures on red and black fibre, with the following results :—

1. Red and black fibre heated at 180° C. : A slight amount of moisture came off in the form of steam, but there was no charring.

2. Red and black fibre heated to 210° C. for forty-five minutes : The specimens got very dry but were not apparently charred.

3. Red and black fibre heated to 240° C. : The specimens first became brittle and then charred.

With material composed largely of vegetable fibre brittleness and charring may be induced by exposing it for a long period of time to temperatures considerably lower than those referred to. With fibre tubes charring frequently occurs as the result of a short circuit, and even if it does not show on the outside of the jacket an examination will frequently show that the inside surface has been blistered.

Note on the Rating of Fuses.

A good deal of confusion exists as to the rating of fuses owing to the variety of conditions on which this rating may be based. The following suggestions are therefore put forward with a view of eliciting discussion on this point, and of possibly clearing away some misconceptions.

The fuse may with advantage be designated by the normal full-load current of the circuit on which it is to be employed. Thus, a "50-ampere fuse" would mean a fuse for the protection of a circuit the normal full-load current of which is 50 amperes.

The figure obtained by dividing the maximum permissible overload by the full-load current of the circuit represents the "sensitiveness," or, more correctly speaking, the insensitiveness of the fuse.

The normal fusing current for a given line of fuses should be obtained by the manufacturers or by an independent testing authority, and the fuses marked with their rating before being placed on the market.

In the United States the regulations given in the National Electric Code (1905) as regards rating are as follows :—

Open-type Fuses.—Must be stamped with about 80 per cent. of the maximum current which they can carry indefinitely, thus allowing about 25 per cent. overload before the fuse melts.

Note: With naked open fuses of ordinary shapes and with not over 500 amperes capacity the *minimum* current which will melt them in about five minutes may be safety taken as the melting-point, as the fuse practically reaches its maximum temperature in this time. With larger fuses a longer time is necessary. This data is given to facilitate testing.

Enclosed Fuses.—With the surrounding atmosphere at a temperature of 75° F. they must carry indefinitely a current 10 per cent. greater than that at which they are rated, and a current 25 per cent. greater than the rating, they must open the circuit without reaching a temperature which will injure the fuse-tube or terminals of the fuse block. With a current 50 per cent. greater than the rating, and at a room temperature of 75° F., the fuses starting cold must blow within the following times :—

Capacity of fuse.	Time.
0–30 amperes	30 seconds
31–60 ,, ...	1 minute.
61–100 ,, ...	2 minutes.
101–200 ,, ...	4 ,,
201–400 ,, ...	8 ,,
401–600 ,, ...	10 ,,

Note on the Time Element of Fuses.

The time element of a fuse may be defined as the time lapse necessary for the heating of the fuse from the cold state to the fusing-point with a given overload. The heat capacity of a fuse will be proportional to the mass heated, the average specific heat of the mass, and the temperature rise from the cold state to the melting-point. With enclosed fuses this heat capacity will vary with the character of the overload, since with large overloads there is insufficient time for the conduction of heat from the fuse to the filling, and the temperature rise of the latter is consequently small. Apart from the above consideration the time required for reaching the fusing-point is for a given fuse inversely proportional to the square of the current. The heat capacity of a fuse may be varied by changes in the fuse metal, the shape of the fuse, or the environment of the fuse. These variations may be made use of for altering the time element of a fuse for a fixed rating to a considerable extent. The greatest difference in time element will be between an open fuse of copper and an enclosed fuse of a sluggish metal such as tin or zinc; Fig. 10 shows the relative time elements of such fuses with a fusing current of about 250 amperes. The results given are collated from Meyer's* experiments for copper fuses and from Edward Taylor's† tests on enclosed fuses. These curves show that with an overload of 50 per cent. the time elements for enclosed and open fuses are as 4 to 1 and at 25 per cent. overload as 7 to 1. The above considerations hold for fuses of the same rating; the time element for a given type of fuse will, of course, vary with the capacity of the fuse.

It is desirable that a definite basis for reference should be established for the time element, and the authors suggest that the time element of a fuse should be defined as follows :—"The time element of a fuse is that time which is required to heat up the fuse from the cold state until it blows with an overload of 50 per cent. reckoned on the normal fusing current of the fuse."

For large-size enclosed fuses the time element as defined above

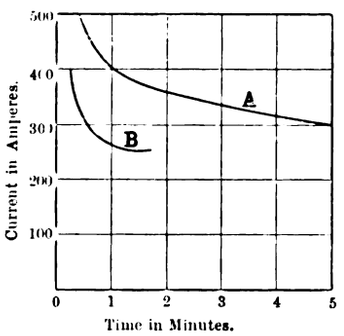


Fig. 10.—Relative Time Elements of Enclosed and Open-type Fuses.

N.F.C. about 250 amperes.

A. Zinc enclosed type.
B. Copper open type.

would be of the order of four or five minutes. For metals with low melting-points the time element will be increased if the external temperature is high.

Note on Short-circuit Currents.

It is evident that the position of a fuse on a system with reference to the generators will largely determine the character of the current rush on short circuit; it would therefore seem advisable that fuses should be tested with the short-circuit currents which would be likely to be met with in the class of circuit which they are intended to protect. It should not be expected, for instance, that a fuse on a distribution board in a house installation should be tested on a dead short circuit across station bus-bars. The authors have restricted their paper to a consideration of fuses up to 50 amperes for house service, and in this class of installation the maximum drop in volts with the full-load current is usually limited to 2 per cent. With the fuse rated to blow with twice the full-load current this maximum drop would be doubled, so that as an average value with the normal fusing current of the fuse flowing in the circuit a drop of 3 per cent. may be taken; this value is also supported by experimental evidence. As already pointed out, this arrangement neglecting the resistance of the fuse allows of a short-circuit current = 33 × N.F.C. of the fuse.

Whether a fuse on short circuit blows before the current has time to reach the value limited by the resistance of the circuit depends upon the nature of the fuse, the amount of the short-circuit current relative to the normal fusing current and upon the inductance of the circuit.

The German regulations as to short-circuit tests are as follows :—

"The output capacity of the source of current and the resistance of the leads are to be so arranged that at the time the fuse blows the total fall of pressure in them shall not exceed 1 per cent. These conditions will be regarded as being fulfilled if in the place of the fuse an adjustable resistance is placed arranged

* *Zur Theorie der Abschmelzsicherungen*, R. Oldenbourg, Berlin, 1907.
† *Street Railway Journal*, vol. 25, p. 548, 1905.

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to carry a current of twenty times the normal carrying capacity of the fuse (this current must not, however, be less than 400 amperes), and at the same time the pressure across the terminals of this resistance must not be less than the normal pressure of the circuit for which the fuse is intended, the drop in the rest of the circuit being not more than 10 per cent. of this. When matters have been arranged to comply with the foregoing conditions the switch is to be opened, the resistance removed, and the fuse replaced. On closing the switch the fuse must melt without maintaining an arc and without explosive violence."

The authors found that when the short-circuit current was limited to 30 or 40 times the normal fusing current for a 20-ampere fuse, the magnitude of the short-circuit current was independent of the capacity of the generators employed within the following limits:—(1) A 50-kw. machine; (2) four 100-kw. generators with a 450 ampere-hour battery in parallel. It would seem, therefore, that if the current rush on short circuit is limited as above for testing purposes, the capacity of the generator need only be such that it will not be seriously overloaded by the short-circuit current in question. Since the duration of the short-circuit current is so small, being of the order of a few hundredths of a second, the voltage of the machine is maintained. In the authors' experiments two or three 100-kw. machines were employed in parallel with the battery mentioned above.

Note on the End Caps of Enclosed Cut-outs.

In enclosed cut-outs in which the fuse wire or strip is carried through a hole or slot in the end cap or ferrule and then secured by solder or in a terminal of some sort, it is necessary to protect these holes from damage from the arc, particularly if they are used as gauging devices to limit the wire or strip employed to a predetermined size. If the distance between the end caps is such that an arc can be set up between them, the hole or slot will either be considerably enlarged or damaged by fusion, or the wire or strip ends will become fused to the caps. This can be prevented by a device due to one of the authors, in which the fuse wire or strip before entering the hole or slot in the end cap or fuse contact makes contact with a washer or other easily renewable metal piece which is in electrical contact with the end caps or fuse contacts, and is therefore at the same electrical potential as they are. The damage will then be confined to the removable metal piece. It would appear advisable to do without free holes or openings in the end caps as far as this is possible, as they not only allow of the emission of flame on short circuit, but seem to favour the persistence of the arc.

DISCUSSION IN LONDON, MARCH 3rd.

Mr. Leonard Andrews, referring to the curious effect of the minimum arc length, namely, that it seemed to be larger with a short-circuit current of ten times the normal fusing current than with thirty-three times the normal fusing current, said that this peculiar feature had been noticed by many who had experimented with fuses. The authors suggested one or two explanations, one of which was that the magnetic blow-out effect due to the larger current in the leads might assist to extinguish the arc. He carried out a number of experiments at Hastings on high-tension fuses, and came to the same conclusion, namely, that the magnetic blow-out effect had a great deal to do with it. A great many of these experiments had been illustrated and described in his book on "Electricity Control," but there was one experiment, not referred to there, which appeared to him to

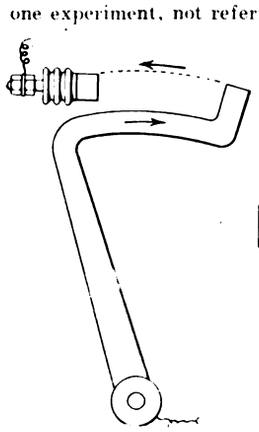


Fig. 11.

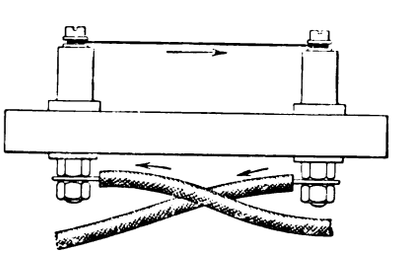


Fig. 12.

Mr. Andrews' Experiments.

show particularly that there was some truth in the author's suggestion. He was endeavouring to utilise this magnetic blow-out effect to extinguish the arc on a high-tension switch in the manner indicated in the diagram above (Fig. 11). It was before the days when they recognised that an open arc was a very bad thing to use. The direction of the flow of current in the switch-blade is opposite to that in the arc, and the latter is repelled. He found that with a 4 in. or 5 in. break, a current of about 100 amperes at 2,000 volts was interrupted reliably every time the switch was opened, whereas with a current of less than 50 amperes the arc was maintained. He also asked whether the authors had tried the experiment of crossing the conductors, as shown in Fig. 12. His experience in carrying out this experiment was that the magnetic repulsion effect was very largely increased. He found, in fact, that the arc from a fuse having a normal fusing capacity of 200 amperes stretched across a pair of terminals 6 in. apart was reliably interrupted when short-circuited across the poles of a 2,000-volt Mordey alternator, whereas with the leads carried straight into the terminals without crossing the minimum no-arc distance would probably be three or four times this length. It appeared to him that this principle might be applied to low-tension fuses with some advantage, at any rate, on alternating-current circuits, where a rapid interruption to the arc would not cause an injurious inductive pressure rise. Early in the Paper the authors had stated that with enclosed fuses they had found the results of short-circuits much more severe with thirty-three times the normal fusing current than with ten times the normal fusing current. This had not been his experience with high-tension fuses. He had frequently experienced cases of fuses of comparatively small capacity entirely failing to break the arc on short-circuits that probably did not amount to more than two or three times the normal fusing current, whereas similar fuses had operated perfectly on very much heavier short-circuit currents. He remembered discussing some years ago with an engineer in America, who had experimented a good deal with fuses on 20,000-volt circuits, and he had informed him that they often found that fuses on their extra high-tension lines worked perfectly on heavy short-circuits, such as might result from direct contact to earth, whereas they entirely failed to interrupt the arc on a slight overload that might be just sufficient to melt the fuses. It was probable that the phenomenon might be due, as the authors suggested when speaking of open fuses, to the fact that with a heavy short-circuit current the fuse wire is entirely volatilised, whereas with a slight overload the wire is melted into one or two pieces only, with the result that a small chain of arcs is formed between the terminals.

Mr. Alexander Russell thought that the Paper would form a partial basis upon which fuses could be rated, but in this connection they would have to consider the effects of voltage which the authors had not taken into account very fully. On the question of the choice of metal for a fuse, he mentioned that the interior of an aluminium or zinc fuse at the moment just before it fractured was molten. In the case of aluminium, the latent heat was 77 and the specific heat 0·3, whilst the melting point was 657. This showed that at the moment of rupture about 30 per cent. of the heat in the fuse was due to the latent heat. The latent heat and vaporisation of the metal should also be taken into account, and possibly the thermal conductivity. It might also be a question whether the most economical fuses to use with the various metals might not be of different lengths. He took it that what happened in the case of a fuse going was that it simply burst all along its length, much the same as a pipe would when the pressure inside became too great. With an aluminium fuse, for instance, the temperature in the interior was considerably higher than on the outside, due to the fact that the outside oxidised, and the oxidised metal was a worse conductor than the pure metal in the interior. It might be objected that he had neglected the skin effect, that when there was a sudden rush of current passing through a fuse, the current would be on the outside, owing to skin effect, but the oscillograms which had been exhibited proved that the skin effect would be quite negligible. The difference of temperature between the inside of the wire and the circumference depended upon the conductivity of the wire, and it was only appreciable when the current density was exceedingly high. In the case of a trolley wire, the difference of temperature at the centre and on the outside was possibly only $\frac{1}{1000}$ C., but in the case of a fuse, when the current density was so enormous, and for different metals than for copper, the difference of temperature was very high. This caused the metal inside to melt, to vaporise, and finally to explode, spurting the metal sometimes five or six yards away and making a report like a pistol-shot.

Mr. W. H. Patchell said the authors appeared to have found out that zinc and aluminium were both bad for fuses, because they oxidised. Years ago the same thing had been found out, and such fuses were given up on that account. In damp cellars they got skins such as were made by caddice-worms, namely, hard scales outside. The *bonâ-fide* metal inside then carried the current long after the metal had melted. He had had to go into the question of fuses several years ago, more particularly for street work. Some people had tried fuses at the end of the feeders, but he did not like them there because the current was too great. With house fuses they never had any trouble if they put in fuses that were large enough, in other words, they could let the consumers' fuses melt and still be quite happy, because the supply authorities would not be sent for. But for street work, in which the districts became bigger and bigger and more important, an accident on one side must

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not be allowed to interfere with the rest of the network, and therefore it was necessary to limit, as far as possible, the extent of the damage. They had tried light fuses which could be put in at certain places where the areas joined, and where they had only to carry what might be called the balancing current between the different areas. The main consideration, then, was to have a fuse which would not cause a gas explosion in the street boxes. He had tried various forms of network fuses, including enclosed fuses. He started, of course, with those mentioned by the authors, which were enclosed in cylinders of red vulcanite. These were not satisfactory on account of damp; then they tried metal casings. They finally got on to a form similar to Peard's patent, and this type had been evolved into a form which was a fuse in a piece of common steam-pipe. They also sent round to all the different makers of silent fuses and gas-proof fuses, and some were obtained, but one day, whilst a Board meeting was being held in a room overlooking one of their sub-stations, there was a tremendous explosion, and on inquiry it was found to be a mains superintendent testing a silent fuse. They also tried various methods of filling tubes. They had not tried Trent sand or Calais sand; in fact, he would like the authors to say what was the difference between these two. Was one a slag sand, and did the other have rather more alumina in it? [Prof. Schwartz was understood to express assent.] He had tried marble dust and plaster of Paris, and could not find anything better than the latter. It did not matter whether it was poured in wet or put in dry. The authors had referred the question of the power behind the fuse. He had heard experimentalists say that this made no difference; but this was not his opinion from experience. He had tried fuses at 100 volts which acted quite well, and the arc did not carry over. On trying the same fuses on 200 and 400 volts they quite failed. The one difficulty in connection with fuses was to secure blocks to carry different sizes of fuses. At present they only had blocks which would carry a particular fuse. With regard to rating, there were all sorts of ratings; sometimes 100 amperes meant a fuse which would blow at this current, and another time a fuse which would carry 100 amperes to blow at 200 amperes. He would like some definite ruling as to how the fuse should be rated. He thought it was an open secret that a part of Prof. Schwartz's experiments had been carried out at the instigation of the Engineering Standards Committee, and it was a pleasure to get a little ahead of the Standards Committee and be enabled to discuss Prof. Schwartz's Paper. For heavy currents fuses had practically been given up entirely, and automatic switches employed as the only practicable substitute. He had seen heavy fuses for low tension with a shunt fuse in parallel, which was supposed to go last, but he had never tried this arrangement. For high-tension work, when he started at 10,000 volts, he used two fuses in parallel, one in a tube open at each end about a foot long and with the terminals about 12 in. apart. Alongside of it was a *small* tube $\frac{1}{8}$ in. in diameter, and a small fuse was threaded in this; but the big one would not go until the small one went. He then tried oil fuses for 1,000 volts continuous current. For several years he had used the Ferranti fuse, but it was impossible to calibrate this owing to the cooling property of the oil. He then adopted the calibrated oil type fuse, which was illustrated in his Paper on the Bow Works. Although this was called an oil fuse, the fuse was just above the surface of the oil as regards the actual visible portion, in a little inverted cup. As soon as the fuse acted it was drawn down into the oil before really there was any time for a surge to take place. This had the advantage that the visible portion was in action, and it was possible to calibrate without the interference of the cooling effect caused by the oil. He had also tried sparklet fuses for heavy currents, but had not adopted them.

Mr. C. C. PATERSON said that in 1902 some tests on sparking in switches carried out by himself and Mr. Alexander Russell, were published in the Institution Journal. The distance which they called the safe sparking distance came out in the case of switches at 50 per cent. greater than the authors gave as their minimum no-arc length. This was understandable, because in a fuse it did not matter if the contacts got a little damaged, whereas in a switch they wanted to avoid this.

Mr. W. M. MORDEY said the experiments which he had made upon enclosed fuses 17 or 18 years ago—and which he had almost forgotten—induced him to come to the same conclusion as the authors in giving preference to copper or silver as the best metals for fuses. They wanted a metal that had as lean a vapour as possible and as little matter as possible, and most people in these days used copper by preference. But for very small currents it was not possible to get a copper wire small enough to be handled practically, and for this reason metals of more or less higher specific resistance were used. As a filling he had tried a great many substances, but had avoided all forms of sand, glass, or powder, and everything that was at all likely to form, when fused, a conducting liquid. He had tried marble dust and various forms of lime, but finally he had settled down upon a very unscientific material, but one which he had found to be the best, viz., the dust scraped out of the inside of boiler flues. This was a highly infusible material, and it was best when passed through a sieve. He had used that with copper wires in an envelope not too tightly rammed. Reference had also been made to more readily oxidisable metals having tubes formed on them which the authors stated conducted similarly to Nernst filaments. He was certainly in agreement with Mr. Patchell in thinking that these tubes conducted by the molten metal inside. Take, for instance, an aluminium fuse three inches long. When heated carefully at such a temperature, as it would not blow out, it was evident that the inside molten metal was protected by the comparatively thick skin of oxide. The shunting of fuses was also old, and although he did not wish to get up and say, "I did it," nevertheless he had obtained a patent for an enclosed fuse of this character many years ago, and he had often used these fuses. They seemed to work all right. His experience was that the effect of ageing made it very difficult to rate fuses. They might be rated and keep their rating fairly well for a time, but the life of a fuse was a rather unhappy one. It was frequently being heated, and it went through various changes; it was oxidised, expanded and contracted, and he found that with all metals with which he was acquainted the rating changed very much. He thought that this would always be one of the difficulties of rating fuses. One interesting point, perhaps, was that he found that copper wires, when examined under a fairly high magnifying glass—not a microscope—showed, after a long period of use, a multitude of small transverse cracks seeming to go right down into the metal. This reminded him of the fact that at the time Edison was experimenting with platinum lamps, in the early days, he had had to give them up because he found that the life of the platinum filaments was so short, and he had attributed the cause to the gradual growth of these minute transverse cracks in the metal itself. With regard to a magnetic arrangement to help to blow out the fuse he supposed that they had all invented such an arrangement one time or another; in fact, he could give a long list of patents for this particular thing. Perhaps the reason why none of these arrangements had been taken up seriously was the same one which had prompted all of them: namely, that when they found someone else had patented a thing and that it was difficult in consequence to make money out of it, they did not follow it up. A great many people had invented an arrangement of a little spiral inside a porcelain holder or merely a conductor coming up to the fuse itself, arranged spirally, so that the field set up would help to elongate the fuse and blow the arc. It was an interesting arrangement in practice, and he thought it was quite worth while putting the idea into a simple form for house fuses, especially now that higher voltages were being used than formerly. He agreed with Mr. Patchell that for house fuses the best thing was to have plenty of metal; a penny made a very good fuse if they had nothing better.

Mr. A. C. CRAMB, in response to an invitation by the Chairman to speak, said that his experience was generally in accordance with the remarks already made with reference to copper fuses. He was in the fortunate position of hardly ever having his fuses go, and therefore he had no experiences of this kind to relate.

Mr. H. M. SAYERS said he had extensively used copper-wire for street main fuses on secondary networks. He had found copper a most useful and trustworthy material, always provided that it was changed sufficiently often. This he found generally to be twice a year, not at six months intervals, but about the end of August and the end of January, so that the time of heavy load was about fairly divided. Under these conditions copper could be relied upon to blow at a very definite current.

Mr. C. H. WORDINGHAM said that as Chairman of the Sub-Committee of the Engineering Standards Committee which had this question in hand, he would like to acknowledge the great help received from Prof. Schwartz on that committee, and also to thank him for the large amount of help that they were looking forward to having. The thing which had struck the members of the sub-committee most was the extreme difficulty of the problem connected with anything in the nature of standardisation. To begin with, it was difficult to classify fuses. With regard to rating, it was a wonder how very little was known at the present time with regard to fuses, and they arrived at the conclusion that they must get carried out a great deal of experimental work before they could attempt to standardise them. The sub-committee had arranged to divide up fuses into different ranges, and different members of the sub-committee were taking up experiments on these lines. They had laid down a common basis, and had taken steps to secure that the experiments should be carried out on identical lines, so that they hoped when they had standardised fuses their suggested regulations would be founded on experimental data of considerable value. He would like to make one or two remarks on points raised during the discussion. He could not help thinking that those who thought the amount of power behind the fuse had something to do with the matter, and those who thought it had little to do with the matter were really talking about two different things. Prof. Schwartz's experiments all related to a wire between two contacts, which were fixed at what he called "no-arc distance," and he quite agreed that experiments on these lines were necessary as a foundation for any standard conditions for fuses; but the container in which these fuses were carried had a very great deal to do with their action in practice. A good many years ago, when 220 volts were first intro-

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duced, he made a number of experiments upon existing house-fittings and small fuses to see how they would stand on the higher pressure, and he found that the amount of power behind the short made an enormous difference. At that time he introduced a system of registering fittings, and he had thought that if he tested the fuse at 30, 40, or 50 times the normal fusing current he had sufficiently well imitated a short circuit. Later on he thought it well to repeat the experiment, and he then tried the same fuses by short-circuiting them dead across a large battery, and in many cases he found that those fuses which had passed the first test failed altogether on the second. He had come to the conclusion that if these wires had been supported between two open terminals there would have been no difference, because the oscillograph tests, shown by Prof. Schwartz, indicated that while a certain amount of power in some cases would make no difference the explosive action of the tubes by the sudden development of heat varied very greatly with the amount of power behind. With regard to the rating of fuses, there was certainly a great deal to do and a great deal to consider. The only thing they were all agreed on was that everybody hitherto had rated fuses rather highly. With regard to fillings, he had recently made some experiments to test the amount of caking that might be expected in damp situations. He had taken a large number of tubes and filled them with fine and coarse emery, steatite, fine and coarse sands, chalk, and several others, and had sent them to sea for three months, and then opened them to find if in any case there had been any caking. The result was that there did not appear to be so much caking as many of them would have expected.

Mr. J. J. FASOLA said he was sorry the Paper was confined to low-tension fuses. With the data before them there should not be any difficulty in selecting suitable materials and no-arc lengths for low tension, but he thought they would all be very grateful if the authors could give similar information with regard to high-tension fuses. The conditions in connection with 5,000 and 10,000 volts, for instance, were quite different, and so far there had been a general tendency to resort to the use of oil. He had seen some very large porcelain cartridge-type oil fuses on the Continent about one foot in diameter, but notwithstanding their large size they were not a complete success, and, of course, they were very difficult to handle. They had a fuse wire entirely in air, and arranged so that the lower contact would be drawn under oil at the moment of disruption. The fusing current could be pre-determined fairly accurately, but the metal vapour very often caused sparking over to exposed metal in the neighbourhood. If, on the other hand, the tube was completely immersed, it was conceivable that it was necessary for a film of oil to form about the silver wire before it could blow, and as the conditions of vapour formation and circulation of the oil and thermal conductivity were never the same twice running, it was impossible to depend upon the fuse blowing at predetermined overloads. When the fuse was partly immersed, matters were still worse, because the fusing point depended upon the level of the oil. The best solution of the problem in his opinion was the fuse described by Mr. Patchell in his Paper before the Institution in 1905, and already mentioned by Mr. Patchell in the present discussion.

As time for adjournment had been reached, Prof. Scharwtz was asked to communicate his reply for publication in the *Journal*.

Three written contributions to the discussion have been received:—

Dr. C. C. Garrard (Ferranti, Ltd.) said that the definition of normal fusing current, as given by the method of measurement described in the "Note on Rating Fuses" at the end of the Paper, was no doubt perfectly correct. The time-current curve tends towards an asymptote, and the point where this asymptote cuts the current axis is the normal fusing current. No current below this value, no matter how long it be kept flowing, should blow the fuse. He was under the impression, however, that the authors in their previous Institution Paper on "Low-Tension Thermal Cut-outs" (the I.E.E. *Journal*, March 14th, 1905, p. 364, Vol. 35) had adopted a different definition of "normal fusing current." The oscillograms given in the Paper seemed to show that the so-called "non-arcing" metals of the cadmium or zinc group arced more than any of the others, which confirmed his own opinion, that the so-called "non-arcing" property was more or less a myth. In his experience of fuse testing, the amount of power behind the tests has always been the most important factor determining the severity of the tests. His own tests, however, had generally been with fuses of large sizes (several hundreds of amperes), and had taken place close up to the terminals of the source of supply of current. The most severe conditions seemed to be close up to the terminals of a large battery. He did not agree with the authors' definition of the time element of a fuse, the object of which, he understood, was to arrive at some time element which could be marked on the fuse. The ordinary user, however, seeing the time marked on the fuse, would think that this is the time taken to blow the fuse. He would not realise that it is the time corresponding to some particular current, and that if the current be a little different from the proper current, say 45 per cent. overload, or 55 per cent. overload, the time element would be altogether different. He had had exactly the same experience with inverse time element relays. Of course, the time element of a fuse was also inversely proportional to the extent of the overload, similarly to such relays. It had been at first endeavoured to mark these relays with certain specified numbers of seconds, but it was found extremely difficult to make even electrical engineers understand these markings. The user saw, for example, the relay marked 5 seconds, and assuming the apparatus to be a kind of clock, proceeded to test it with a stop-watch. Generally speaking, no particular regard was paid to the current flowing through the relay, and the result was that the relay was said to be out of order. He had come to the conclusion that the inverse time element of any circuit-breaking apparatus should only be defined in terms of a curve. If the full curve cannot be given, it was better not to mark the time element at all. To illustrate this he took the curves given in Fig. 9, for two fuses of the same normal fusing current. Defining the time element in accordance with the author's definition, that of the free fuse is about four seconds, that of the enclosed fuse about one second. I think now it would be an assumption legitimately made by 99 persons out of 100, that if these two fuses were placed in series with each other, and the same overload current passed through them, the one-second time element fuse should blow before the four-second time element fuse. This, however, did not follow. If the overload was but small, just above the normal fusing current (say 15 per cent.), then the four-second time element fuse would blow before the one-second time element fuse. If, on the other hand, the overload were very large, as, for example, several hundred per cent. above full load, it would be a matter of chance which one would blow first, as if the curves are prolonged the time element disappears altogether in both cases. The matter of time elements of fuses was also of great importance in connection with another subject, viz., to the fuse-shunted trip coils used very greatly at the present day to impart a time element to automatic alternating-current circuit-breakers. Of course, an ordinary trip coil operates practically instantaneously, and the idea is, by shunting the current through the fuse, that the time taken by the fuse to blow will impart the necessary time element to the apparatus. The main object of a time element circuit-breaker was to attain the possibility of having two or more circuit-breakers in series, so arranged that with a definite overload through them they would open in a predetermined order. In the Paper he had submitted to the Institution, but which had not yet been read, he had shown that it is not possible to attain this end by simply altering the size of the fuse wire. Prof. Schwartz and Mr. James' Paper also showed that it is quite impossible to arrive at this end by altering the materials of the fuses or their surroundings. Under conditions of short circuit, therefore, it was impossible to arrange switches in series one with another, controlled by fuse-shunted trip coils such that a discriminating action between the switches would be attained.

Mr. E. B. SCHATTNER gives it as his experience that fibre is the only material which will answer satisfactorily as a casing for enclosed fuses. Neither glass nor porcelain, he says, have the necessary elasticity and strength to withstand the shock of a bad short circuit. An insulated metal tube would, in his opinion, be dangerous. He endorses the remarks made as to the "Nernst effect," and recommends that most, if not every kind, of sand should be avoided as a filling. He has watched sand-filled fuses re-establishing a short circuit after about 60 seconds. Shunted fuses, he found, worked badly on power circuits. The main and shunt fuses fuse at the same instant when sufficient power is behind, and his conclusion is that the essential requirement in a good enclosed fuse is the immediate cooling of the arc and vapours. Both the "Koolark" and the sparklet fuse, he added, work on this principle.

Mr. J. H. M. WAKEFIELD writes:—I recognise that the Paper does not deal with fuses of so low a nominal fusing current as three amperes, but as a considerable number of these are used by the Post Office for protecting telegraph and telephone wires against lighting and power circuits, it may not be considered out of place to put on record that all such fuses outside a building are made of soft drawn platinum wire 5 mils in diameter, connected to copper caps, and enclosed in a glass tube, 3 in. diameter and 2 in. long. Platinoid wire was used in the first instance, but weather effects soon showed that disconnections in the fuses were very frequent, especially after a frost. The effect of contraction and expansion, as mentioned by Mr. Mordey, no doubt applies to a case of this kind. Platinum wire was therefore substituted, and up to the present has been found to meet requirements satisfactorily.

DISCUSSION AT MANCHESTER, MARCH 3RD.

Mr. W. CRAMP, after remarking on the large amount of work which the preparation of the Paper must have involved (for one set of curves alone over 800 experiments had been necessary), said that he was particularly interested in the section on the temperature rise of the jackets of enclosed fuses, upon which very little work had previously been done. Unfortunately, however, it would be difficult for designers to deduce immediately from the results the best form for a fuse intended for any special purpose. He suggested the possibility of attacking the

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whole subject from a more theoretical point of view. Preece's original fuse formula was derived from the equation :—

$$C^2 = K \frac{JTE}{P} D^3$$

where K is a constant.
D is the diameter of the wire.
C is the fusing current in amps.
J is Joule's equivalent (gramme-calories)
T is the elevation of the temperature of the wire at fusion.
P is the specific resistance of the wire at temperature of fusion.
E is the emissivity in gr. cals. per sec. per deg. at temperature of fusion.

Now Preece introduced inaccuracies by assuming everything constant but C and D, and writing the formula :—

$$C = K_1 D^{\frac{3}{2}}$$

where K_1 is a constant and has a value of about 40 when D is in inches. In 1892 Ayrton and Kilgour (*Phil. Trans.*, R.S. 183A, 1892, p. 371), found the values of E for platinum wires up to 0·014 dia., and pointed out that taking E as constant would make an error of "hundreds per cent." in some cases. Indeed, their curve plotted on a diameter base shows that E varies from 0·002 to 0·005, or more for wires of diameter varying from 14 mils to 3 mils. E. G. Brown showed in 1900 (*Trans., N.Z.Inst.*, Vol 33, p. 364, *et seq*), that tin wires have emissivity values almost similar to these of platinum, and not incompatible with the values well known for steam pipes. What was now wanted was the values of E and K for the following variables: Different metals exposed in air, and also for different metals enclosed, both to be taken with terminals of large and small mass and of various materials. Referring to other points in the Paper, Mr. Cramp contended that no distinction could be drawn between inductive and non-inductive circuits, for the oscillograms showed that, for the purpose of the Paper, the circuit might always be considered as inductive. He estimated that the explosive force of a fuse calculated in the manner shown by Prof. J. J. Thomson for a disruptive discharge, was probably of the order of 600 atmospheres. The terms no magnetic field, lateral magnetic field, and longitudinal magnetic field, referred to in connection with Fig. 2, were, he thought, misleading, inasmuch as with the particular arrangements adopted the distribution of flux would be such as not properly to be characterised by either term. In either case part of the field would be "lateral," part "longitudinal." The results, however attained with the arrangement shown in Fig. 1 were very remarkable. The authors had not called attention to a marked effect visible in curves *A* and *B*, Fig. 5. In virtue of the fact that in *B* there are more turns on the blow-out coil, the blow-out should be much more marked than in *A*. The reverse was the case, however, showing that the inductance added by the blow-out coil more than compensated for the blow-out effect. Finally, Mr. Cramp called attention to a number of enclosed fuse samples which he tested for Prof. Ayrton some years ago, on behalf of the Admiralty. It was found that by far the best enclosed fuse was Siemens & Halske's silver wire embedded in plaster of Paris, which never failed to act. On the other hand, Dorman & Smith's damper procelain holders smashed frequently on short circuit, and on limited overload the "no-arc" fuses were very unsatisfactory, for they would blow and yet still continue to carry almost full-load current with a slightly higher resistance.

Mr. C. F. SMITH took exception to the authors basing their tests on the assumption of a drop in the circuit of 3 per cent. with the normal fusing current of the fuse, as representative of the conditions likely to be met with in house services for mains and distribution fuse-boards He had calculated roughly the value of the self-induction in an ordinary two-wire circuit, and took as an example the case of two parallel conductors separated by a distance equal to ten times the radius of the conductor. On this basis, the self-induction came out at about 0·1 millihenry per 100 yards of circuit. Assuming a length of 100 yards, and taking the rate of fall of the current after its maximum value is reached (from the oscillograms in the Paper) to be 33,000 amps. per sec., the drop in the leads due to self-induction during the blowing of the fuses would appear to be :—

$$\frac{dc}{dt} = \frac{33000 \times 0{\cdot}1}{1000} = 3{\cdot}3 \text{ volts},$$

i.e., the drop in the conductor due to self-induction would be greater than the drop due to resistance. This, however, was not a fair measure of the effect of the circuit inductance, because the value of dc/dt was taken from the authors' curves obtained with a choking coil in the circuit, of which the self-induction was given as 25 millihenries. The rate of fall of the current in a circuit without artificial inductance should be about 250 times as great as that just found, *i.e.*, there ought to be a reverse E.M.F. in the circuit, or breaking, having a value of $3{\cdot}3 \times 250 = 760$ volts. What he wished to emphasise was that an E.M.F. of self-induction of large value compared with the total voltage applied to the circuit would certainly be formed in a circuit which would be termed by the authors "non-inductive." He also pointed out that a circuit having a true self-induction of 25 millihenries would show a very much higher rise in voltage than anything shown on the oscillograms. Doubtless iron saturation and capacity effects in the winding of the coil had actually had a great influence at the moment of fusion, and the value given for the inductance of the coil could not be taken as any guide of the actual inductance of the circuit. On looking at some curves given by Oelschlæger in the *E.T.Z.* for 1904, he found that on a short circuit made as nearly "dead" as possible the value of the rate of change of current was practically 9×10^6 amps. per sec. The reason the effects obtained by the authors appeared to be independent of the capacity of the generators was, in his opinion, the relatively large drop in the circuit compared with the drop due to armature resistance of the generator's armature.

Mr. S. J. WATSON (Borough Electrical Engineer, Bury) said that he had found aluminium of considerable use in connection with feeder and distribution section boxes placed in different parts of Bury. These fuses are about 200 ampere normal carrying capacity, and, even with exceedingly bad short-circuits close up to the boxes, they seemed to cause no trouble and made very little mess. He objected to the semi-enclosed type of fuse, and preferred one entirely sealed up at the ends. In a particular case, a fuse, carrying a normal current of about 100 amperes, on one of the Bury traction boards, was at a distance of some three or four feet from a four-pole changeover switch, the top connections of the switch being for lighting and the lower portions for traction. This fuse blew, and the metal blew across to this changeover switch and caused a short-circuit across the terminals of this switch, and practically shut the machine down, and that was with a tin fuse. The amount of the metal for the 100 amperes was possibly three or four strands of 14 gauge tin, and at that distance it caused an arc to be set up between a difference of potential of about 400 volts. There would be at least 1½ in. distance between the two terminals. Of course, had that fuse been entirely sealed at both ends, such a thing would not have happened. It also had an important bearing on the risk of fire. Another very important point was on the mixture, or the purity, of the tin and the lead. He had at different times had a number of tests carried out on the ordinary tin fuse wire, and found that with a given diameter of wire, supposed to be of exactly the same quality, very different results were obtained. He thought that the makers of wire of that kind should pay a good deal more attention to that point.

Dr. C. C. GARRARD also spoke. His remarks were substantially the same as in the written communication already quoted.

Prof. SCHWARTZ, replying to Mr. Cramp, said that as the Paper dealt with experimental work they had been doing over the last two years for the Engineering Standards Committee, they had purposely avoided making any very definite statements, or drawing up any conclusions, because the matter was in the hands of the Standards Committee. Referring to the use of aluminium, he said that about two years ago some aluminium fuses from section pillars were brought to his notice, which were corroded where the aluminium strip made contact with the copper jaws, owing to the aluminium being highly electro-positive to the copper; this might be reduced by coating the surfaces with blacklead or tinning the contacts. For small circular wires the action of the oxide sheath was prejudicial; it holds up the molten metal until it is vapourised. Aluminium also necessitated a larger mass being used, and this should be avoided. Silver had not been used very largely in this country. Up to about a year ago it was used very largely in Germany, but the Germans had recently congratulated themselves on the discovery that copper was better than silver.

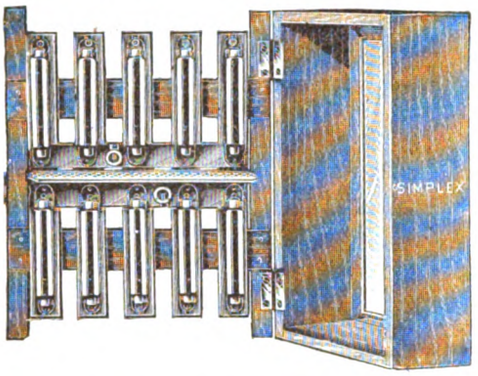
Mr. W. H. N. JAMES said that Mr. Cramp's suggestion that the longer duration of arc with 20 turns as compared with 10 in Fig. 3 was possibly due to the increased inductance obtained, would not hold, as in each case there was extra inductance in the circuit which was large in comparison to that due to the turns round the fuse.

The Berlin Suspended Railway.—The traffic authorities of Berlin, before deciding whether to permit the erection in the east portion of the city of an electric mono-rail suspended railway, required that a short portion of the constructional ironwork of the same should be erected in the narrowest street through which the railway will pass, in order to test the effect on the street traffic and the general effect as regards unsightliness, &c., of the central steel supporting pillars. A portion of the steel construction, about 150 ft. in length, has consequently been put up in the Brunnenstrasse, which has a breadth of only 72 ft., and is described in *Electrische Kraftbetriebe & Bahnen*. Three pillars, each of a different design, have been put up in order that the most suitable design may be chosen. The track and other constructional work supported by the pillars has also been added in order to see if the light is much cut off. The pillars are spaced about 50 ft. apart, and occupy some 10 or 12 sq. ft. each of the road surface. The height of the pillars is about 32 ft., and the total width of the structure at the top some 18 ft. The cars will be suspended from a single rail on either side of the structure, and to ensure the stability of the whole, the central pillars are supported on girders placed crosswise under the street, the girders themselves being supported at each end on concrete foundations. Shorter girders are placed lengthwise under the street, to ensure stability in the other direction. The bottom of a car will be about 20 ft. above the surface of the road.

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A NEW FUSEBOARD

THE accompanying illustration shows a new pattern of fuse-board for the ordinary class of house work, which is being put on the market at a very reasonable price by Simplex Conduits, Ltd. The board illustrated is of the five-way pattern. Three different types of fuses can be provided, type A being the ordinary grooved china fuse bridge; type B, a tubular fuse carrier for 15 ampere circuits, and type C, a magazine replacement fuse. The latter allows non-technical persons to easily replace a fuse, and the bobbin on the five-ampere size carries



50 replacements. These fuses are mounted on two battens, and when in position divided by a fillet of asbestos. The case itself is strongly made of teak, with dove-tailed joints throughout, and a glass front. It is not provided with lock and key, but this can be arranged for at a slight extra charge. All the brass connections are of ample size, to give the necessary capacity, and the finish of the whole article is as good as is in keeping with the low price at which it is sold.

The Charing Cross, West End, and City Electricity Supply Company.—In our analysis of the accounts of this company, on page 347 of our last issue, at the bottom of the first column, the words "load factor" were by a clerical error included in the same line as maximum demand, and the figures for the load factor were omitted. These should have been 21·9 per cent. for the West End undertaking, and 19·1 per cent. for the City undertaking.

Glasgow Local Section of the Institution of Electrical Engineers.—We understand from the secretary of the Glasgow Local Section of the Institution of Electrical Engineers that the Paper proposed for reading at the ordinary meeting last Tuesday was not available on that date owing to the inability of the "Papers Editing Committee" to deal with it sufficiently early to allow of timely printing and distribution. In view of these circumstances, the Committee were obliged to postpone the meeting announced in our last issue.

"The Journal."—The February number of the Journal of the Institution of Electrical Engineers, which had just been published, contains the following Papers, with reports of the discussions thereon at the London meetings:—"The Dielectric Strength of Insulating Materials and the Grading of Cables," by A. Russell; "Automatic Cab-Signalling on Locomotives," by J. Pigg. The Inaugural Addresses of the chairmen of five of the local sections are included, and the following Papers discussed before the local sections:—"The Magnetic Testing of Iron," by W. H. F. Murdoch (Leeds); "Further Notes on the Electrical Driving of Textile Factories," by H. W. Wilson (Manchester); "The Torque Conditions in Alternate-Current Motors," by V. A. Fynn (Birmingham). An original communication, by P. H. Powell, on the air-gap correction coefficient, is also published. The next number of the Journal will contain a portrait of the late Lord Kelvin, and a memoir specially written for the Journal by Dr. Silvanus P. Thompson, F.R.S.

The Siemens Engineering Society, Stafford.—An engineering society has been started in connection with the Stafford works of Messrs. Siemens Bros. Dynamo Works, Ltd., under the presidency of Mr. Lee Murray. The following Papers have been read before the society since its inauguration:—December 8th, 1907.—Presidential address. Mr. Lee Murray on "Coal and its Application to the Production of Power Gas." December 2nd, 1907.—"The Siemens-Schuckertwerke Single-phase Commutator Motor," by Mr. Schenkel. December 20th, 1907.—"Commutation Troubles: their Cause and Cure," by Mr. S. P. Smith. January 23rd, 1907.—"The Economical Life of an Electric Lamp," by Mr. H. G. Williams. On Tuesday, March 10th, a lecture will be given under the auspices of the Society, at 8 o'clock, at the Oddfellows' Hall, Stafford, by Professor Gisbert Kapp, on "The Electrification of Railways." All the Papers read before the society, besides being published in the official magazine, *The Electron*, are being published in pamphlet form for the convenience of the members. A conversazione held towards the end of April will conclude the present session.

CATALOGUES AND PAMPHLETS RECEIVED

SINGLE-PHASE MOTORS.—A leaflet from E. Brook, Ltd., of Huddersfield, gives a list of single-phase motors in sizes from ⅛ to 20 h.p., which are in stock for immediate delivery.

SINGLE-PHASE MOTORS.—A leaflet from the Union Electric Co. gives prices of a complete series of single-phase induction motors ranging from ¼ to 60 h.p. for 50, 60, 83, and 100 cycles. Under 1 h.p. they are listed for the squirrel-cage type, and over 30 h.p. in the slip-ring type only, but the intermediate sizes are standardised in both forms. The list is conveniently arranged, and a complete code facilitates ordering.

SWITCHGEAR.—A new catalogue is to hand from Messrs. Parmiter, Hope & Sugden, of Manchester, which gives particulars of this firm's well-known "Ajax" iron-clad switches, knife switches, and a very complete range of iron-clad fuses, distributing boards, and motor starters. Some illustrations of complete main switch boards of the firm's manufacture are given, and appended to the catalogue is a "progress sheet" which illustrates certain new patterns which are on hand at the works, and will be put on the market in a few weeks. These include a new form of enclosed three-pole switch and fuse, in which a separate lid is provided for both the switch and fuses, arranged so that if required they can be interlocked so that they cannot be opened at the same time, and neither can be opened except when the switch is off. Two smaller new patterns of combined ironclad switches and fuses are also shortly to be introduced. We understand that all the standard gap switches, fuses, knife switches, and distribution boards are kept in stock and can be despatched the same day as ordered.

THREE-PHASE MOTORS.—A leaflet from T. W. Broadbent, Ltd., of Huddersfield, contains a specification and price list of three-phase protected type induction motors, in sizes ranging from ¼ to 50 b.h.p. of the squirrel cage type. A series of starters of the auto-transformer type are also included.

Tramways and Light Railways Association.—The March Circular of the Tramways and Light Railways Association states that it has been decided in future to hold annual conferences in various parts of the kingdom. In view of the fact that the Franco-British Exhibition is to be held in London during the current year, it is thought that it might meet the convenience of the out-of-town members if the first Congress were held in London, in connection with such exhibition, and the first week in July has been fixed as a suitable date. A small committee has been formed to arrange details, and full particulars will be published at a later date. Members wishing to read Papers should communicate with the secretary.

A sub-committee of the Tramways and Light Railways Association is engaged upon the preparation of a standard form of accounts, and of a recognised system to be adopted by tramway companies to facilitate the assessment of their property for income-tax purposes. Communications have been carried on for some time past with the authorities at Somerset House, and it has been intimated to the association that in order to give effect to the recommendations contained in their committee's report, the Commissioners must first be satisfied that all tramway companies shall present their accounts in similar form. A standard form is already in use by municipal tramway undertakings, and this committee intend to submit to the various companies a draft form for their approval. Once this matter is settled there is every reason to believe that the Commissioners will favourably consider and give effect to the proposal to include, if not permanent way, at any rate rails and setts, in the term "Plant and Machinery," and that they will also be prepared to entertain proposals in regard to fixed overall rates of allowance for depreciation on the various portions of tramway undertakings. The importance of any such concessions would be of the greatest value, and it is earnestly hoped that all the constituent companies will give their serious consideration to the proposals to be submitted to them by this committee.

Wireless Telegraphy.—The following announcement appeared in the *London Gazette* for Friday:—1. The Wireless Telegraphy Act, 1904, shall apply to British Ships whilst on the high seas Provided that a person on board a British Ship which is registered in any British Possession (other than the Channel Islands and the Isle of Man) or in any British Protectorate shall not be deemed to commit an offence against the Wireless Telegraphy Act, 1904, by reason of the installation or working of wireless telegraphy on such ship if the authority in such Possession or Protectorate having power by law so to do shall have granted a licence for the installation and working of apparatus for wireless telegraphy on that ship and if such person is acting in accordance with the provisions of such licence. 2. The Interpretation Act, 1889, shall apply for the purpose of the interpretation of this Order as it applies for the purpose of the interpretation of an Act of Parliament. 3. This Order shall be published in the *London Gazette* and shall come into operation immediately from and after the expiration of three months after this Order is so published.

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ELECTRIC PROPULSION OF SHIPS

MR. HENRY A. MAVOR read a Paper recently on the above subject at a meeting of the Institution of Engineers and Shipbuilders in Scotland.

The use of steam in a turbine, he said, involves essentially a speed of rotation far above what is customary in reciprocating engines. It is not surprising, therefore, that the steam turbine, when applied to marine propulsion, should be materially modified, and that the marine steam turbine is a compromise in which some sacrifice of economy has been made for the sake of avoiding a greater loss due to the characteristics of the propelling apparatus. Within the limits of practice, the efficiency of the steam turbine is increased by increased speed of revolution; while the efficiency of the propeller is decreased by a corresponding change. Fast-running turbines and slow-running propellers are respectively highly efficient instruments, but hitherto there has been no proper method of coupling them together. The underlying principle of the proposals here made is the use of a high-speed turbine running at a uniform velocity for all speeds of the ship, and driving a dynamo from which electric power is taken to a variable speed motor or motors coupled direct to the shafts of propellers of maximum efficiency. The dynamo and motor here occupy an intermediate position, as indeed they do in all cases, between the power and the work, and in effect constitute a gearing which can submit to modifications of its own characteristics, to meet the characteristics on the one hand of the prime mover, and on the other hand of the machinery to be operated.

The author then dealt in a general way with some of the differences in the behaviour of continuous-current and alternating motors, pointing out the inferiority of the latter as regards starting torque. The ordinary multiphase induction motor, he continued, also compares unfavourably with the continuous-current motor in respect of its availability for changes in speed. The continuous-current motor can now be made to give varying speeds through any necessary range without much loss of efficiency, the only consideration being cost. Hitherto the induction motor has not been able to meet this requirement. Where very frequent starting and stopping have to be combined, as they often are, with gradually varying speed, something new must be attempted if the alternating motor is to take the field. The author has been at work on this problem for some years, with the result that he claims to have solved the problem, and that he can meet most of the demands which are likely to arise in practice and deal with some new fields of enterprise which have hitherto for various reasons remained closed to the electrical engineer.

Hitherto the use of electric motors for marine propulsion has been confined to small craft, such as submarines, and one or two small barges and other craft on the Russian rivers and canals. A small electrically operated and propelled dredger has also been constructed in Germany. The motors in these cases are continuous-current machines.

The continuous-current motor, which is so convenient for small applications of power up to 100 horse power, becomes less convenient over this size. Above 1,000 horse power it is not a very practical machine for power purposes where starting and stopping have to be frequently accomplished, and it is not specially suitable for marine work. The multiphase induction motor, on the other hand, has all the properties to be desired in a marine motor except hitherto the facility of speed control. This problem may now be said to be solved.

Some years ago the idea of rotating the outer member of the motor, usually called the stator, occurred to the author, and appeared to offer a solution of the starting difficulty, and this suggestion was made at a meeting of the Institution of Civil Engineers in 1904. The proposal was that the external member should be mounted so as to be free to revolve concentrically with the rotor or armature of the motor. The armature being connected to the load and the outer member being free to rotate, the outer member starts to revolve in a direction opposite to the working direction of the rotor, and having only its own inertia and friction to overcome, it quickly reaches synchronous speed. The motor is now in a position to develop its full load torque with full load current, and all that is necessary is to apply a mechanical or other brake to the external member, bringing it to rest gradually while the rotor starts and accelerates as the outer member or "spinner" comes to rest. The start can thus be made without excessive call for current and without jerk.

This idea soon developed into a proposal to modify the ordinary working speed of the motor by so arranging the external member that it could be driven at any desired speed by gearing interconnecting both members, and an arrangement was worked out and patented for putting this idea into practical shape. It will be seen that by the use of a fast and loose pulley or friction clutch to transmit a part only of the power of the motor the starting can be accomplished with a very small loss of energy. This method, although serving the purpose for which it was designed and giving a useful solution of the difficulty, did not appear to be the final stage. The idea of rotating the outer member and controlling its speed suggested the idea of controlling its motion independently of gearing or other arrangements which involved disadvantageous complications, and a simple apparatus was evolved, which entirely gets over the difficulty of starting, and gives a change of speed in either direction. In this machine the outer member or spinner is made to act as the inner member or rotor of a second motor, the stator of which embraces the spinner. The machine is thus two motors concentrically arranged round the common axis. The three speeds, which may be described as prime, secondary, and tertiary, are attained without loss of efficiency, but if intermediate speeds are desired they are obtained by a slipping brake or external resistance in each case equally with a consequent loss of efficiency. This loss of efficiency is very small, and is less than the loss involved where series wound continuous-current motors are used for speed variations, or intermediate speeds may be obtained by providing a separate supply of current to the external motor and changing its speed by change of periodicity of the supply.

The attainment of three speeds without any loss of efficiency in this class of motor is a very important improvement, because it at once renders it available for such work as steel rolling mills, haulages, hoists, calendering and printing machines, lathes and boring mills, and last, and perhaps the most important of all, driving vehicles either on or off rails, including vessels on the sea.

A proposition to apply electric motors to drive a ship involves primarily a consideration of the conditions with respect to the propeller and the prime mover. Naturally, the propeller with its shaft comes first, as upon its efficiency of transformation of energy depends the size of the prime mover. It is necessary to institute a comparison for any given ship of the normal propeller as used with existing machinery, and see what are the prospects of economy by the substitution of electric transmission for the direct connection between the engine and the screw.

At first sight it does not appear that any economy could be made by the introduction of two successive energy transformations in the dynamo and motor respectively to take the place of a direct transmission.

The maximum possible efficiency of these two transformations with the transmission shaft is not more than about 88 per cent.; while the efficiency of the direct transmission shafting is probably not less than 95 per cent. We thus have a loss of at least 7 per cent. as a primary handicap against the proposal. This consideration may be taken as disposing of the possibility by change of transmission of any economy in ships of moderate size with slow-running propellers of upwards of 70 per cent. efficiency. If electric driving is to be introduced into such ships it must be on other grounds than propeller economy. The case is different when we come to deal with ships in which the power is large and the propellers are run at a high speed. Such cases are becoming common in vessels driven by steam turbines. A very short incursion into the study of propellers is sufficient to show the trend of the conditions which here emerge.

For any given ship, the designer who is at liberty to choose a large propeller for any given power has considerable advantage, as the efficiency may be as high as 70 per cent., and as low as 45 per cent. To say what improvement is possible in any case is by no means an easy matter, because the actual efficiency of any given propeller is often unknown; but the difference in efficiency between the probable bests, when the diameter can be changed, may be found approximately, and it is this which has been attempted. The introduction of electric drive enables one to include in the consideration all speeds of revolution of the propeller, both low and high. The revolutions at which the propeller may be efficiently used are fixed by the diameter and pitch. While, therefore, one may have ascertained what is the possible improvement in efficiency, one must, before claiming the possibility of such improvement, deal with the problem with the limiting diameter of the propeller as a first element in the calculation. It is this consideration which makes any saving in propeller efficiency difficult in high-speed passenger steamers of shallow draught. The difficulty of improving the efficiency of ships of moderate size with slow-running propellers has been shown, so that the most attractive field of enterprise, from the propeller point of view, is in large ships of deep draught and high speed.

If the ship is to be electrically driven, it will probably be found that the most convenient steam prime mover will in all

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cases be a turbine. The limit of speed of rotation, when the turbine is to be used for driving a dynamo or alternator, is of a different order altogether from the limit of speed imposed upon the turbine by its direct connection to the propeller. In some cases it will be easy to adopt an increase of ten times in the speed of revolution. The turbo-electric generator with its motors compares favourably in economy, cost, and weight with the marine steam turbine directly connected to the propeller shaft, and therefore running at a speed lower than that called for by considerations of steam economy in the turbine. The reversibility and speed variability of the electric motor driven by the turbo-generator run unidirectionally at constant speed dispenses entirely with the objectionable heavy and costly go-astern turbines mounted on the propeller shaft.

The case of a ship which had in the first case a total of 17,000 horse power delivered to the three propellers, and a speed of 20¾ knots, was considered. The propellers were 8 ft. 1½ in. diameter, and the speed of revolutions was 377 per minute. This example was worked out in detail in an appendix to the Paper, and it was shown that the maximum probable efficiency of these propellers was 62 per cent. An electric equipment would permit of the use of propellers of about 14 ft. diameter at 140 revolutions per minute, and an efficiency not less than 70 per cent.—an improvement more than sufficient to cover the loss in the electric motors.

Turning now to the generators, it will be found that the steam turbo-alternator, as used on land in sizes corresponding to those now under discussion, can deliver one electrical horse power to the motors for 12·2 lb. of steam per horse power hour, allowance having been made for all intermediate losses, and for 4 per cent. for driving auxiliaries, no superheat being used, so as to make the comparison with normal marine practice. This figure is startlingly lower than anything which has been touched at sea. It is for full speed and power, but the comparison must also be made at low speeds and powers, and more particularly at the normal working speed of the ship. It will be found that there is certainty of economy in this comparison, again because of the higher speed of revolution of the turbine, which in the electric case runs at the same speed for all powers, while, of course, the direct connected turbine must vary its speed of revolution with the speed of the ship. It is not possible to base any generally conclusive argument on these data, but there is evident encouragement to give detailed study from this standpoint to any particular case which may arise. The same limitation applies to weight and cost. In the example referred to an estimate has been made of the weight, with the result that it appears probable that the decrease in the weight of the steam equipment will more than compensate for the heavy slow-running motors and propellers so that the weight will not be greatly changed. The cost will probably closely follow the weight.

CORRESPONDENCE

THE FUTURE OF THE TELEPHONE SERVICE.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—There has recently been much discussion of "the telephone question" at Chamber of Commerce meetings and in the Press, but several of the most important points are lost sight of. Perhaps you will allow me space to state a few broad propositions based on long experience and observation of the working of the telephone service in America, and in the principal countries of Europe.

The telephone service we shall have always with us. It is the quickest, the most direct, and the most perfect means of communication; and it is the cheapest. Since all business depends on communication, and communication is also largely required in social and domestic affairs, the telephone service is certain, if conducted on sound lines, to have an enormous development in this country. In spite of all the difficulties (for a clear view of these difficulties the student of the subject may read *Public Ownership and the Telephone in Great Britain*, by Hugo R. Meyer, Macmillan and Co.), the telephone system of the country doubles itself about every six years. But I hope in my lifetime, and I am not so young as I should like to be, to see at least ten times as many telephones working in the United Kingdom as there are now. Such a development can only be brought about, however, by an enterprising administration, a highly efficient service, and a practical tariff.

The present quarrel of the Chambers of Commerce with the telephone administration is actuated solely by the large user of the telephone service fearing that he is about to lose a bargain—which he thinks the flat rate for unlimited service gives him. This fear drives him to strange statements. The measured rate—payment for service in proportion to service rendered, a principle which is accepted in all other services and all other businesses—is described as "a tax on trade and commerce," and as likely to check the development of the telephone.

To describe a change in the method of charging for telephone service which offers low rates to the majority of users as a "tax on trade and commerce," is manifestly an exaggeration, for the amount spent on local telephone service in the average business establishment is a very small percentage of the total working expenses of that establishment. In the largest concerns, who are the chief opponents of the measured rate principle, the cost of local telephone service is probably only a fraction of one per cent. of the total expenses. So much for the "tax on trade."

But the most vital point, and strangely enough it is one that is largely neglected by both parties to the discussion, is that the measured rate makes for efficiency of service, whereas the flat rate directly encourages the large users to spoil the service for themselves and for others. It is a most difficult thing to make the telephone subscriber realise that he is largely responsible for the general efficiency of the service. Over the actual manipulation of the telephone instrument, over the attention and efficiency with which inquiries and messages by telephone are received and dealt with, and over the facilities provided for handling the telephone traffic flowing in and out of his establishment, the subscriber has full control. It should be clear to every telephone user that the quality of service other users get largely depends upon him. Yet what is one's daily experience? That the telephone is all too frequently left to the office boy or to other junior employees who show a marked disinclination to handle the instrument and the service properly or to deal with inquiries and messages promptly and intelligently. Again, the largest concerns, the very establishments with which prompt communication is most in demand by the business community, are so continuously "engaged," owing to their telephone lines being constantly blocked with outward calls, that one is often obliged to abandon the attempt to communicate with them, after having spent much more time on several ineffective calls than one effective call promptly completed would have occupied. In all large towns there are subscribers who are "engaged" to attempted calls hundreds of times daily—to the exasperation of their correspondents, and to the general detriment of the service; in many cases, also, the lost call must mean loss of business to the firm for which it was intended.

Now, what is really the prime requirement of the business man—the essence of "the telephone question" from a practical and commercial point of view? I say unhesitatingly it is efficient service—the maximum of effective calls, promptly and effectively dealt with at the incoming end. There is no difficulty to-day in equipping and organising a telephone service so that the average call shall be put through within 30 seconds. But it is essential for real efficiency that the subscriber on his part shall provide facilities for receiving the call and organised attention for handling it effectively. This the measured rate tariff directly encourages him to do, whereas the flat rate tariff operates in exactly the opposite way. Under flat rates the charge for extra lines is relatively high, so the subscriber refuses to take them. The measured rate tariff makes low charges for lines and instruments, and low wholesale rates for calls. The large user is thus encouraged to provide, instead of one or two individual lines and telephones, a group of lines and telephones, made interchangeable by means of a switchboard. This arrangement, technically known as a "private branch exchange," is extremely flexible. It can be designed to fit any establishment. Every department has its telephone, and every call goes straight to its billet with the minimum of delay. As the lines are worked in a group it is seldom that all are "engaged" simultaneously, and by watching the traffic the equipment can be so kept up to the requirements that the "engaged" call is eliminated. Thus, the big user gets a thoroughly effective service, which is what he needs far more acutely than an apparently cheap rate—for a rate which causes inefficient service is only apparently cheap. I venture to say that the large user has no real conception of what adequate telephone service means until he organises his telephone equipment on the "private branch exchange" basis.

What the measured rate principle will do for the development of the telephone in Great Britain and for the efficiency of the service is amply demonstrated by results in America. Thirteen years ago there were in Greater New York about 18,000 telephones under flat rates, and development was almost stagnant. Measured rates were introduced and the private branch exchange scheme was devised to provide adequate service for large users. To-day there are over 300,000 telephones in New York. A third of those are connected to private branch exchanges, and the ineffective call, which was formerly as great an evil in New York as it is in English cities to-day, has been nearly wiped out. The telephone in New York, besides being used in an efficient way by the large concern, has spread to all sorts of small establishments and to a very large proportion of private residences—for the measured rate tariff makes equitable terms to all classes of telephone users.

Did the Chambers of Commerce but thoroughly study the subject and realise that the measured rate principle of telephone tariff makes both for general efficiency of service and for wide development of the telephone, they would undoubtedly petition the telephone authorities to abolish the flat rate forthwith instead of arguing for its retention. I am, &c.,

HERBERT LAWS WEBB.

55, Old Queen Street, Westminster, S.W.,
March 5th, 1908.

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REVIEWS OF BOOKS

Thomas Alva Edison: Sixty Years of an Inventor's Life. By F. A. Jones. 375 pp. 7¾ in. by 5½ in. Several illustrations. (London: Hodder & Stoughton.) 6s.

More exaggerated statements have appeared in the less responsible sections of the Press about Edison than about any other man living, so that many readers will take up a book such as this with the hope of seeing the great man depicted as he is, and not as he is imagined to be, as well as to get some idea of the relative place of his work in the development of electrical engineering amongst that of others. It would be unkind to say that the reader will be disappointed in these respects, for not only is there much evidence of authenticity in the writer's statements, but there is a pleasant feeling all through that the pages are written by one who knows and understands as a friend the man about whom he is writing. As to Edison's life work, however, the author is at a disadvantage, for an account of the inventor's work of much more interest could have been written by one whose technical knowledge enabled him better to understand the inventor's aims and objects. The general impression apt to be caused is that Edison was the one and only worker in the subjects to which he devoted his activities, and an untechnical reader will lay down the volume with a hazy notion that Edison originated, rather than perfected, the quadruplex system of telegraphy, that he alone "invented" the microphone, and that no one else succeeded in producing a practicable incandescent lamp. It might also almost be inferred that the versatile experimenter was, at the time of the equipment of the first Edison supply station, the only dynamo builder in the world. It must not be thought that we wish in any way to belittle Edison's work. There is not one of the many subjects that came into his hands that he has not left his mark upon, and it is difficult to realise how many industries in the United States are the direct outcome of his persistent endeavours.

We have not space to recapitulate the many branches of Edison's work through which the author leads us. An interesting account is given of his boyhood and youth as newsboy and telegraph operator, and his experimental work on telegraphy, telephony, the incandescent lamp, the phonograph, and other subjects, and of particular fascination is the story of the establishment of the first Edison supply station in New York.

Edison's greatness seems to lie as much in his extraordinary perseverance and his almost unparalleled capacity for long and continuous work as in his remarkable ingenuity and powers of perception. He has never posed as a man of science or a mathematician; indeed, to use his own words, referring to mathematicians, he "soon found he could guess a good deal closer than they could figure," so he went on guessing. His perseverance is shown by the fact that in the search for a suitable material for lamp filaments, he experimented on about 6,000 specimens of different kinds of bamboo, and only found three species which gave good results.

We naturally turn to the chapter on the storage battery for information as to how much of the obviously exaggerated statements made about the principal object of Edison's latest work is true, but we soon find that the author knows little more about the matter than ourselves, as is shown by the following quotation:—"It will be readily understood that in the manufacture of a perfect storage battery, one of the hardest nuts to crack was the invention of an ideal accumulator or condenser—that portion of the battery capable of containing large quantities of electricity." Again, in one place it is definitely stated that cobalt is used in the latest form of the battery, although further on the active material is spoken of as nickel. The usual extravagant claims are made as to its suitability for automobile work. Two facts, however, are significant, first, that so little is known about the battery, which quite accords with Edison's characteristic of not allowing information to leak out until he sees success in sight, and secondly, the fact that large factories are being put up for its manufacture, a thing which a man of Edison's great business ability would not permit unless the experimental stages were passed.

Universal Electrical Directory (J. A. Berly's), 1908. Pp. 1508, 10 in. by 6 in. (London: H. Alabaster, Gatehouse, and Co.) Price 14s.

No special alterations have been made in the arrangement of this indispensable work, which makes its appearance for the 26th time, but this may be taken as sufficient testimony to the degree of perfection which the compilation and arrangement of the contents has reached. There are still the four sections, viz., British, Colonial and General, Continental, and U.S.A., and, despite the elimination of unimportant entries, the total number of names now exceeds 35,000. Lists of all electricity undertakings in the United Kingdom, British Colonies, and some other countries are given, showing the nature of the supply, system of distribution, capacity of plant, voltage, and chief engineers' names, and in the case of alternating current the phase and periodicity also appear.

Local Government Board Annual and Official Directory for 1908. Pp. 282, 7 in. by 5 in. (London: "Local Government Journal" Office.) Price 1s. 6d.

The seventeenth edition of this valuable work to all interested in municipal affairs has been published; it contains information regarding municipal electric supply undertakings in the metropolis.

ELECTROCHEMISTRY AND ELECTROMETALLURGY

The *Times Engineering Supplement* recently contained an interesting article upon "Bullion Refining by Aid of Electricity." As is well known, large quantities of gold and silver are obtained from the slimes produced in the electrolytic refining of copper, and it is estimated that in the United States alone at least £3,500,000 worth of these metals is annually obtained. In the deposition of the copper, the conditions are such that the gold is precipitated in the metallic form, and the silver is produced as the sparingly soluble sulphate, and through an addition of a small quantity of sodium chloride to the bath as the insoluble chloride. The first attempt to electrolytically fine bullion appears to have been made in 1881 by the Norddeutsche Affinerie at Hamburg, the method employed being that of Wohlwill, but exactly what it consists in is kept secret. By the refining of silver containing lead, they are said to produce more than 100,000 kilos. of silver per annum.

The Moebius cell, patented in 1885, and first worked in Kansas in 1886, is largely employed in the copper refining districts, although the refining is often done by ordinary metallurgical methods. It would appear, however, that gradually the metallurgical parting processes are being superseded by the purely electrochemical. The advantages of electrical refining are (1) greater simplicity, (2) greater cleanliness, and (3) reduced losses. The main disadvantage is the large amount of metal locked up, upon the value of which interest charges have to be met.

The silver to be refined is usually refined metallurgically to 950 fine, and this is employed as anode material in a bath containing silver nitrate and a little nitric acid or sulphuric acid and nitre. As the anode goes into solution, considerable slimes are produced, and, to prevent these falling into the bath and contaminating it, the anodes are enclosed in linen bags. The cathodes consist of thin sheets of pure silver. The silver is deposited in a crystalline form on the cathode, and the slimes containing gold remain in the linen bags. If the silver being refined contains much copper, there is a danger of the copper being deposited out, especially if the voltage used is at all high. In some cases where the bullion employed is very rich in copper, the anode solution is caused to flow into a receptacle containing strips of copper. This causes the copper to react with the silver solution and silver to be deposited,

$$2AgNO_3 + Cu = 2Ag + Cu(NO_3)_2.$$

In such a case the cathodes are of copper, and copper is the metal deposited out electrolytically. Several types of Moebius cell are employed, the older ones being very similar to copper depositing vats. More recently, however, the cathode has been made of a revolving band of silver, the anodes being placed above it in shallow porous porcelain troughs. As the band travels to the end of the bath, it meets another band which works outside the bath and carries off the crystals of silver from the cathode. This in turn passes against a scraper, which effectually removes all the crystals, and causes them to fall into a receptacle placed outside the vat.

A plant at Perth, Amboy, owned by Guggenheim Bros., is worked on this principal. It consists of 48 vats, each 14 ft. by 16 ft. by 7 ft. deep. The electric plant produces 220 amperes at 90 volts, and is capable of depositing 24,000 oz. per day. The American Smelting & Refining Co. also operates a similar plant. This installation has 144 vats, and the electrical generating plant has a capacity of 62 kw.

Gold in silver bullion containing only 2·10 parts of gold per 1,000 of bullion can be recovered by the Moebius process, the cost of separation being stated to be 0·062d. per oz. of bullion. The silver produced tests 999·5 to 1,000. In Europe the most important installation of this process is that of the Deutsche Gold und Silber-Scheide-Anstalt at Frankfurt.

The Balbach Smelting & Refining Co., of Newark, U.S.A., employ a vat which differs considerably from the Moebius vat. The anodes are cast into thin slabs, and are encased in cloth. They are then placed in a wooden frame, which hangs just

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below the surface of the electrolyte. The cathodes consist of slabs of Acheson graphite, which cover the floor of the vats, and have an effective surface of eight square feet. A current density of 20 to 25 amperes per square foot of cathode surface is employed, the E.M.F. being 3·8 volts to each vat. The silver is deposited in the crystalline condition, and is removed from time to time. The current efficiency is said to be 93 per cent. The chief disadvantage in the electrolytic deposition of silver is the crystalline form in which it is deposited. Easterbrooks claims to have overcome the difficulty by using gelatine in the electrolyte, and by an improved method of circulation. Under these conditions, a smooth, coherent deposit of silver is said to be formed with a current density of 10 amperes per square foot.

For the refining of gold there appears to be only one method – that of Dr. E. Wohlwill, the chemist to the Nord-Deutsche Affinerie, at Hamburg. The process is in operation at Frankfurt, Hamburg, Paris, New York, Philadelphia, and San Francisco. It is shortly to be introduced into one of the principal London refineries. In this process the impure gold anode, 1/6 in. thick, containing 15 per cent. of silver, is placed in a cell containing an acidified solution of gold chloride, thin sheets of pure gold being used as cathodes. The electrolyte contains from 25 to 30 grams of chloride of gold, and 40 c.c. of strong hydrochloric acid per litre. During electrolysis the temperature of the bath is kept at 65° C.

In 24 hours 80 per cent. of the gold will be dissolved and redeposited at the cathode. Another 10 per cent. will be found mixed with silver chloride in the anode slimes, and 10 per cent. will hang together as anode. The anode and cathode are placed 1·25 in. apart, and the gold is deposited in a crystalline condition. Small quantities of platinum and paladium are usually present in the anode, and these are recovered by chemical treatment of the electrolyte. One important point is the very small amount of space which the plant takes up. The vats at Hamburg are sufficient to produce 75 kilos. pure gold in 24 hours, but they only cover a space of 24 sq. ft. The Wohlwill method is also worked at the United States Mint in Philadelphia, where seven cells are in use, capable of producing 5,000 oz. fine gold per week.

ELECTRICAL SCIENCE

British and American

Electric Discharges through Gases.—On Saturday last, at the Royal Institution, Prof. J. J. Thomson delivered the first of a course of six lectures on electric discharges through gases. The lecturer said that he would deal first of all with the most inconspicuous and only recently investigated branch of the subject, that is, the discharge of electricity through the atmosphere at ordinary temperatures and pressures. Coulomb had attributed the loss of charge, which took place when a charged body was suspended in the air, to the conductivity of the air; but this fact was not accepted until after Prof. Boys' experiments, with electroscopes with quartz-fibre suspension and supporting pillars of various lengths. This loss of charge has been found to be proportional to the volume of gas surrounding the charged body, and also proportional to the mass of the gas, except in the case of hydrogen. The loss of charge or the conductivity of the air was due to the charged particles in the air. To demonstrate the existence of these charged particles, Prof. Thomson showed an experiment in which a volume of dust-free air was suddenly expanded; the moisture in the resultant supersaturated air was deposited in the form of a cloud, the charged particles forming the nuclei for the drops of water. There were, he said, normally some 1,000 of these particles per cubic cm. of air. If a little radium were brought near the vessel containing the supersaturated air, the condensation was more complete, as the presence of the radium increased the number of charged particles in the air. It was found by experiment that the rate at which a charged body lost its charge was decreased 30 to 40 per cent. if the body was enclosed in a thick lead vessel, also that the rate at which a body exposed to the atmosphere lost its charge varied from day to day. A series of observations made by Mr. Dykes showed that the fluctuations in the rate at which some electroscopes lost their charge corresponded with the fluctuations in the amount of radium emanation present in the atmosphere. Thus the conductivity of the air is due to and is a measure of the amount of radium emanation in the air. Prof. Thomson showed a table in which the amount of radium in rocks of various kinds was given. This amount varied from 5×10^{-12} grams per gram for oolite to less than 1×10^{-12} grams per gram for chalk. In close connection with this was the amount of emanation present in the air. Sea-water was peculiarly free from traces of radium, and it would be interesting to have some figures for the conductivity of air in mid-Atlantic. It might be asked, Prof. Thomson added, how the earth could retain its charge of negative electricity if the air conducts? If there were not some means of re-charging the earth, the charge would be lost in an hour. A few hundred amperes would suffice for the whole of the surface of the earth, but the difference of potential amounted to several millions of volts. In Prof. Thomson's own opinion, this re-charging was effected by rain as follows:—With a drop of temperature, the moisture in the air condenses with dust particles for the nuclei of the drops, and thus the air is being continually filtered from dust particles until at the higher altitudes the air is dust-free, and condensation with the negative particles as nuclei takes place. The drops of rain from the higher altitudes have therefore a charge of negative electricity. Only recently has it been definitely proved that drops of rain are negatively electrified. These drops fall at a slower speed than non electrified drops, as they have to be drawn to the earth by gravity against the potential of the earth. The charge thus brought down by rain is spread all over the surface of the earth and the charge thus continually renewed. With regard to the theory that the negative charge of the earth was renewed by a bombardment of negative particles from the sun, Prof. Thomson said that in his opinion the particles would not arrive with sufficient energy to enable them to overcome the difference of potential existing between the outer layers of the atmosphere and the earth's surface.

Continental

A New Kind of Rays.—The well-known Italian physicist, Augusto Righi, announces, in the *Rendiconti dei Lincei* for February 2nd, that he has discovered a new kind of radiation consisting of what he terms "magnetic rays." It consists of a projection of molecular magnets from the cathode when immersed in a strong magnetic field. The molecular magnets follow the magnetic lines of force, and trace them out visibly. That cathode rays are projected along the magnetic lines of force when the field is very strong was proved as long ago as 1858, by Plücker, and Villard studied this phenomenon in detail two years ago. Now a cathode particle or electron, projected along a magnetic line of force, describes a spiral whose generating circle is the smaller the stronger the field. The axis of the spiral coincides with the magnetic lines of force, and when the generating circle is very small, the path of the cathode particle cannot be distinguished from the line of force. But these magnetic rays do not, as a rule, convey a charge. Righi concludes that they really consist of binary systems, an electron revolving round a positive atom, with the plane of its orbit normal to the direction of propagation. Such a system would constitute a very flexible molecular solenoid, and would have considerable stability. A divergent field would produce a retardation of the system, and eventually a return to the cathode.

Dispersion in Interstellar Space.—An important discovery appears to have been made by C. Nordmann. It has hitherto been considered as certain that light of all wave-lengths is propagated with the same speed through the ether, whatever may happen in ordinary matter. An obvious instance of this is the disappearance and reappearance of Jupiter's satellites, which should be coloured if interstellar dispersion existed. But if Jupiter were removed a million times further, some perceptible difference might arise. Now the author has practically obtained such conditions in the case of Algol and λ Tauri. These are both "occultation binaries." The method, which is described in the *Comptes rendus* for February 24th, consisted in obtaining monochromatic colour curves for these two stars, and looking for any lag of one curve behind the curve of another colour. Such a lag was actually observed. In Algol red light was 16 minutes ahead of blue light, and in λ Tauri this difference amounted to a whole hour. If the dispersion is the same in all space, it means that λ Tauri is three or four times as far away as Algol. In any case, the lag of the blue behind the red does not exceed one part in two million.

Electrolytic detectors.—In the Ferrié electrolytic detector a very fine platinum point is immersed in sulphuric acid, and the opposite electrode has a large surface. The impinging wave, gathered up by the antenna, is brought to a high potential by a suitable transformer. The detector is contained in the secondary circuit, together with a condenser adjusted to resonance. The platinum point is permanently charged to a positive potential closely approaching the point of electrolysis, by means of an auxiliary battery, and the telephone is placed in the polarising circuit. If this circuit has a low resistance, the degree of syntony obtainable is very high. Ordinarily, the resistance is several thousand ohms, but it may be reduced by heating the detector to 120° C. It then falls to a few hundred ohms. At the same time, the capacity increases from a hundredth of a microfarad to 0·5 mf., but this has no perceptible effect upon the sensitiveness, and is easily compensated. As regards the mode of action of the detector, it appears that the positive limb of the primary current curve increases the polarisation and the current in the secondary, but the energy required for this increase is furnished by the oscillatory circuit itself. A detailed study of these processes is contributed by H. Abraham to the *Comptes rendus* for February 24th.

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"ELECTRICAL ENGINEERING" PATENT RECORD

(This Patent Record is compiled by our own Editorial Staff and is Strictly Copyright.)

Specifications Published March 5th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

3,982, S. O. COWPER-COLES. Vessels for containing fused salts during electrolysis. As only some liquid metals, such as tin, lead, or mercury, can withstand the action of the fused salts, the inner retaining vessel is formed by such a liquid. The outer vessel, which is heated externally, is constructed of iron, or other suitable conducting material, and is spherical or parabolical in shape. This vessel is rotated at a sufficiently high speed to cause the liquid metal within it to distribute itself by centrifugal force over the inner surface. There is a continuous flow of the liquid metal through the apparatus, and the reduced metal is carried away wth the said liquid metal. A carbon electrode is introduced into the vessel from above, and the vessel itself forms the other electrode. Four claims, two figures.

4,152, J. S. PECK. An arrangement for equalising the load on alternating-current systems, and for supplying slow speed induction motors with low-frequency currents from high-frequency circuits. The stator winding of the induction motor of a motor-converter set is connected to the supply mains, the rotor winding being connected across to the suitable points on the armature winding of the direct-current generator. This generator has a shunt field system of the usual type, and the current generated is supplied to a direct-current motor coupled to a flywheel. The working motor is fed with current taken off by means of slip-rings connected to the cross-connections between the two rotors of the motor-converter set. The working motor thus normally receives its current direct from the rotor of the induction motor, and in cases of overload, also from the armature of the direct-current machine, which acts as a rotary-converter, taking in current from the flywheel motor, which then acts as a generator, and converting it to alternating current for driving the working induction motor. When the induction motor is not working, the converter set supplies power to the flywheel motor, accelerating and storing up energy in the flywheel. One claim, one figure.

7,048, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*) Wedges for retaining armature conductors in slots, particularly in the case of induction motors, where the surface of the iron core should be, as nearly as possible, an unbroken area of magnetic material. The wedges can consist either of a series of longitudinal or transverse strips of magnetic material connected together, but electrically insulated from one another. For instance, a pile consisting of alternate strips of iron and fibre, riveted together; or, again, they can be moulded in a material consisting of iron-filings or iron-wool, and a suitable binding material, as sodium silicate. In the latter case a backing of some strong fibrous material is provided to strengthen the magnetic wedge. Five claims, four figures.

9,572, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). A method of fusing metallic filaments to the leading in or supporting wires. The welding of the wire to the filament is performed by means of an electric arc, in a protecting jet of some reducing gas, such as hydrogen, surrounded by an envelope of an inert gas, such as carbon dioxide. A special nozzle for the gas jet is described. Five claims, four figures.

10,861, FRANKLIN PUNGA. A multiple circuit multiple winding for direct-current armatures. Equalising connections between the different individual windings are provided, so that the potential of each commutator segment is as nearly as possible mid-way between the potentials of the two adjacent segments. (A description and a diagram of this winding will be found in ELECTRICAL ENGINEERING Vol. II., page 884). Two claims, three figures.

14,955. T. TORDA & L. TORDA. An arrangement of boosters in multiple wire distribution circuits. Each booster is provided with two series windings, one in series with the outer wire, with which, also, the armature is in series, and one in series with the neutral or inner wire. These windings are so arranged that if the two windings of one booster are assisting each other, the windings of the other booster are opposing each other. As a result, the pressure between the inner and the two outer conductors remains constant with unbalanced and varying load. Three claims, two figures.

24,751, SIEMENS-SCHUCKERTWERKE GES. Means of artificially cooling commutators of high-speed machines. The cooling medium, for instance, oil, is fed or pumped in through a central inlet passage in the shaft, and is discharged out of this passage through radial ducts in the shaft on to the inside surface of the commutator segments. It leaves the commutator at the same end as that at which it enters. Four claims, two figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1906 Patents

28,600, BECK & DEUTSCHE BECK-BOGENLAMPEN GES. Arc lamps.
28,601, BECK & DEUTSCHE BECK-BOGENLAMPEN GES. Arc lamps.
28,638, GIN. Induction furnaces.

1907 Patents

3,783, LEVY. Wireless Telegraphy.
3,962, RICHMOND. Electric batteries.
3,981, COWPER-COLES. Zinc and aluminium alloys.
4,026, VOSMAER. Resistance coils for rheostats.
4,031, FYNN. Alternate current motors.
4,085, COLEMAN. Electric alarm apparatus.
4,137, CABOT. Wireless signalling systems.
4,181, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*) Prevention of electrolysis.
4,211, CROMPTON & CO., MACFARLANE, & BURGE. Rotary transformers and motor generators.
4,593, MARCONI & MARCONI'S WIRELESS TELEGRAPH CO. Transmitting apparatus.
4,832, CHRISTENSEN. Voltaic cells.
5,100, CÔTE & PIERRON. Electric furnace.
5,506, LAMME. Alternating-current commutator machines.
6,289, WALTER. Methods of electrical control.
7,180, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*) Electrical resistances.
8,984, HOOKHAM & HOLDEN. Electricity meter.
9,591, GROSS. Supports for arc lamp carbons.
9,923, ROBERTS. Electric switching mechanism.
11,177, HADDAN (*Polyphos Elektrizitäts-Ges.*). Röntgen ray apparatus.
13,072, WHITE. Electric controllers.
13,195, BRITISH THOMSON-HOUSTON CO. (*Allgemeine Electricitäts Ges.*) Railway signalling systems.
16,087, MACKENZIE (*Lorenz*). Telephone alarm.
16,952, KJELLBERG. Electric welding or soldering.
20,201, SIEMENS BROS. DYNAMO WORKS, LTD., & HOLMES. Searchlight projectors.
20,949, SIEMENS BROS. DYNAMO WORKS, LTD. (*Siemens Schuckertwerke Ges.*) Control of electric vehicles.
23,317, HARTMANN & BRAUN AKT.-GES. Frequency indicators.
24,288, BOSCH. Contact breakers for electrical ignition.
24,874, RICHARDSON. Electric conductors.
25,118, ARCIONI. Alternating current thermal wattmeters.

Complete Specifications open to Public Inspection before Acceptance.

1908 Patents

3,056, STRUBLE. Relays.
3,251, IVERSEN. Regulation of hoisting plants.
3,242, GROUVELLE, ARQUEMBOURG, & JORET. Use of the motors of automobiles as brakes.
3,283, ALLGEMEINE ELEKTRICITÄTS-GES. Arc lamps.
3,285. ALLGEMEINE ELEKTRICITÄTS-GES. Rock-drills.
3,401, JENNEY. Automatic switches.
3,464. ANDERSSON. Electric arc lamp.
3,465. ANDERSSON. Carbon holder for arc lamps.
3,492. MÄHL. Meters.
3,505. MERTENS. Current-collector for electric cars.

Expiring Patents

The following Patents expire during the current week, after a life of fourteen years:—

5,508, of March 16th, 1894. ALEXANDER MUIRHEAD. Improvements in the apparatus for automatic transmission on submarine cable circuits. The improvements consist in a special shaping of the contact-making levers, and in the employment of grooved rollers mounted on the same axis as the spur-wheel, for controlling the movement of the levers. Six claims, eleven figures.

5,651, of March 17th, 1894. E. J. PRESTON & A. B. GILL. A method of suspending a belt-driven train-lighting dynamo. The tension in the belt is such that after a certain predetermined speed has been attained, the belt slips and no further increase in the speed of the dynamo takes place. Also, a rocking switch, mounted freely on the dynamo shaft, which reverses the direction of the current when the direction of rotation of the dynamo is reversed. The switch is controlled by a governor, which causes it to be closed as soon as a certain speed is reached. Six claims, nine figures.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. 1906	Dividend Paid. 1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ltd.	10	7	5/-*	11—12	+¼
Do. 4½% Cum. Pref.	10	4½	4½	10—11	
Do. 6% Cum. Second Pref.	10	6	6	10—10¾	
Do. 4½% Debenture, Red.	Stock	4½	4½	100—103	
Bromley (Kent) E. L. & Power Co., Ltd.	5	5½	2/-*	4⅜—5½	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	95—98	
Brompton & Kensington E. S. Co., Ltd.	5	10	4½%*	7¾—8¼	
Do. 7% Cum. Pref.	5	7	7%*	7—8	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	97—100	
Ch. Cross. W. E. & City E. S. Co.	5	5	5%*	4¼—4⅝	
Do. 4½% Cum. Pref.	5	4½	2¼%	4¼—4¼	
Do. 4% Deb. Red	Stock	4	4%	97—100	
Do. "City Undertaking," 4½% Cum. Pf.	5	4½	4½	4¼—4⅜	
Chelsea Electric Supply Co., Ltd.	5	4½	2-*	3½—3⅝	-⅜
Do. 4½% Deb. Red	Stock	4½	4½	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	5%*	10—11	
Do. 6% Cum. Pref.	10	6	6%*	11½—12½	
Do. 5% Deb. Red	Stock	5	5%	122—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	99—102	
City of Durham E. P. Dis. Co.	5	4	2/1%*	3—3⅜	
Do. 5% Pref.	5	5	5%*	4⅜—4⅝	
County of London Elect. Sup. Co. Ltd.	10	5	4%*	7⅞—8½	
Do. 6% Cum. Pref.	10	6	6%*	11—11½	
Do. 4½% Deb. Red	Stock	4½	4½%	105—108	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	97—100	+1
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	-⅛
Do. 6% Cum. Pref.	5	3½	—	⅛—1¼	-⅛
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	60—70	-5
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4⅜—5½	
Do. 5% Cum. Pref.	5	5	2/6*	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6¼—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E. L. Co.	5	10	5/-*	8—9	
Do. 4% Deb. Red	Stock	4	4%	96—99	+1
Kens. & N'tng Hill E. L. Cos. Db. Rd.	Stock	4	4%*	99—103	
London Electric Supply Corporation	3	4	2/1½d*	1¼—1⅜	
Do. 6% Pref.	5	6	6%*	4⅜—5	-⅛
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	3/-*	5¼—5⅜	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5¼	-⅛
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D.	100 & 500	4½	4½%	98—101	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	9¼—10¼ xd	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	5%*	6⅜—6⅝	
Do. £2 Pm.	5	8	1/4½d*	6¼—6⅜	-⅛
Do. 5% Pref. (fully paid)	5	5	5%*	5¼—5⅜	
Do. 10/- Pm.	5	5	1/4½d	5¼—5⅜	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11—12 xd	
Oxford Electric Co., Ltd.	5	7	2/6*	5⅜—6¼	
Do. 4% Deb. Red.	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7¼—8¼ xd	
Do. 7% Non-Cum. Pref.	5	7	7%	6¼—7 xd	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—1¼	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2¾—3	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅜—⅝ xd	
Do. 7% Cum. Pref.	1	7	7%	1¼—1⅜ xd	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	101—104	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1⅛—2¼	
Do. 5% Cum. Pref.	5	5	2/6*	2—2⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	10*	7¾—8⅛ xd	-¼
Do. 4½% Cum. Pref.	5	4½	4½%	5—5½	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	88—91	
Central London	Stock	4	3%	64—67	
Do. 4% Preferred.	Stock	4	4%	82—84	
Do. Deferred.	Stock	4	2%	44—47	
Do. 4% Debentures.	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	81—84	+3
City and South London Cons.	Stock	2½	4¼%	38—40	
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	114—117	
Do. 5% Perp. Pref. 1896	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11¼d.	1⅛—1⅜	
Gt. Northern, Piccadilly & Brompton	10	4	4%	5¼—6½ xd	
Do. 4% Perp. Deb.	Stock	4	4%	87—90	+1
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	½%	36—37	-½
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½%	71—74	-1
Metropolitan District	Stock	nil	—	9⅛—10½	+½
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Deb.	Stock	4	4%	70—75	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pr. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	40—44	
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅜—⅝	
Do. 5% Cum. Pref.	1	5	5%	⅛—⅜	
Do. 4½% Deb. Red.	Stock	4½	4½%	91—96	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	4¼—4⅜	-¼
Do. 5% Perp. Deb.	Stock	5	5%	97—100	
Do. 4½% 2nd Deb.	Stock	4½	4½%	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4⅜—4⅝	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	98—101	

NAME.	Amount of Share.	Dividend Paid. 1906	Dividend Paid. 1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%	%		
Dublin United Trams Co.	10	6	6%*	12¼—13¼	
Do. 6% Pref.	10	6	6%	12¼—13⅛	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅜—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7—8	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4¼—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	87—92	-2
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—⅛	
Do. 5% Cum. Pref.	1	5	5%	⅜—⅝	-1/16
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	97—99	-1
National Elec. Construction Co. Ltd.	1	10	2/-	¼—⅜	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅜—1⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9½d*	¼—⅜	
Do. 5% Cum. Pref.	1	5	5%	¼—⅜	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4¼—5	
Do. 6% Cum. Pref.	10	6	6%	9¼—10¼	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	1/1¼	¾—1⅛	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	70—75	+7
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1¼	
Do. 6% Cum. Pref.	5	nil	—	3¼—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	3½%	54—57	
Do. 6% Pref. Crd.	Stock	6	6%	97½—99½	
Do. Def. Ord.	Stock	1⅝	1%	13—13⅜	+¼
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	87—90	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3¼	
Do. 10% Cum. Pref.	5	10	5/-*	8¼—9½	
Do. 4½% Debs.	50	4½	4½%	99¼—102½	
Direct United States Cable Co. Ltd.	20	4¼	4⅝%	13⅝—14¼	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12⅜—13¼	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5⅜	5%	130—135	-1
Do. 3½% Pref.	Stock	3½	3½%	83—86	
Do. 4% Mort. Deb.	Stock	4	4%	100—103	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	31—33	-1
Indo-European Telegraph Co. Ltd.	25	13	65/-	54—57	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	
National Telephone Co., Ltd., Pref.	Stock	6	6%	107—109 xd	-1
Do. Deferred	Stock	5½	6%	107—109 xd	-1½
Do. 6% Cum. 1st Pref.	10	6	6%	10—12 xd	-½
Do. 6% Cum. 2nd Pref.	10	6	6%	10—12 xd	
Do. 5% 3rd Pref.	5	5	5%	5⅜—5⅝ xd	
Do. 3½% Deb. Red	Stock	3½	3½%	97—99	
Do. 4% Deb. Red.	Stock	4	4%	100¼—102½	
West African Telegraph Co. Ltd.	10	4	4/-	10—10¼	
Western Telegraph Co., Ltd.	10	7	6%	13⅛—13⅝	
Do. 4% Deb.	Stock	4	4%	98⅜—101½	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅛—⅜	
Do. 6% Cum. Pref.	1	6	7½d	25/32—27/32	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅜—3⅝	
Do. 6% Pref.	1	6	7½d	1 1/16—1 3/32	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6⅝—7⅛	
Do. 6% Cum. Pref.	5	6	6%	5⅝—6¼	+⅛
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	101—104	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	83—87 xd	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—⅜	
Do. 4% Mort. Deb. Red.	Stock	4	4%	44—49	+1
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅜	-1/16
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	77—80 xd	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10¾—11¾	
Do. 5% Cum. Pref.	5	5	5%	5⅜—5¾	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106—108	
Consolidated Electrical Co., Ltd.	1	3	8¼d*	1/16—⅛	
Crompton & Co., Ltd.	3	5	5%	1⅝—2 1/16	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1⅜—1⅝	+⅛
Do. 6% Cum. Pref.	1	6	7½d	1 1/16—1 3/16	+1/16
Do. 4½% Deb. Red	Stock	4½	4½%	99—102	
Edison & Swan United "A," £3 paid	5	4½	2/6	2—1	
Do. do. (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	⅛—⅜	
Do. 7% Cum. Pref.	2	7	—	1⅛—1⅜	
Do. 4½ 1st Mort. Deb.	Stock	4	4%	64—68	-1
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7¾—8¼	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	5/-*	11¾—12¾	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5¼ xd	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%*	99—101	
Tel. Const. & Maintenance Co.	12	15	5%*	33—35	
Do. 4% Deb. Bds. Red	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1¼	
Do. 6% Cum. Pref.	5	nil	6%	3¼—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

ABERDEEN: *Electricity Supply in Cults.*—A report has been received from the Electrical Engineer, giving two schemes to cope with the immediate wants of the Cults district. The first one involves the transmission of high-tension current to a sub-station, where it will be transformed to low pressure at an expenditure of £2,724. The second scheme provides for the laying of three high-tension cables instead of one as far as the city boundary, with a view to providing for the increasing demand within the city. This, the Engineer estimates, would cost £6,660. The Electricity Committee recommend that the second scheme be adopted.

Supply to Suburban Tramway Co.—A letter has been received from the secretary of the Aberdeen Suburban Tramways Co. asking what terms the Council will propose in the event of the company requiring a supply of electrical energy for their undertaking, after the expiration of the present agreement, which will shortly terminate. It may be pointed out that for some time past the Tramways Company have openly stated their opinion that the present rate is too prohibitive for them to continue, and the erection of their own power station has been hinted at.

ABERSYCHAN: *Order Revoked.*—The Board of Trade have revoked the Electric Lighting Order of 1905, as from February 25th, 1908, regarding the whole area of supply.

ACCRINGTON: *Power Supply.*—It is stated that the contract which the Corporation have just renewed for the supply of electricity to Messrs. Howard & Bullough for another five years represents the largest supply given by any municipality in the county to a single business concern.

AVONMOUTH: *Supply from Bristol.*—The laying of the feeder cable, by which the supply to the Avonmouth dock is to be obtained from the Bristol Corporation station, is being carried out by Messrs. Siemens Bros. & Co. The transmission pressure is 6,600 volts, and the cable is lead-covered and laid in stoneware troughs filled with bitumen. Transformers at the docks will reduce the pressure to 250 volts in the case of the old dock and 600 volts in the case of the new dock.

BARROW: *Electricity Charges.*—A letter has been received from the Barrow-in-Furness Traders' Association, asking the Electricity Committee to appoint a sub-committee to meet a similar sub-committee of the association to discuss the question of electricity charges. The Electricity Committee has refused to accede to this request, but the association has been informed that the chairman of the committee and the Borough Electrical Engineer will be pleased to meet members of the association at the electricity works for an informal discussion of the whole question.

BIRMINGHAM: *Expenditure on Tramway Cables.*—At the meeting on Wednesday last week, the chairman of the Tramways Committee moved that the sum of £12,293 expended in laying cables, and £1,021, the cost of laying the cables for the Aston tramway route, should be assigned, under the provisions of the Birmingham Corporation Act, 1905, to the electric lighting undertaking. The resolution was carried.

BOLTON: *Tramways Parcel Traffic.*—After much discussion the Bolton Town Council have finally decided to inaugurate an elaborate system of parcel carrying by tramcar, in accordance with terms and conditions arranged with the Bolton Combined Tramways Association.

BRIDLINGTON: *Revised Tariff.*—The Electricity Committee have resolved that the price to consumers of from 500 to 749 units per quarter be at the rate of 4½d. per unit, and to consumers of 750 units and upwards per quarter, 4d. per unit.

BRIGHOUSE: *Breakdown.*—A rather serious breakage occurred last week to one of the gas engines at the electricity works, when the piston and a portion of the cylinder were hurled a considerable distance, owing to the bursting of the latter. No one was injured. There is considerable trouble in maintaining the supply.

BRIGHTON: *Electric Omnibuses.*—At the meeting of the Corporation on Thursday, the Watch Committee reported that the Brighton, Hove & Preston United Omnibus Co., and a Mr. Thornton, representing a London company, had written regarding the substitution of electric omnibuses for some of the seven petrol omnibuses now in use in the first case, and for the introduction of a new service in the second case. The committee had replied to Mr. Thornton that, provided such electric omnibuses were approved by the committee and the Chief Constable, no objection would be made, on the understanding that he agreed to run a service of electric omnibuses from Preston Circus to the northern boundary of the borough. An amendment was moved to omit the portion of the minutes relating to Mr. Thornton's application on the ground that it showed favouritism and was detrimental to the interests of the existing company. After some discussion this was carried by 25 votes to 23.

BUENOS AIRES: *Underground Electric Railways.*—H.M. Consul reports that since the proposal made last year to construct electric tube railways in Buenos Aires, both the Mayor and Municipal Council have been changed, and it is impossible to say with any degree of certainty whether or when the work will be carried out.

BURNLEY: *Electricity Statistics.*—The annual financial report of the Burnley Corporation, just issued, shows profits on the electricity undertaking of about £6,000. For the coming year the profits are estimated at £4,900, the chief reasons being an extraordinary increase in the assessment of the department from £1,300 to £4,000. In the tramways department there is a balance of £10,000, which it is proposed to place to depreciation and reserve—the largest surplus the department has reported.

New Tramcars.—The Council has referred back for further consideration a resolution by the Tramways Committee, relating to the purchase of five tramcars at an estimated cost of £800 each.

CALCUTTA: *Electricity Supply.*—The increase in the business of the Calcutta Electric Supply Corporation is shown by the fact that the number of units delivered to consumers during the five weeks ended January 31st was 401,412, compared with 366,569 units in the corresponding five weeks of 1907.

CARLISLE: *Electricity Employees Dinner.*—The fifth annual dinner of the employees of the Corporation Electricity Works was held on Friday. In proposing "The Carlisle Electricity Undertaking," the chairman, Mr. C. D. Burnet, Chief Electrical Engineer, stated that for the eleven weeks ended February 15th, 1908, 29,850 additional units had been sold, compared with the same period of 1907, but the revenue was less by £170.

CEYLON: *Import Tariff.*—A notice has been issued that electric motors shall in future be admitted into Ceylon free of duty.

CHELMSFORD: *Street Lighting.*—The Electric Supply Corporation and the Chelmsford Gas Co. are to quote in competition for the erection, lighting, cleaning, and maintenance of certain additional street lamps which are required.

DOVER: *Supply to Admiralty Harbour.*—The following particulars of the scheme in accordance with which the Electricity Department propose to supply electricity to the Admiralty Harbour have been approved by the Corporation:—The charge for lighting to be 2⅞d. per unit up to 200,000 units per annum, with a guaranteed minimum annual consumption of 100,000 units; units in excess of 200,000 per annum to be charged at 2⅜d. The maximum demand for lighting not to exceed 100 kw. in event of this demand being exceeded, the 2⅞d. rate shall be payable on an additional 10,000 units beyond the 200,000 units for each additional 10 kw. demanded, and the guaranteed minimum annual consumption shall be increased by 100,000 units for each additional 10 kw. demanded. The power rate proposed is 2¼d. per unit up to 200,000 per annum, with a minimum of 100,000 units, 2d. per unit up to 300,000 units, and 1¾d. beyond. If the maximum power demand exceed 250 kw., the 2¼d. rate shall be payable on an additional 8,000 units beyond the 200,000 units per annum for each additional 10 kw. demanded, and the guaranteed minimum shall be increased by 4,000 units for each additional 10 kw. demanded.

DUNDEE: *Coal Supplies.*—The Special Committee of the Council which was appointed to inquire into the system of coal supply to the electricity department, in consequence of a report on the matter by Mr. Richardson, the engineer, have now submitted a report in which the whole question is gone into very fully, and confirmed the statement that money could have been saved had the advice of the engineer been more closely followed.

EAST HAM: *Broken Trolley Wire.*—On Saturday one of the overhead wires on the tramway system in Station Road, Manor Park, snapped, but nobody was injured.

Tramways.—At a meeting of the Town Council on Tuesday, the Electric Lighting and Tramways Committee reported the acceptance by the North Metropolitan Tramway Co. of the Council's offer for acquisition of the section of track owned by them in Romford Road. The Borough Engineer and the Engineer and Manager were directed to prepare plans and estimates for the construction of the track and overhead equipment along this section of road. A report is also to be presented on the question of inter-running with West Ham along the Romford Road.

ELLAND: *Projected Tramways.*—It is reported that a company is being promoted to construct tramways connecting Elland, Rastrick, and Huddersfield. The carrying out of the scheme will mean the construction of lines from West Vale, the extreme point of the Halifax service, to Fartown, the nearest point of the Huddersfield service. The gauges of the two services are different, but this difficulty is to be met by the laying down of a third rail. Parliamentary sanction to the scheme has already been obtained.

ERDINGTON: *Tramways.*—The report on the working of the tramways from the date of their inauguration on April 22nd, 1907, to January 31st, 1908, shows total receipts £9,970, or an average of 10·67d. per car mile. The expenditure has been £8,562, leaving a balance of £1,408, out of which provision for a reserve would have to be made.

FOLKESTONE: *Electricity Works Rifle Club.*—At the annual general meeting of the Rifle Club formed of the employees of the Folkestone Electricity Supply Company, last week, Mr. T. Hesketh, Chief Engineer of the company, was re-elected captain as well as hon. secretary and treasurer.

GUILDFORD: *Electrical Exhibition.*—The Guildford Electricity Supply Co. have been awarded a gold medal for their

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exhibit of applications of electricity at the Trades Exhibition at the Guildford Drill Hall, last December.

LEEDS: *Electric Power Charges.*—A deputation of electric power users in Leeds waited upon the Council last week to ask for a reduction in the charges for energy for lighting, where this was used to a large extent on the premises of consumers taking considerable quantities for power purposes. It was suggested that a reasonable proportion should be given at power rates for lighting purposes, and, as instances, were mentioned Bradford, where 5 per cent. of the energy for power purposes could be used for lighting, and West Ham, where 10 per cent. could be so used. It was further pointed out that the tariff for power at Huddersfield was 1d. with discounts, which reduced this to ¾d. per unit in the case of large consumers, whilst in Bradford the minimum rate was ¾d. with discount, which reduced it to ½d. per unit.

Price of Electrical Energy.—A deputation representing some of the leading local manufacturing firms waited last week upon the City Council in order to urge that the price charged for electrical power should be lowered to a scale more nearly corresponding with that charged to large consumers in neighbouring towns, such as Bradford, where the minimum rate was stated to be ¾d. per unit, with discount, which brought it practically down to ½d.

LONDON: *London County Council: Hammersmith-Harlesden Tramways.*—The Board of Trade has consented to the use of the overhead trolley system for the portion of the tramways from Hammersmith Broadway to Uxbridge Road. Communications are taking place between the Board and the London County Council with regard to the similar consent concerning the Uxbridge Road to Harlesden Road tramway.

The Highways Committee recommend that arrangements should be made with Messrs. Reid Bros., who have the contract for laying the cable ducts along the road of the Hammersmith-Harlesden tramways, to undertake similar work simultaneously for the Postmaster-General, at an extra cost not exceeding £1,500, the Post Office paying a proportion of the cost.

Deptford: Opening of Roads.—The Works Committee of Deptford Borough Council call attention to the abnormal number of openings made by the L.C.C. in that portion of the roads which they are under obligation to repair as tramway authority. The L.C.C. is to be asked to minimise as much as possible the breaking up of streets consistent with the discharge of its statutory obligations.

Hammersmith: Franco-British Exhibition.—The Law and Parliamentary Committee report that the agreements with the Franco-British Exhibition Committee, and with the Kensington and Knightsbridge and the Notting Hill Electric Lighting Companies, regarding the supply of electrical energy to the Franco-British Exhibition, have been exchanged, and that the Exhibition Committee have paid the deposit of £1,000 as arranged. The Electricity and Lighting Committee, having had under consideration the question of improving the lighting of Wood Lane, has resolved upon the substitution of incandescent electric lights for the present gas lamps, of which there are at present 13, having a total candle-power of 295, the annual cost being £59 9s. 9d. The estimated cost of conversion (the present gas standards being used and fitted with the Osram metallic filament lamp) is £78 6s. 8d., the annual cost of lighting will be increased to £52, and the total candle-power increased to 1,144.

Hackney.—The London County Council have agreed to contribute one-third of the cost of street widenings in Mare Street and Lower Clapton Road for reconstruction of tramways, provided that the cost does not exceed £170,000. As, however, later estimates put the cost at £54,465, the Borough Council hope that the London County Council will agree to pay two-thirds of the cost.

Highgate Hill Tramways.—The Highways Committee of the London County Council report having had under consideration for some time past the question of the purchase of the undertaking of the Highgate Hill tramways. The tramways, which are worked by cable traction, consist of about ¾ route mile of partly double and partly single track, situated in London and Hornsey. The Council was in a position in 1903 to serve notice to acquire compulsorily, under section 43 of the Tramways Act, 1870, the portion of the undertaking situated in London, but the Council decided on October 20th, 1903, not to exercise its powers of purchase at that time. These powers of compulsory purchase will, in the ordinary course, recur in 1910. The company has introduced a Bill into Parliament in the present session (i) to authorise the company to reconstruct its tramways for electric traction on the standard gauge, (ii) to postpone the date of compulsory purchase of the lines by the local authorities, of which the Council is one, under the Tramways Act, and (iii) to confer on the company running powers over portions of the Council's tramways. The Council on January 28th, 1908, decided to petition against the Bill, and steps are being taken to oppose it accordingly. The company has, however, approached the Council with a view to the purchase by the Council at an early date of the whole of the company's undertaking by agreement under section 44 of the Tramways Act, 1870, in which event the company would not proceed further with its Bill. As the result of negotiation, the company has now expressed its willingness to sell its lines, &c., upon terms which the Committee feel justified in recommending the Council to accept. They accordingly suggest that a special meeting of the Council, of which one month's notice must be given, should be held under the provisions of the Tramways Act, 1870, to consider the matter as soon as practicable.

Islington: Electric Light Tariff.—The Lighting Committee have been empowered by the Council to modify, should they deem it desirable, the scale of charges to large consumers of electricity possessing high-load factors, provided always that such modification apply to all consumers taking current under the same conditions, and that every such modification be reported to the Finance Committee for their sanction.

London Electric Power Bills.—The Electric Lighting Committee reported at the last meeting that an informal conference of representatives of metropolitan borough councils owning electricity works, held at the Islington Town Hall on February 20th, the following resolutions were adopted:—(*a*) That those Metropolitan Borough Councils who are electric lighting undertakers be recommended to strenuously oppose the London Electric Supply and the London and District Electricity Supply Bills now before Parliament. (*b*) That in the opinion of this conference the development of the electricity supply of London can best be carried out by a combination of the existing undertakers. (*c*) That all the Metropolitan Borough Councils be recommended to authorise their electrical or consulting engineers to confer with a view to the drafting of a scheme on the basis referred to in the preceding resolution, and to the submission of such scheme for consideration by the representatives of such Borough Councils at a meeting to be called for the purpose. (*d*) That the Islington Borough Council be requested to convene such further meetings as may be necessary. It was resolved that the resolutions be approved.

Lambeth.—An agreement has been sealed between the South London Electric Light Corporation and the Borough Council whereby the old-standing dispute with regard to the destructor is to be settled by the lighting of the Brixton Town Hall free of charge.

Marylebone.—The Borough Council Electric Supply Committee issued a report on Tuesday on the results of the last six months' working, which, though not covering a period equal as to revenue earning to half of a complete year, affords a fair guide as to the costs of working and probable gross revenue for the year. The average yield per unit sold to private consumers was 4·42d., compared with the average estimated last March of 4·65d. This diminution is brought about by the large proportion of new businesses at the cheaper rates of supply, and the fact that the more profitable among the old consumers have elected to be charged on the maximum demand rates, which give a low average price in proportion to the number of hours of burning in each individual case. During the year ended March, 1906, the average attained was 5·15d. per unit, and during the year following, 4·7d. During the current year it will probably be 4·42d. With regard to the working costs for the six months, the report states that they are at a higher rate than the Committee estimated, owing largely to the increased price of coal, and abnormal repairs both at the works and on the distributing system. There was a special charge of £1,734 in respect of the cost of rendering effective for its present work the accumulator charging set at a sub-station, purchased from the company, which was not included in the year's estimates. The management costs have been steadily reduced, and during the six months work out at 0·243d. against 0·270d. estimated for the year. The repairs charges have been considerably reduced during the current quarter, and this, together with further economies effected in the standing charges, should result in a more favourable return for the March quarter. For the reasons named, the Committee explain, the estimate of March last as to the year's working will not be realised, and the complete year's accounts may show a small deficit. The question of more economical costs of production is receiving the Committee's careful attention, and the Consulting Engineer is advising them on this as well as on the revision of the tariff of charges to consumers. The necessity for adopting active measures tending to a large increase in sales, in order to spread the very heavy standing charges for loan service, management, and distribution expenses over a large number of consumers, the Committee say they are fully alive to.

Poplar.—The second annual dinner and smoking concert of the electricity department was held at the Eastern Hotel, Limehouse, on Saturday, Mr. J. H. Bowden, Borough Electrical Engineer and Manager, presiding.

At the last meeting of the Borough Council, the report of the Electricity Committee, embracing the result of the inquiry of the Board of Trade Commissioner on the recent boiler explosion, was submitted. (The Commissioner's conclusions were given in Electrical Engineering, January 23rd, p. 115.) The committee, after full and careful consideration of the evidence at the inquiry, came to the conclusion that they were not satisfied with the organisation and qualifications of the present works staff, and said they had directed the engineer to report as to the qualifications of the staff, together with a scheme of re-organisation. The committee's action was approved.

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A joint committee of the Works and Electricity Committees reported as to the installation of a new refuse destructor capable of supplying steam to the electricity undertaking. The committee agreed upon a scheme put forward by the Horsfall Destructor Company, of which the capital cost would be £17,700. The amount of loan on present destructor required to be paid off is £3,694. The annual cost was estimated at £5,345. Last year the disposal of refuse cost £5,293, but under the proposed scheme the receipts from by-products would be £3,608, reducing the net annual cost (on an average) of the last three years to £1,968. The joint committee propose that the Electrical Engineer should supervise and maintain the steam-raising plant, and that all repairs, cleaning, &c., should be carried out by his department. The committee's proposals were referred to the Finance Committee.

Stepney: Blyth's Wharf Scheme.—The Board of Trade has consented to the adoption of a 6,000 volt transmission system from the proposed generating station at Blyth's Wharf, subject to the usual conditions.

Woolwich: Hiring of Fittings.—The Borough Council has accepted the London County Council's terms and conditions both with regard to the proposed loan of £3,000 for the supply, on the hire rental system, of arc lamps, motors, radiators, and wiring, and to the appropriation of an existing loan of £3,000 for hire-purchase purposes, and a mortgage has been sealed to secure the former, repayable in ten years.

MIDDLESBROUGH: *Electricity Supply.*—At a recent meeting of the Electric Lighting Committee, Mr. H. Taylor, the Electrical Engineer, reported a reduction of the units sold to 123,000, as against 150,000 for the previous year, and a corresponding reduction in income from £1,688 to £1,646. This was accounted for partly by the rise in the price of coal and partly by the shipyard strike.

NEWCASTLE-UNDER-LYME: *Tramways.*—The Council has decided to rescind its resolution refusing consent to the doubling of the existing tramway track by the Potteries Electric Traction Co., for which the company now has a Provisional Order before the Board of Trade.

NEWPORT: *Sunday Trams.*—The employees of the Corporation tramway system are protesting against the proposal to run trams on Sundays, which is now under consideration by the Corporation.

OLDBURY: *Transfer of Provisional Order.*—The Council has sealed an agreement with the Birmingham & Midland Tramways, Ltd., for the transfer of their electric lighting Order. An agreement has also been entered into with the company with regard to the working of tramways in the district. The agreements are to be submitted to the Local Government Board for approval.

SWINDON: *Telegraph Breakdown.*—Owing to the breakage of an iron telegraph pole on Tuesday night of last week, after a heavy fall of snow, the town was without telegraphic communication for two days, and the local papers appeared without any telegraphic news. The pole which carried the trunk lines fell across a house and dragged down several other poles.

YORK: *Tramways.*—The application for the construction of electric tramways by the Corporation, which was opposed by the North-Eastern Railway Co., has been granted by the Light Railway Commissioners on condition that special arrangements were made for the protection of and access to the station. The whole scheme involves a cost of about £128,000. The route proposed is about six miles in length, partly single and partly double track. The cost of the electrical equipment, on the surface contact system, is estimated by Mr. J. W. Hame, City Electrical Engineer, at £24,294. The route along Micklegate is to be abandoned in order not to interfere with Micklegate Bar.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ASTON MANOR.—The Corporation invite tenders for one 300-kw. and two 400-kw. turbo-alternators with the necessary starting and field controlling gear. Full particulars from Mr. R. Foster, Borough Electrical Engineer (fee £1 1s., returnable), and tenders to the Chairman of the Electricity Committee, Council House, Aston Manor, by March 14th.

The Corporation invite tenders for the extension of the power station at Chester Street. Particulars from the Borough Surveyor, fee £1 1s. (returnable), and tenders to the Chairman of the Electricity Committee by March 16th.

BELFAST.—The Tramways and Electricity Committee invite tenders for twelve months' supply of stores, including electrical accessories. Particulars from the rolling stock superintendent, Tramway Offices, Napier Street, and tenders to the Town Clerk by March 16th.

BOLTON.—The Tramways Committee invite tenders for stores during the year ending March 31st, 1909, including overhead materials, lighting materials, trolley pole, sundries, gear and pinion wheels, and brakeblocks. Full particulars from Mr. A. A. Day, Chief Engineer and Manager, and tenders to the Chairman of the Tramways Committee, Town Hall, by March 16th.

The Electricity Committee invite tenders for stores, including lubricating oils, joint-boxes, service fuse-boxes, &c., meters, mains sundries, motors and transformers, and motor-starting switches. Particulars as above, and tenders to the Chairman of the Electricity Committee by March 26th.

BURNLEY.—The Guardians for the Burnley Union invite tenders for electrical supplies for the ensuing year. Tenders close on March 16th.

BURY.—The Corporation invite tenders for the supply, delivery, and erection of two 2,000-kw. turbo-alternators with exciters and condensers. Specifications and general conditions may be obtained from Mr. S. J. Watson, Electricity Works, Bury (fee £2 2s., returnable), and tenders to the Town Clerk by March 16th.

DEWSBURY.—The Electricity Committee invite tenders for surface condenser and cooling tower. Full particulars from the electricity works (fee £1 1s., returnable), and tenders to the Chairman of the Electricity Committee by March 30th.

ERITH.—Tenders are invited for stores for the year ending March 31st, 1909, including carbons, meters, lamps, cables, joint boxes, bitumen, insulating tapes, and compound and cut-outs. Specification and forms of tender from the Chief Electrical Engineer (fee £1 1s., returnable), and tenders by March 18th.

FARNWORTH.—The Council have decided to spend £7,000 on transforming plant, extensions, and other purposes connected with their electricity undertaking. The Engineer has been instructed to prepare plans.

FELIXSTOWE.—A storage battery and booster are required. Tenders by March 25th. (See advertisement this week.)

GILLINGHAM.—The Council invite tenders for the supply of electricity meters and lubricating oils during the ensuing twelve months. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by March 23rd.

GLASGOW.—Tenders are invited for:—(1) Large water-tube boilers; (2) 1,000 kw. motor generator and rotary converter; (3) extra high-tension and direct-current sub-station switchgear. Tenders to the Town Clerk by March 24th. (See advertisement this week.)

HALIFAX.—The tramways manager has reported that considerable renewals to the track and electrical equipment are required. The total estimated cost of the renewals and new loop lines recommended amounts to £10,870.

HEYWOOD.—The Electricity Department invite tenders for the supply, delivery and erection of the following:—(1) A Lancashire boiler, feed pump, steam, feed, and blow-off piping, water filter, and economiser; (2) steam engine and dynamo, condensers, air and circulating pumps, water-cooling tower, exhaust and circulating piping, return water and oil separator pumps; (3) lighting switchboard, alterations to traction generator, panels, combined booster and balancer set, and cable connections between machines and boards. Full particulars from the Consulting Engineer, Mr. J. R. Salter, Atherton, Lancashire, fee £3 3s. (returnable), and tenders to the Chairman of the Electricity Committee, Town Hall, Heywood, by March 16th.

ITALY.—The *Gazzetta Ufficiale* of February 26th contains a copy of a decree authorising the Tramvia Automotofunicolare di Catanzaro to construct and work an electric tramway for the transport of passengers and goods between the railway station of Catanzaro Sala and the piazza Independenza in the town of Catanzaro. The *Gazzettas*, containing further information, may be seen at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, London, E.C.

LANCASHIRE COUNTY ASYLUM.—Tenders are requested for the supply of electrical goods and supplies to the Lancashire County Asylum, Preston, for the year ending April 5th, 1909. March 13th and March 19th are the respective dates for tendering.

LANCASTER.—The electrical engineer has reported that a new cable and alterations to the switchboard at the Town Hall are necessary, at an estimated cost of £275.

LEEDS.—The Electric Lighting Department invite tenders for the supply of steam coal and various supplies, including rubber-covered cables, main boxes, jointing and insulating material, electric lamp fittings, and sundries. Particulars from the Manager, and tenders to the Town Clerk by March 31st.

LONDON: *London County Council.*—The L.C.C. on Tuesday sanctioned the borrowing by Islington Borough Council of £6,935, for extension of mains and house services in connection with the electricity undertaking.

Tenders are invited for (*a*) about 32 miles of high-tension three-core lead-covered electric cables, &c., and (*b*) about 50 miles of low-tension lead-covered electric cables, &c., and about 30 miles of telephone cables for the Council's tramways. Tenders by March 21st. (See an advertisement.)

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Fulham.—The Electricity and Lighting Committee has acquiesced in the proposed erection by the Electrical Engineer of a suitable pavement transformer chamber, at an estimated cost of £356. The committee has also adopted the recommendation of the Electrical Engineer to expend £159 10s. for the adequate equipment of the workshop at the electricity works, in order that the department may undertake its own repair work, &c. The tools proposed to be obtained are a planer (4 ft. by 2 ft. by 2 ft.), a radial drill (3 ft. 6 in. radius of arm, with tool-table beneath), a small 3½ in. mechanics' lathe, and a small bench emery grinder.

Poplar.—The engineer reported, with regard to provision to be made to meet next winter's maximum load, that the present plant has been loaded up to danger zone during this winter, and that it would be necessary to provide for an increase of not less than 400 kilowatts. The Electricity Committee have negotiated with several supply companies for a bulk supply, but, on the most favourable terms offered, the cost would be far in excess of that at which the current could be obtained by an extension of the Council's own generating plant, space for which is available in the existing buildings. The provision and maintenance of an additional generating station at Millwall would be exceedingly costly by reason of want of diversity of supply, costly coaling and condensing arrangements, duplication of standby plant, duplication of generating staff, and cost of land in excess of that necessary for a sub-station. The engineer states that he does not consider batteries effective plant; there is grave risk in relying upon them for anything but occasional peak loads, while the absence of standby and the heavy cost of upkeep are against present reconstruction or extension of the batteries to temporarily meet the increased demand. The engineer's proposal is to replace an existing 200 kw. generating set with a 1,000 kw. turbo-generator capable of developing a 20 per cent. overload, and the provision of an additional boiler. This would complete the equipment of the present station, and any further extensions required would necessitate an extension of the existing buildings. The installation now proposed, with the steam afforded by the new dust destructor, is expected to render further extensions of the generating plant unnecessary for at least three years.

Capital expenditure must also be incurred for distributing plant, including new feeders, additional sub-station and sub-station plant. In regard to this the engineer reports that during the winter portions of the distributing system have been strained in an equal proportion to the generating system, most of the feeder cables have been overloaded, thereby wasting a considerable amount of energy, and causing not only loss in revenue, but necessitating generating power which would otherwise have been avoided. To comply with statutory requirements as to voltage of supply and to keep the efficiency of the distribution system within economical limits, certain alterations and additions were necessary. In the north district the existing sub-station has not yet been brought into use. This is now absolutely necessary, as several complaints of low voltage have been received. Opening this sub-station would bring into operation one feeder which has hitherto lain dormant, and it will also be necessary to lay a new feeder and connect the Old Ford feeder with the sub-station. In order to start up, the engineer proposes to re-transfer a 250 kw. set from Glengall Road station to the northern sub-station, and instal a new duplicate set of 250 kilowatts in reserve. In the central district the feeder to Coborn Road must be extended, and a new feeder must be laid from the generating station to High Street, Poplar, in order to relieve the load on adjacent feeders, and to supply large new demands. The demand for current in the southern district has been much more rapid than was anticipated. It has been difficult to cope with the winter's load on account of the variable lengths of feeders out of the Glengall Road station and the overload upon them. At times it has been necessary to raise the bus-bar voltage, which would normally be at 480/490 to 522. This represents a demand upon the generating station of 1,370 kw., but if it had been possible to maintain the supply at 480 bus-bar voltage, the demand upon the station would have been only 1,260 kw. As the demand increases, the bus-bar voltage will rise still further, and the voltage of supply will become more variable and unsatisfactory. In these circumstances a second sub-station in the extreme south of the area is absolutely necessary. The engineer estimates the cost of the generating and distributing extensions now proposed will be about £27,200. The Council provisionally approved the extensions indicated, and authorised the committee to obtain tenders from selected firms for the types of plant required.

St. Pancras.—Tenders are invited for the supply of arc lamp carbons for twelve months. Full particulars from the Electricity Offices, 57 Pratt Street, Camden Town (fee, £2, returnable), and tenders to the Town Clerk by March 23rd.

MANCHESTER.—The Electricity Committee invite tenders for the supply, delivery, and erection at the Stuart Street Generating Station of a 6,000-kw. turbo-alternator with exciter and condenser plant complete. Particulars, &c., from Mr. F. E. Hughes, Secretary to the Electricity Department, Town Hall, Manchester (fee £2 2s., returnable), and tenders to the Town Clerk by March 25th. Further particulars and information can be obtained from Mr. S. L. Pearce, Chief Electrical Engineer, Dickinson Street, Manchester.

OLDHAM.—Sanction has been received from the Local Government Board to borrow £1,500 for meters.

RAWTENSTALL.—Tenders are invited for the supply, delivery, and laying of steel rails, points, crossings, and accessories for the tramway permanent way. Full particulars from Messrs. Lacey, Sillar & Leigh, 2 Queen Anne's Gate, Westminster, London, and 78 King Street, Manchester (fee £5 5s., returnable), and tenders to the Town Clerk by March 27th.

Tenders are also invited for the supply, delivery, and erection of a 192-tube economiser, also direct and alternating current meters. Particulars as above, and tenders to the Town Clerk by March 23rd.

SOUTHEND.—A Local Government Board inquiry was held last week into the application of the Town Council for sanction to borrow £26,690 for extensions to the electricity undertaking. During the course of the proceedings it was stated that it is proposed to spend £10,134 upon the provision of a condenser which, it is anticipated, will effect a saving of £466 per annum. The estimates for the ensuing year show a profit on the undertaking of £2,000.

SPAIN.—The *Gaceta de Madrid* of February 19th contains a copy of a decree authorising the Spanish Government to call for fresh tenders for the telephone construction. This contract comprises (*a*) the construction and working of the inter-urban service of the north-west; (*b*) the construction and working of the inter-urban service of the south-east; (*c*) the construction and working of the inter-urban service of the south; (*d*) the extension of the inter-urban service of the north-east, the addition of 19 new stations, and the working of the system. Tenders for each or all of the sections will be received up to noon on April 2nd, 1908, and deposits of (*a*) 182,000 pesetas (about £6,216); (*b*) 145,000 pesetas (about £5,000); (*c*) 150,000 pesetas (about £5,172); and (*d*) 167,500 pesetas (about £5,776), will be required to qualify tenders, these deposits being calculated as 5 per cent. of the value of the work.

The *Gaceta* of February 21st contains a notice to the effect that the municipality of Valencia are prepared to receive offers for the contract of electric lighting in the city during a period of 30 years from January 1st, 1910.

The *Gaceta* of February 22nd contains a notice to the effect that the Dirección-General de Obras Publicas of Madrid are prepared to receive offers, which must be presented within one month, for a concession for an electric tramway between Sevilla and Camas, on terms more favourable to the Government than those of the offer already presented by the Sevilla Tramways Co., Ltd.

Under similar circumstances the Dirección are prepared to receive offers for a concession for an electric tramway from the calle de Valencia, Barcelona, to the calle Alta de San Pedro, for which an application has been made by the Cia. de Ferrocarril de Sarria at Barcelona.

The Cia. del Tranvia Urbano de Bilbao have also applied to the Dirección for a concession for an electric tramway from calle de Fernandez del Campo to the goods station of the Santander-Bilbao railway at Bilbao, and competing offers may be presented under the conditions named above.

STOKE-UPON-TRENT.—Tenders are invited for a 300-kw. steam generator (single acting engine and direct-current dynamo), together with a water-tube boiler and surface condensing plant. Full particulars from Mr. P. J. S. Tiddemann, Electrical Engineer, and tenders to the Chairman of the Electricity Committee by March 14th.

SUNDERLAND.—The Sunderland District Electric Tramways Co. invite tenders for the three additional turnouts on their line between Philadelphia and Silksworth. Tenders to the Manager by March 27th.

SWEDEN.—H.M. Consul at Gothenburg has forwarded a copy of the conditions and drawing relating to a call for tenders for the supply of two large traverse-cranes, required for the large water power station of the Kungl. Trollhätte Kanal och Vattenverk (The Royal Trollhättan Canal and Water Works) at Trollhättan, whence copies of the specification and conditions of tender may be obtained. Further information will be given by the Superintending Engineer of the Water Works. Tenders must be received not later than midday on March 21st. The conditions and drawing may be inspected by British makers on application at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, London, E.C.

SYDNEY.—Manufacturers and dealers in electric lighting supplies and plant, especially metallic filament lamps and flame arc lamps, are invited to send catalogues and other literature to Mr. H. R. Forbes, electrical engineer to the Municipal Council of Sydney, addressed, Town Hall, Sydney, New South Wales.

WARRENPOINT.—It has been decided to invite Mr. Pegg, of Messrs. Wilson, Miller & Pegg, to attend the next meeting of the Urban District Council in connection with the proposed electric lighting scheme for the town.

WEST HAM.—The Finance Committee have recommended that application be made to the Local Government Board for a loan of £51,600 for the electric light department.

WIGAN.—Tenders are required by March 25th for alternatively an electric light installation and a gas installation for the new workhouse infirmary at Billinge. Particulars from Messrs. Heaton, Ralph & Hendon, architects, Wigan.

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TENDERS RECEIVED AND ACCEPTED

AUSTRALIA: *Queensland.*—The tender of Mr. R. B. Hungerford, of Sydney, has been accepted by the Postmaster-General's Department for the supply and delivery of a common battery switchboard at Brisbane, together with 650 subscribers' telephones; the tender also includes increasing the capacity of the main frame, intermediate frame, and multiple jacks of both junction and subscribers' sections of the switchboard, for a total sum of £7,016 15s.; also for the supply and delivery of additional apparatus required on the present magneto board at £195.

BAILDON.—A scheme submitted by the Bradford Electrical Engineering Co. for the electric lighting of the district is under consideration by the Council.

BELFAST.—The tender of Messrs. Callender's Cable & Construction Co., for the supply of cables to the Electricity Department has been accepted.

BIRMINGHAM.—The tender of Messrs. Johnson & Phillips for the equipment of a 6,000-volt transmission line for the Birmingham, Tame, and Rea Drainage Board has been accepted.

BLACKBURN.—An order has been placed with the British Thomson-Houston Co., Ltd., for the supply of new tramcars.

BRISTOL.—The Electricity Committee have accepted the following tenders in connection with the Avonmouth scheme:—Messrs. Bruce Peebles & Co., three 3-phase to direct current converters, £3,647; Messrs. Clapham Bros., hot well and cooling tanks, £386 10s.

CLEVELAND.—Messrs. Bolckow, Vaughan & Co. have ordered two surface-condensing plants from the Mirlees Watson Co. for the Cleveland Ironworks, South Bank.

DUNDEE.—Further contracts have been placed in connection with the new electricity works, amounting in the aggregate to about £21,000. The tenders in question are for the switchgear and transforming plant for the power-house and sub-stations, which have been divided between the British Thomson-Houston Co. and the British Westinghouse Co. The contracts for carbons have been given to Messrs. Crompton & Co. for 12,000 pairs, the Union Electric Co. for 1,000 pairs, and the Oliver Arc Lamp Co., 12,000 pairs. The contract for oil has been granted to Messrs. Alexander Pringle & Co., Dundee.

GRANGE-OVER-SANDS.—The tender of W. Till has been accepted for the buildings of the electric power station at the Westmorland Consumption Sanatorium.

HULL.—A report has been submitted by the Electrical Engineer (Mr. Bell) upon the six tenders, mentioned in our last issue, which have been received for new generating plant. The acceptance of the tender of the Lahmeyer Co. (£4,591) was recommended, and a long explanation was given of the reasons which led him to favour the acceptance of this tender rather than either of those of British manufacturers at lower figures. After some discussion the recommendation was adopted.

LEEDS.—The electric lighting department have accepted the tender of the Mirlees Watson Co. for a surface-condensing plant.

LONDON: *London County Council.*—The Highways Committee have considered the 19 tenders, which were received for the rebuilding of the two bridges carrying Caledonian Road over the Great Northern Railway and the Regent's Canal, in connection with the electrification of the tramways in that thoroughfare, viz., Dick, Kerr & Co., Ltd., London, £6,895 11s. 2d.; W. Muirhead & Co., Ltd., London, £7,030 10s. 5d.; Joseph Westwood & Co., Ltd., Millwall, £7,152 14s. 3d.; Rowlingsons & Co., London, £7,355 8s. 3d.; Rawkins & Jackson, London, £7,497; P. Wilson & Co., London, £7,497 5s. 5d.; Orr, Watt & Co., Ltd., Motherwell, N.B., £7,584 14s.; W. Manders, Leyton, £7,615 7s. 1d.; D. R. Paterson, Ltd., Camden Town, N.W., £7,679 7s. 6d.; Greig & Matthews, London, £7,868 17s. 4d.; D. G. Somerville & Co., London, £8,114 6s. 9d.; W. Pattinson & Sons, Ltd., Westminster, S.W., £8,231 10s. 1d.; A. Jackaman & Son, Slough, £8,349; Heenan & Froude, Ltd., Manchester, £8,896 12s. 7d.; Anthony Fasey & Son, Leytonstone, £8,902 10s. 10d.; Alfred Thorne & Sons, Westminster, S.W., £9,562 7s. 6d.; The Motherwell Bridge Company, Ltd., Motherwell, N.B., £10,035 7s.; Pedrette & Co., Finsbury Park, N., £10,348 1s. 8d.; Thos. W. Pedrette, Bush Hill Park, N., £10,601 3s. 6d. The chief engineer's estimate comparable with the above tenders is £7,842. The Committee recommend that the lowest, namely, that of Messrs. Dick, Kerr & Co., Ltd. (£6,895 11s. 2d.), be accepted. The firm proposes to sublet the supply of the steelwork, and no objection is taken to this course.

The following tenders have been received for wiring and fitting the new Holloway fire station:—W. J. Fryer & Co. (accepted), £185; Nursey & Marr, £200; W. G. Cannon & Sons, Ltd., £248 13s.; John Bryden & Sons, £256; Duncan, Watson & Co., £275; J. O. Grant & Taylor, £320.

The following tenders have been received for the supply and delivery of about 525 tons of track rails and fastenings required for the reconstruction of the tramways from Brixton Road to near Camberwell Green. The amounts of the tenders are as follows:—Walter Scott, Ltd., Leeds, £3,978 2s. 6d.; Bolckow, Vaughan & Co., Ltd., London, £4,053 11s. 5d.; Barrow Hæmatite Steel Company Ltd., London, £5,062 1s. 3d. The chief engineer's estimate, comparable with the above tenders, is £5,816 2s. 6d. The Committee recommend that the lowest should be accepted.

Battersea.—The Lighting Committee of the Borough Council has accepted, subject to usual approval, the following tenders for annual supplies for the electricity department:—Price's Patent Candle Co., Ltd., oils; W. H. Wilcox & Co., engine-room stores (with the exception of packings); K. Beldam and Co., asbestos, &c., packings; Foster & Co., coal (1bstock peas and Mardy small nuts); Hudson & Co., coal ("Broomhill" bituminous); Sloan Electrical Co., Ltd., carbons for arc lamps, &c.; Ferranti, Ltd., ampere-hour meters; British Thomson-Houston Co., Ltd., watt-hour meters; Electrical Co., Ltd., Nernst lamps and fittings; Edison & Swan United Electric Light Co., Ltd., and General Electric Co., Ltd., incandescent electric lamps; Pryke & Palmer, ironmongery, tools, &c.; Callender's Cable & Construction Co., Ltd., bitumen, compound, and cable jointing. No tender has been accepted for service boxes, &c., but these goods are to be obtained from Callender's Cable & Construction Co., Ltd., and the British Insulated & Helsby Cables Co., Ltd., as required.

Hammersmith.—The Electricity Committee recommend (subject to the usual sanction) that the tender of Messrs. Babcock & Wilcox (£1,285) be accepted for a water tube boiler, and the tender of the Stirling Boiler Co. for a similar boiler at £1,671.

Poplar.—The Electricity Committee, in view of the present low price of copper and the probability of an early advance, authorised the Engineer to enter into an arrangement with the Western Electric Co., who submitted the lowest quotation in competition with other companies, for the purchase by the company of 30 tons of copper to be made up into cable as required by the Council in the next two years, at a fixed schedule of prices. The Council approved this course.

Stepney.—The Borough Council has received the following tenders for annual supplies in connection with the electricity undertaking:—Arc lamp globes, City Glass Co. (accepted), (*a*) total, assuming quantities are ordered, £64 7s. 6d., (*b*) remarks, first delivery end of eight weeks, instead of four weeks as required by the specification; Carl Quitman (*a*) £51 0s. 10d., (*b*) the Borough Electrical Engineer and Manager informed the Council that this amount by an accompanying letter is increased to £68 18s. 1½d. Rubber cable: Baxter & Caunter (accepted), £122 12s. 6d.; W. T. Henley's Telegraph Works Co., Ltd., £149 14s.; T. A. Glover & Co., Ltd., £149 14s. 2d.; India Rubber, Gutta Percha, and Telegraph Works Co., Ltd., £153 10s. 9d.

Westminster.—At the meeting of the City Council on March 5th, the recommendation of the Works Committee, that the tender of the Westminster Electric Supply Corporation be accepted for the lighting required in connection with the Marble Arch Improvement scheme, was adopted.

Woolwich.—The Borough Council has accepted the following tenders:—Maintenance of electric light and power installations, bells and telephones, at Plumstead and Woolwich Baths, for a period of five years, E. P. Allam & Co., £110 per annum (E. J. Wilkin and Son tendered at £160); two spare armatures and two field coils for the public wash-house, and one spare armature and one field coil for the establishment ironing-room at the Plumstead Baths, Siemens Bros.'s Dynamo Works, Ltd., £59 15s. (less 2½ per cent. if paid within a month of presentation of invoice).

NORWICH.—The Corporation has accepted the tender of Messrs. Laurence Scott & Co. for an electric motor at £450.

RAWTENSTALL.—The District Council has placed a contract for the supply and erection of a traction storage battery and booster with the D.P. Battery Co.

Institution of Electrical Engineers.—The following is the result of the ballot for new members at the meeting on Thursday:—*Associate Members:* H. E. I. Bax, C. Bollam, H. M. Cuff, F. J. Gerard, W. J. Gray, T. Hall, T. H. Hurst, H. Lees, A. N. Rye, D. Sinclair, Lieut. E. J. Stevens, R.A., H. E. Turner, C. Wade, J. M. Walshe, A. E. Wilkins, J. W. F. Wyatt. *Students:* W. H. Apthorpe, J. W. Arnott, R. H. Barbour, W. R. Brown, H. C. Chindian, N. J. Cook, H. C. Ellis, S. Fahmy, A. C. Fendick, J. Fleming, W. S. Gould, R. E. Grime, H. H. Hayhurst, G. S. Heime, J. A. Hogan, W. Holt, R. G. Isaacs, H. Jack, H. F. Jefferson, F. H. R. Lavender, S. W. Ledbrook, D. C. McPherson, H. J. Magrath, G. V. Massey, G. T. Medforth, W. A. Olds, C. Papageorge, W. H. Peberdy, W. Pitt, H. W. F. Pouter, J. L. Ridsdale, A. T. Robertson, C. I. Roddick, C. G. Saltren-Willett, A. G. Savill, J. F. Shipley, G. M. S. Sichel, P. Smith, S. Thompson, A. D. Villares, J. D. A. Vincent, A. Wadsworth.

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COMPANIES' MEETINGS AND REPORTS

BRITISH ENGINE BOILER & ELECTRICAL INSURANCE.—At the annual meeting on Thursday, a dividend of 4s. 6d. per share, making 7s. 6d. for the year, and a bonus of 2s. per share was declared for 1907. The sum of £7,000 has been added to the reserve fund, bringing this up to £66,000 and £2,409 were carried forward.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY.—At the ordinary general meeting on Tuesday, Mr. H. R. Beeton, chairman, presiding, the report and accounts given in our last issue were adopted. The chairman opened his speech with a reference to the death of Mr. William Page, who had been connected with the company for over seventeen years, and was on the Board at the time of his death. In moving the adoption of the report and accounts, he pointed out that the growth in capital expenditure during the year, chiefly in mains, had been rather less than usual owing to the generating plant not having been increased. Mainly owing to the increased cost of coal, the growth of the net revenue had been somewhat retarded, but due to savings in other directions, the total works costs per unit did not amount to the extra 10 per cent. in the cost of coal. The accounts showed only the small increase of £335, and the directors, in recommending the distribution of the same dividend as last year, and appropriating a similar amount to depreciation and reserve, carried forward a larger balance by nearly £1,000. In reply to a question, the chairman stated that the Board was inclined to agree to the suggestion of paying the dividends, less income tax, in future.

At a special meeting held subsequently, the promotion of the London Electricity Supply (Joint Committee) Bill was approved.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION.—At the annual meeting at Newcastle on Tuesday, Dr. J. T. Merz presiding, the report and accounts given in our last issue were adopted.

HUELVA GAS & ELECTRICITY.—The report for 1907 shows a net profit of £3,222, to which has to be added £251 brought forward from last accounts. A dividend of 4 per cent. free of tax is recommended, and £1,000 carried to reserve. After writing off a number of small amounts, the sum of £743 is carried forward subject to directors' and auditors' fees.

MANSFIELD & DISTRICT TRAMWAYS.—The report shows a substantial increase in the receipts. After providing for debenture interest and the six per cent. dividend on the cumulative preference shares for 1907, there remains £888 to be carried forward. Depreciation will be dealt with in future accounts.

METROPOLITAN ELECTRIC SUPPLY.—Mr. W. Harrison Cripps presided at the ordinary general meeting on Tuesday. The report and accounts given in our last issue were adopted. He stated that the gross receipts had increased by £5,047 during 1907, but in view of the fact that during the previous year the company received about £5,000 in respect of the Marylebone portion of the undertaking, the actual increase was over £8,000. This, however, was somewhat less than the directors had anticipated, and they attributed the result mainly to the increased use of metallic filaments lamps, and partly to the fact that the last quarter was a poor one. At the same time, the directors did not believe that the increased use of metallic filament lamps would ultimately do the electric supply business any great harm. The figure for rent, rates, and taxes showed an increase of £200, and in this connection he had a complaint to make. One Borough Council had previously assessed the company at £9,000, but this has been increased to £21,000. Long and costly arbitration proceedings had to be taken, in consequence, with the result that £10,000 were struck off. Although the Borough Council had to pay the costs of the inquiry, the money came from the ratepayers, and the company, as one of the largest ratepayers, had to bear a share of this. With regard to the year 1908, the equivalent of 24,300 8-c.p. lamps had been added to their connections during the first nine weeks, compared with 14,000 in the first nine weeks of 1907. At a special meeting held subsequently, the London Electricity Supply (Joint Committee) Bill, of which the company is a promotor, was approved.

NEWCASTLE-ON-TYNE ELECTRIC SUPPLY.—The report states that the total connections to the company's system at the end of the year amounted to 92,764 h.p., showing an increase of 22,764 h.p. over last year's figures. The profit of the year, including balance of £2,145 brought forward from 1906, amounted to £87,597. Out of this there have been paid interest on debentures, loans, &c., £25,470, and interim dividends on the amount called up on the preference and ordinary shares, £20,457, leaving a balance of £41,469, which the directors recommend should be appropriated as follows:—In the payment of further dividends of 2½ per cent. on the amount called up on the preference shares, and 5½ per cent. on the amount called up on the ordinary shares, making the total dividends for the year 5 per cent., and 8 per cent. on the preference and ordinary shares respectively, £34,444; in transferring to depreciation, £5,000; and in carrying forward, £2,025. The revenue of the company has increased from £176,810 in 1906 to £240,469, a rise of 35 per cent. Under normal conditions this would have resulted in a corresponding increase in profit, but the cost of coal has been heavy, amounting to over £58,000 in excess of the previous year, which is much beyond the proportionate increase on the additional business done, the difference being due to the great rise in the price of coal. The expenditure on capital account during the year, for extensions to meet the demands of certain large consumers, and on the system generally, has been £218,934. A tunnel under the River Tyne is in course of construction between Carville and Hebburn. This direct connection between the power station at Carville and the main cable system of the County of Durham Electrical Power Distribution Company, Limited, at Hebburn, will increase the effective capacity of the existing main cable system north and south of the River Tyne. In December last the County of Durham Electrical Power Distribution Company, Limited, made an issue of £250,000 first mortgage debenture stock. In view of the fact that the existing profits of that company are considerably more than sufficient to meet this charge, and that this capital will be utilised for the development of the Distribution Company's system, which will result in a large demand for electricity from the Company under the existing agreement, the directors agreed that the company should guarantee the interest on this stock. This issue of stock was over-subscribed. The issue of capital foreshadowed in the last annual report was, for various reasons, postponed, and temporary loans have been obtained in the meantime to meet the ordinary extensions of the business. To discharge these obligations, and also to provide for the erection of a new power station at Dunston, in the county of Durham, further capital will be required. This new station is wanted to enable the company to cope with the steadily increasing demand for electric power on both sides of the river: over 27,000 h.p. of new business, in addition to that already connected, having already been contracted for. It is proposed, therefore, to make an issue of share capital in the near future, and with this object in view, an increase in the capital of the company of £500,000 is necessary.

At the annual meeting at Newcastle on Tuesday, Dr. J. T. Merz, who presided, stated that the company is spending £20,000 on a tunnel under the Tyne at Wallsend, in order to obviate the expense and inconvenience of carrying the cables up the Tyne, over the high level bridge at Newcastle, and back to Hebburn. It was estimated that this would save £12,000 in capital expenditure, in addition to £2,000 a year due to the electrical losses. The company also proposes putting down new works at Dunston-on-Tyne, where they had leased 30 acres of land, and intended installing at first 30,000 h.p. of plant. To meet the expenditure upon this station—namely, £250,000—and to pay off loans, it was proposed to issue £500,000 in £5 preference shares, and the same amount of ordinary shares. The report and accounts were adopted, and in answer to a question, the Chairman stated that the whole of the further capital has been purchased by Lloyd's Bank and others at a premium, and the preference shares would be sold to the public at par, and the ordinary shares at £1 premium.

O. C. HAWKES, LTD.—At the meeting held at Birmingham last week, the report abstracted in our last issue was adopted. The chairman said that the trading results were not as good as in 1906, but he saw indications of a return to their former prosperity. The electrical department, he said, was answering all their expectations.

STAR OMNIBUS.—At an extraordinary general meeting on Friday to consider the question of whether the company shall continue operations, or be voluntarily wound up, Mr. W. A. Perry, who presided, said that their present unsatisfactory position had been brought about by the fact that most profitable omnibus routes had been wiped out of existence by the London County Council tramways, which were being run at fares which could not possibly pay. Nearly every route in the suburbs of London had been covered by electric tramways, whilst when the omnibus companies sought relief in the centre of London they were met by the competition of tube railways.

W. T. HENLEY'S TELEGRAPH WORKS.—At the ordinary general meeting on Saturday, the report and accounts, given in our last issue, were adopted. During the course of his speech, Mr. S. Gedge, who presided, referred to the fact that 21 years ago the business of the company had been on sale provided their debts were paid, the company to sacrifice the remaining £70,000 of its share capital. They were all glad now that no sale was effected, as that £70,000 was worth at the present day £170,000. The profits for the past year admitted of the payment of a dividend of 18 per cent., and this would still have left a small margin for reserve. The directors had considered it wise, however, to divide only 75 per cent. of the profits, and to set the remainder aside.

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PARLIAMENTARY INTELLIGENCE

LONDON ELECTRIC POWER BILLS.—In the House of Lords on Thursday, the Earl of Onslow moved that the London and District Electricity Supply Bill, the London Electric Supply Bill, and the London (Westminster and Kensington) Electric Supply Co. Bill, should be referred to a Joint Committee of both Houses of Parliament. In the course of a short speech his Lordship described briefly the objects of the three Bills in question, and stated that there were two opinions on the matter, viz., one, that the electrical supply business of the metropolis should be undertaken by a commercial company, and the other that it should be provided by municipal enterprise. He thought the time had arrived for carefully considering the whole position, and it was with the object of having the matter threshed out by the most competent tribunal that Parliament could appoint, that he asked that the Bills should be referred to a Joint Committee. The motion was agreed to, and has now to come before the House of Commons.

PROGRESS OF ELECTRICAL BILLS.—The London and Windsor Motor Roads, Tramroads, and Tramways Bill was read a first time in the House of Lords on Monday.

The Bristol Tramways Bill was read a second time in the House of Lords on Tuesday

ROCHDALE CORPORATION BILL.—This Bill was before the Unopposed Committee of the House of Commons on Monday, and was ordered to be reported for the third reading. Part IV. refers to some short lengths of new tramways, for which £2,500, repayable in 40 years, is to be borrowed. The period for construction is five years. Part VI. of the Bill authorises the supply of electricity in bulk outside the Corporation area, and also the use of the generating station for tramway purposes.

TELEGRAPH CONSTRUCTION BILL.—On the second reading of this Bill in the House of Commons, the text of which was given in our issue for February 20th, Mr. Harold Cox will move that it is undesirable to give larger powers to the Post Office until the House has been placed in possession of fuller information as to the financial results of the management of telegraphs and telephones by the Post Office. Motions have also been handed in by Mr. Courthope and Mr. G. Gibbs to the effect that the second reading should be postponed six months.

APPOINTMENTS AND PERSONAL NOTES

Messrs. Norman A. Thompson and J. G. Wilson, consulting engineers, of 22 North Bridge Street, Edinburgh, have dissolved partnership by mutual consent. Mr. Thompson will carry on the consulting practice.

The Woolwich Borough Council has appointed Mr. Ernest Wallace Martin, Woolwich, assistant distribution engineer, at a commencing salary of £90 per annum, rising by annual increments of £10 to £140 per annum. There were 43 candidates.

At the next meeting of the Islington Borough Council, recommendations by the Lighting Committee and the Law and Parliamentary Committee will be considered: that the following increases of salary be granted in the electricity department:—M. H. Adams, Constructional Engineer, £160 to £170; A. Jarratt, meter tester, £2 per week to £2 5s. per week.

The salary of Mr. W. J. Bache, City Electrical Engineer at Cheltenham, has been increased from £400 to £450 per annum from April 1st.

Mr. H. R. Forbes, formerly Resident Engineer for the London District to the Electrical Engineers' Department of the Great Western Railway, has been appointed Electrical Engineer to the Municipal Council at Sydney, New South Wales, and sails this month to take up his appointment.

Mr. W. H. Frazer having accepted the position of Chief Engineer to the Anglo-Portuguese Telephone Co., has resigned his position on the Engineer-in-Chief's staff of the National Telephone Co., and will be shortly leaving for Portugal.

Northampton Institute.—The sixth annual dinner of the day students of the Northampton Institute was held in the Queen's Salon, Holborn Restaurant, on Friday, February 28th. Mr. E. V. Pannel was in the chair, and among the guests were Dr. R. Mullineux Walmsley, Dr. C. V. Drysdale, Mr. H. M. Hobart, Mr. C. E. Larard, and others.

Electricity in Horticulture.—We understand that Mr. J. H. Priestley, Lecturer in Botany at the Merchant Venturers' Technical College, Bristol, has been carrying out experiments upon the effect of electricity on plants, chiefly from the point of view of the use of high-tension current. The Board of Agriculture has granted the sum of £50 to the College to enable experimental apparatus to be fixed in the College garden.

X-Ray Dermatitis.—At a meeting at Birmingham on Thursday to consider the question of providing assistance for Dr. Hall Edwards, who, as we stated in our issue for February 20th, has had one hand amputated through injuries caused in consequence of experiments with X-rays, it was decided to raise a fund which will be invested. £309 was subscribed in the room, and Sir Oliver Lodge, who presided, stated that the King was interested in the case, and a small Civil List pension might also be granted.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars net c.i.f., port of arrival, quoted on Tuesday night, was £59 to £59 10s. per ton (last week £58 15s. to £59 5s.).

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—Notice is given of an intended dividend in the bankruptcy of George Collier, trading as H. Collier & Co., gas and electrical engineer, 89 Long Acre, London. The last day for receiving proofs is March 18th. The trustee is Mr. E. L. Hough, Bankruptcy Buildings, Carey Street, London.

In the Chancery Division on Saturday, Mr. Justice Warrington was asked as a matter of urgency to appoint a receiver and manager of the "X" Accumulator Co., Ltd. Upon the company appearing and consenting, a receiver and manager was appointed.

The trustee in the bankruptcy of C. V. De Falke, electrical engineer, 17 Shaftesbury Avenue, London, has been released.

Telegraph Traffic.—The Governor of Jamaica in Privy Council approved under Section 2 of Law 7 of 1904, "The Telegraph Control Law," the following rules with respect to licenses under that law:—Every application for a licence must be signed and sealed and addressed to the Clerk in Privy Council, and delivered at Headquarter House, Kingston. Three copies of the licence; a description of the telegraphic apparatus, mechanism, or contrivance to be employed, plan on a scale not less than 1 in. to 100 ft., showing exact location of the proposed stations, detailed drawings of the apparatus must accompany the application. Certain rules are also laid down for advertising and notices, as well as penalties for infringement of the law. The state of telegraphic facilities in Central and South America does not appear to be at all satisfactory, as regulations imposing limitations on senders of telegrams have not been withdrawn, although in force for considerable periods; thus, private telegrams for Costa Rica, Nicaragua, and Honduras have been prohibited since 1903, excepting at sender's risk; telegrams for Cartagena, Barranquilla, and Santa Marta have been subject to delay since 1906; and restrictions are imposed in the Argentine. On the 6th instant the cable between Martinique and Guadeloupe became interrupted, cutting off this latter island by the French system, to whom the cable belongs. The point of connection between the West India & Panama Telegraph Co. and the French system being also at this island, these systems cannot exchange messages until the cable is restored. The cable between Chio and Tenedos of the Eastern Telegraph Co. was repaired on the 8th instant

Nuisance from Brighton Corporation Motor Generator Station.—In the Chancery Division on Saturday, Mr. Justice Joyce delivered a considered judgment in an action by the Rev. Edward Heath and others, incumbent and trustees of the Church of St. Mary and Mary Magdalen, Brighton, for an injunction to restrain the defendants from so using the machinery for the purpose of generating electricity as to cause a nuisance and annoyance to the worshippers. We have previously reported the case in our issues for January 23rd and 30th, and February 6th. Mr. Justice Joyce said the plaintiffs were not, because their premises were used as a place of worship, entitled to anything more than the ordinary amount of quiet they had in a town. They had no special right because of the purposes for which the church was used. As to what amount of noise, or annoyance from noise, would be sufficient to maintain an action there was no definite legal rule or measure. It was a question of fact in each case. In the present case, the locality was that of a large town, the neighbourhood being poor and certainly not within which could be described as a residential part of Brighton. A nuisance of the kind could not be excused merely on the ground that the works were in a suitable place, but in considering whether the comfort of the plaintiffs was materially interfered with, regard must be had to the character of the neighbourhood and surrounding circumstances. Upon the evidence, his Lordship thought the sound complained of could not be heard during any singing or playing of the organ, or when there was any other sound in the church. In certain parts of the church it could not be detected by listening, even when there was otherwise personal silence, and sometimes it could not be heard at all anywhere in the building. He thought the noise ought not to distract the attention of ordinary healthy persons. The law did not regard trifling inconveniences, and things of that sort must be looked at from a reasonable point of view. It was obvious that the granting of an injunction would be a serious matter in the case. He thought, on the whole, the plaintiffs had not established their right to relief. He was of opinion that the action failed, and must be dismissed. If the case went no further he suggested that the defendants might very well not insist upon costs. Mr. Astbury, K.C., on behalf of the Corporation, said his clients would consider what his Lordship had said with regard to costs. It may be pointed out that Mr. C. P. Sparks, Chief Engineer of the County of London Electric Supply Co., inspected the church and works, and reported to the court.

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MISCELLANEOUS CITY NOTES

BRITISH INSULATED & HELSBY CABLES.—A dividend of 4 per cent., together with a bonus of 2 per cent., is recommended for the half-year to December 31st, making 10 per cent. for the year. The sum of £37,000 is transferred to reserve and depreciation, and £28,000 carried forward.

CANADIAN GENERAL ELECTRIC CO.—The Canadian Bank of Commerce, London, has received a telegram from Toronto stating that the directors of the Canadian General Electric Company, Ltd., in view of present industrial conditions in the United States and Canada, have considered it prudent in the meantime to reduce the dividend on the common stock to 7 per cent. per annum. They have accordingly declared a quarterly dividend of 1¾ per cent. for the three months ending March 31st, 1908, being at the rate of 7 per cent. per annum on the common stock.

DIRECT SPANISH TELEGRAPH CO.—The directors recommend a dividend of 4 per cent., free of Income Tax, on the ordinary shares for the half-year ended December 31st, 1907.

BRUCE PEEBLES & CO.—The petition against the appointment of Mr. A. W. Tait (London) and Mr. J. A. Robertson Durham (Edinburgh), joint liquidators in the voluntary winding up of Messrs. Bruce Peebles & Co., was heard at Edinburgh on Thursday. The petitioners represented creditors to the extent of £4,666. An objection was taken to the appointment of Mr. Tait, either alone or in conjunction with another, on the ground that he was a director of the company, and not subject to the jurisdiction of the Court. Messrs. A. A. Krauss & Sons, Bristol, suggested that the Court should appoint one official liquidator, or a joint liquidator with Mr. Robertson Durham, other than Mr. Tait. Having heard arguments, the Lord President, after pointing out that there was an overwhelming majority of shareholders in favour of the proposal to appoint the two gentlemen in question, stated that he saw no sufficient reason why the Court should disturb the liquidation that had been going on. He knew of no objection in law to appointing a liquidator because he was not subject to the jurisdiction of the Court, and whilst he admitted that the appointment of Mr. Tait as sole liquidator would have been objectionable, this objection was removed by the appointment of Mr. Robertson Durham as joint liquidator. Mr. Robertson Durham was well known in that Court, and it would be his clear duty to report to the Court when he thought the time had come, if it ever did come, that Mr. Tait should resign.

OFFICIAL ANNOUNCEMENTS AND SMALL ADVERTISEMENTS.

Official Advertisements are charged at the rate of **1/-** per line (column width).

Small Prepaid Advertisements of Situations Vacant and Wanted, Plant for Sale or Wanted, &c., are inserted at the rate of **1/-** for the first 12 words and 1d. per word afterwards. Three insertions for the price of two. Advertisements can be received up till Wednesday morning first post.

Letters should be addressed to THE KILOWATT PUBLISHING CO., LTD., 203–6, Temple Chambers, London, E.C.

TENDERS INVITED.

CORPORATION OF GLASGOW.

ELECTRICITY DEPARTMENT.

THE CORPORATION invite Tenders for the supply of the undernoted Plant from Firms who have experience in the manufacture of same, and can show similar plant in operation in this country:—(1) Large Water Tube Boilers; (2) 1,000 K.W. Motor Generators and Rotary Converters, and (3) Sub-Station Extra High Tension and Direct Current Switchgear. Copies of the Specifications and Forms of Tender may be obtained on application to Mr. W. W. Lackie, Engineer, 75, Waterloo Street, Glasgow, on making a Deposit of Two Guineas in respect of each Specification. The amount deposited will be returned on receipt of *bona fide* Tenders. Sealed Offers marked "Electricity Department, Tender for .....," must be lodged with the Subscriber not later than 10 a.m. on Tuesday, 24th March, 1908.

The Corporation do not bind themselves to accept the lowest or any offer.

A. W. MYLES,
Town Clerk.

City Chambers,
Glasgow.
10th March, 1908.

FELIXSTOWE URBAN DISTRICT COUNCIL.

THE URBAN DISTRICT COUNCIL of Felixstowe are prepared to receive tenders for the following.

STORAGE BATTERY AND BOOSTER.

Specifications, General Conditions, and forms of tender may be obtained on and after Saturday, March 14th, 1908, at the Offices of the Consulting Engineer, Mr. Reginald P. Wilson, 66 Victoria Street, Westminster, on payment of a sum of two guineas.

This sum is required as a deposit, and will, after the Council shall have entered into a contract upon the tenders received, but not before, be returned to the tenderer provided he shall have sent in a *bona fide* tender and shall not have withdrawn the same. In any other case the deposit will be forfeited.

The tenders must be sent in on the Official Form and all instructions contained therein must be complied with.

Tenders, endorsed "Storage Battery and Booster," must be addressed to the Clerk, Felixstowe Urban District Council, and must be delivered at the Town Hall, Felixstowe, not later than 12 noon on Wednesday, March 25th, 1908.

The Council do not bind themselves to accept the lowest or any tender.

F. B. JENNINGS,
Clerk to the Council.

Town Hall, Felixstowe.
March 7th, 1908.

TENDERS INVITED.

COUNTY OF LONDON.

THE LONDON COUNTY COUNCIL invites tenders for the manufacture, delivery, and laying of:—

(*a*) About 32 miles of high tension, 3 core lead-covered electric cables, &c., and

(*b*) About 50 miles of low tension lead-covered electric cables, &c., and about 30 miles of telephone cables for the Council's tramways.

Full particulars, and also information as to the conditions to be observed by tenderers, will be given in the *London County Council Gazette*, of 9th and 15th March, 1908. The Gazette, which is published weekly, contains particulars of all the tenders invited by the Council, and can be obtained from Messrs. P. S. King and Sons, 2 and 4, Great Smith Street, Westminster, S.W., price 1d., post free 1½d. an issue, or for the whole year a prepaid subscription of 6s. 6d. Tenders must be upon the official forms to be obtained from the Clerk of the Council at the County Hall, Spring Gardens, S.W., upon payment to the Cashier of the Council of the sum of £2 for each of the two specifications, &c. This fee will be returned only if a *bona fide* tender shall be submitted. No tender will be received after 11 a.m. on Saturday, 21st March, 1908. The Council does not bind itself to accept the lowest or any tender of any person or firm who shall on any previous occasion have withdrawn a tender after the same had been opened, unless the reasons for the withdrawal were satisfactory to the Council.

G. L. GOMME,
Clerk of the London County Council.

County Hall, Spring Gardens, S.W.,
4th March, 1908.

JOURNAL OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

EDITED BY G. C. LLOYD, Secretary.

Part 187. Price 5s.

"The Dielectric Strength of Insulating Materials and the Grading of Cables." (With discussion.) By A. RUSSELL, M.A.

"Automatic Cab-Signalling on Locomotives." (With discussion.) By JAMES PIGG.

Inaugural Addresses by the Chairmen of the Birmingham, Dublin, Glasgow, Leeds, and Newcastle Local Sections.

"The Magnetic Testing of Iron." (With discussion.) By W. H. F. MURDOCH, B.Sc.

"Further Notes on the Electrical Driving of Textile Factories." (With discussion.) By H. W. WILSON.

"The Torque Conditions in Alternate Current Motors. (With discussion.) By V. A. FYNN.

"The Air-Gap Correction Coefficient." By P. H. POWELL, M.Sc.

Messrs. E. & F. N. SPON, Ltd., 57, Haymarket, S.W.

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ELECTRICAL ENGINEERING

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Displayed Advertisements, *Tuesday first post.*

Corrections in Standing Advertisements, *Monday first post.*

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Telegrams: "Circling, London." Telephone No.: 5569 Holborn.

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Binding Covers for Vols. I. and II. of *Electrical Engineering*, Jan.-June and July-Dec., 1907, can be obtained, price 2s. each, post free 2s. 4d., from the above address. Readers can have their volumes bound by their own bookseller; or they may send their numbers with index to us, carriage paid, with the reader's name and address, and a remittance of 4s 6d. per volume under separate cover. The volumes will then be bound and returned carriage paid to any address in the United Kingdom.

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SUMMARY

The proposal in the House of Lords that the London Electric Power Bills should be referred to a Joint Committee of both Houses of Parliament was rejected in the House of Commons on Tuesday. (Page 424.)

Progress is being made with the preliminary arrangements for the Electrical Exhibition to be held in Manchester next October. The announcement made in our issue of March 5th, that the Exhibition will be held in Platt's Fields, is correct, and the rumour circulated by a contemporary that the Exhibition is to be postponed until next year is authoritatively contradicted. (Page 425.)

Prof. Schwartz and Mr. James write that their recent Paper dealt largely with enclosed fuses, "not because the Engineering Standards Committee were obsessed with the sinister intention of forcing rows of obese cartridge fuses into the distended jaws of consumers' distribution boards." Mr. S. G. C. Russell, Consulting Electrical Engineer to the Phœnix Fire Office, agrees with us that the standardisation of fuses is not necessary, but rather the standardisation of fuse-boards. Messrs. Eckstein, Heap & Co. announce that they make alternating-current motor-starting switches with no-voltage release. Mr. A. R. Bennett replies to Mr. H. L. Webb's letter in our last issue. (Page 425.)

The Paper read by Messrs. R. K. Morcom and D. K. Morris last week, before the Birmingham Local Section of the Institution of Electrical Engineers, considered the design of apparatus for artificially loading alternators for testing. The arrangement described consisted of a water resistance combined with specially designed choking coils for obtaining any desired power factor. In the discussion which followed several speakers gave their experiences with water resistances of other forms than described in the Paper, especially with circular iron tanks. The influence of the peculiar wave-form produced by the special design of choking coil described was also discussed. (Page 427.)

In last Friday evening's discourse at the Royal Institution, Mr. G. Marconi gave an account of the progress of Transatlantic wireless communication as carried out by his company, and outlined the developments which have taken place since the first signals received in 1901 to the improved methods with "semi-continuous" oscillations and aerials giving a certain amount of directive effect as used to-day. He complained of the attitude of some sections of the technical Press, which appeared to be attempting to protect the interests of the cable companies; and, although not giving any definite particulars of the amount of traffic which his stations could handle, he took up a most optimistic attitude as to the future. (Page 430.)

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IN a Paper read before the Association of Engineers-in-Charge, Mr. H. D. WILKINSON outlined the main features of the control of electrically-operated lifts, and described in detail several particular safety devices. The question as to whether a worm gear was really self-sustaining or not was raised in the discussion, and the uselessness of the no-voltage release for lift work was referred to. (Page 431.)

IN a Paper read before the Manchester Association of Engineers last week, Mr. S. L. PEARCE dealt generally with the subject of steam turbine engineering. The leading types of turbine were described at some length and compared, and some of the principal advantages of the steam turbine over the reciprocating engine were pointed out. (Page 433.)

SOME advertising signs, in which special colour effects are obtained, have been put on the market. (Page 434.)

PROF. J. J. THOMSON has been nominated for the Presidency of the British Association at the Winnipeg meeting in 1909. (Page 434.)

SOME additional generating plant which has been necessitated at the Wolverhampton Electricity Works by the rapidly increasing power-load was inaugurated on Monday. Two new 1,000 kw. three-phase turbo-generator sets have been put down, the alternators of which are the first machines of this class made by the Electric Construction Co., and embody a number of interesting points of design, especially as regards the construction of the rotors. New boilers and a new switchboard have also been installed, as well as a 500 kw. motor-converter and a synchronous motor-generator of the same capacity, which serve as connecting links between the new three-phase sets and the older continuous-current plant in the station. (Page 435.)

AN automatic switch has been introduced for cutting small transformers for metallic filament lamps out of circuit when not in use, in order to avoid the all day open circuit losses. (Page 440.)

SIR WILLIAM H. PREECE, K.C.B., gave a lecture at the Institution of Electrical Engineers last Thursday, describing his impressions on revisiting America last year. He gave interesting figures with regard to the growth of telegraphy and telephony in the United States, and was enthusiastic over the Barclay type-printing telegraph machine, which has proved of great service in that country. In the course of his remarks with regard to the Electrical Testing Laboratory in New York, he mentioned that the Engineering Standards Committee (presumably the British one) is about to frame a specification for standards for metallic filament lamps. (Page 441.)

OWING to the recent drop in price of aluminium, and notwithstanding the present low price of copper, it is still claimed by the *Chemiker Zeitung* that aluminium is cheaper as a conductor than copper; and owing to the new process of welding it, which has recently been introduced by M. U. SCHOOP its use is likely to extend. Under "Electrochemistry and Electrometallurgy" short notes are also given on frothing in alkaline accumulators, forming of iron electrodes, and electrochemical industries in Norway. (Page 443.)

UNDER "Electrical Science," in the British and American Section, is given an account of Prof. J. J. THOMSON'S second lecture on electric discharges through gases, in which he continued to discuss the conductivity of gases at normal pressures. Some new and trustworthy formulæ for calculating the current and potential from a needle-point in air are also given. In the Papers abstracted in the Continental Section, GUILLET describes an electrical induction method of measuring very small lengths; REGENER counts the number of alpha-particles projected by polonium by means of the spinthariscope; and WIEN calculates the wave-length of Roentgen rays from Planck's law of radiation. (Page 444.)

IN place of the ordinary reading and discussion of a Paper, the meeting of the Manchester Local Section of the Institution of Electrical Engineers on Tuesday, March 10th, was devoted to a lecture by Mr. W. ROSENHAIN on the internal structure of metals, in which the bearing of the results obtained by the microscopic study of the crystalline structure of pure metals and alloys upon the explanation of some of their properties was discussed. (Page 445.)

AT a meeting of the Electrical Contractors' Association, Mr. L. GASTER read a Paper on metallic filament lamps, in which he described the leading types, and in particular the new Z lamp, which, it is claimed, will burn in any position, and is suitable for both alternating and direct current. (Page 445.)

A NEW form of universal photometer of American design is described. A modified Lummer-Brodhun arrangement of prism is used, and the comparison lamp is mounted on a sliding carriage. Measurement either of luminous intensity or illumination may be made. (Page 446.)

AMONG the patent specifications published last Thursday is one by V. A. FYNN, describing a method of obtaining the necessary phase displacement for starting single-phase motors of the split-phase type. A specification by the BRITISH THOMSON-HOUSTON Co. covers a method of prevention of electrolytic corrosion of buried pipes and cables by alternating currents, and consists in superimposing a uni-directional current on the alternating current. B. LAMME has patented a method of preventing single-phase series commutator motors from acting as direct-current generators. The patent for the well-known Reason double-cover two-pole fuse-box expires during the current week. (Page 447.)

CONSIDERABLE progress has been made with the inquiry at Caxton Hall, Westminster, into the proposed Home Office regulations since our last issue, mainly due to a very sensible suggestion that a private informal conference should be held between a Committee representing the objectors and the representatives of the Home Office. In this way, by adjourning at midday on Monday, an agreement had been come to by yesterday morning upon the details of the first 20 regulations (excepting Regulations 17 and 18, referring to switchboard galleries and passage-ways). Mr. A. P. TROTTER gave evidence on Monday in regard to overlapping between the existing Board of Trade regulations and the proposed rules of the Home Office. In order to avoid this, he proposed that an addition should be made to Board of Trade regulation A1, stipulating that it shall not apply to factories. Evidence was also given by Mr. E. GARSIDE, Managing Director of Engineering Instruments, Ltd., as to the manufacture of no-voltage releases for alternating-current motors. Both on Tuesday and Wednesday the sitting lasted only a few minutes. (Page 449.)

IT has been reported to the Bath Corporation that the term within which the electricity works were to be purchased by Mr. Schenk on behalf of the Somerset Electric Power Co., will expire on March 31st. A new proposition has been made, and is now under consideration, by which the deposit of £2,500 will be forfeited. The London County Council has made a proposition to the City of London Corporation for a conference with regard to tramways over Southwark Bridge. The owners of the patents of the Cope shallow conduit system of traction have offered to lay down a line between the cable tramway terminus at Murrayfield and the Edinburgh Exhibition free of cost, and to remove it, if necessary, at the close of the Exhibition. A letter has been received from the Board of Trade by the Hanwell Urban District Council regarding the condition of the tramway track in that district. The letter encloses a communication from the London United Tramways Co., which expresses the view that the complaints of the Council have grossly exaggerated the condition of

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the track. It is proposed to form two companies, one for lighting and one for power, to take over the electricity undertaking of Johannesburg Corporation. The accounts of the Hackney Electricity Works show that for the fifth year in succession the generation and distribution costs are the lowest in the metropolitan area, namely 0·73d. per unit sold. An arrangement has been arrived at between the National Electrical Construction Co. and the Oxford Tramways Co., for the promotion of a new company to acquire the existing horse tramways and reconstruct them for electric traction on the surface contact system. The arrangement has to receive the sanction of the shareholders of the company and also of the Corporation. (Pages 451–453.)

The Ayr Corporation is to apply for sanction to borrow £30,000 to meet extensions of the electricity works during the next eight years. The Burslem Corporation has decided to apply for £12,000. A surface condenser and cooling tower is required at the Dewsbury Electricity Works; water-tube boilers, 1,000 kw. motor-generators, and extra high-tension switchgear at Glasgow; electrical stores at Edinburgh, Bolton, Bray, Belfast, Leeds, and Nottingham; double-deck tramcars at Wolverhampton; and battery and booster with switchboard at Whitehaven. (Pages 453 and 454.)

The report of the British Insulated & Helsby Cables, Ltd., shows a profit of £172,332, including £36,713 brought forward from last year. At the meeting of the Devonport & District Tramways Co., last week, Mr. W. G. Bond stated that failing a more satisfactory arrangement with the Devonport Corporation as to the terms of their lease, the Company was prepared to negotiate for the sale of the undertaking. The report of the City of London Electric Lighting Co. shows a balance available for distribution of £179,371, and a final dividend of 6 per cent. has been declared upon the ordinary shares. The sum of £20,474 is carried forward. The County of London Electric Supply Company's accounts show a net revenue of £109,089, and after deducting debenture interest and interim dividends, a further dividend of 6 per cent. per annum was declared upon the ordinary shares. At the meeting on Monday, Mr. J. B. Braithwaite, the chairman, stated that their connections in 30-watt lamps amounted to over one million lamps, which was a record for London. A profit of £23,120 is shown by the North Metropolitan Electric Power Supply Co. for the year 1907. After providing for debenture and loan interest, there is a balance of £12,672, and the directors recommend a dividend at the rate of 4 per cent. per annum, carrying forward £386. (Pages 456–458.)

We are happily able to give unreserved contradiction to a rumour circulated by a contemporary last week that the Electrical Exhibition to be held in Manchester in October would be postponed until next year. Far from this being the case, we announced a fortnight ago that the use of Platt's Fields, belonging to the Manchester Corporation, had been placed at the disposal of the Exhibition Committee, and, from the additional particulars, which we publish on another page, it will be seen that considerable progress has been made with the plans for the buildings, and that a draft prospectus and plans of floor space are being prepared for circulation to prospective exhibitors. There can be no doubt that the electrical industry will benefit considerably by this Exhibition, whether the existing depression is alleviated before October or not. Enormous strides have been made in economical electric lighting since the last general electrical exhibition in London, and it is meet that they should be effectively demonstrated to the general public. Of equal importance, moreover, is the fact that a special public is to be found in Manchester in the shape of large power-users, who should be made better acquainted with the great advances in electrical power applications during the past few years. This branch of the industry was rather neglected on the previous occasion, and the manufacturers of electrical plant should profit by the opportunity that will now be offered them to create new business relations in the Midlands and North of England, and to improve existing ones.

The subject treated by Mr. R. K. Morcom and Dr. D. K. Morris in their Paper read at Birmingham last week is one which most central engineers have had forced upon them, but has not often received such scientific treatment as it was given by these authors. The methods adopted for testing plant on site are usually crude in the extreme, and although many engineers will doubtless still be content to rig up wonderful arrangements of barrels and other material easily obtained locally—such as would cause the factory inspector of the future immediately to produce his book of regulations—Messrs. Morcom and Morris have suggested excellent means whereby a permanent artificial load with a wide range of usefulness may be constructed. The most valuable part of the Paper was the investigation into the design of special choking coils to be employed in conjunction with liquid resistances for obtaining heavy inductive loads with an accurately adjusted power-factor. The importance of such tests is often overlooked, and mainly on account of difficulties which are overcome by the apparatus described they are rarely carried out. Tests of this nature have not to be conducted with sufficient frequency in an average generating station to warrant the outlay on a special plant of the form suggested, but there is no doubt that some such arrangement for power-factor adjustment would be extremely useful in the test-room of a large manufacturing works.

By suggesting a series of conferences in Committee, the objectors to the Regulations drafted by the Home Office to govern the use of electricity in factories have considerably shortened the proceedings before the Commissioner appointed to hear the objections. Eighteen Regulations have been provisionally agreed to, most of them after some amendment; the two rules relating to switchboard galleries and passage-ways were still to be discussed yesterday, but a compromise has already been arrived at with regard to the rule as to no-voltage releases being necessary for all motors, to which, it will be remembered, there was great opposition. Apparently the objectors have not been able to obtain the entire exclusion of alternating-current motors from this Regulation, but it has been amended by the substitution of the words "every motor or group of motors" for "every motor over one-third of a horse-power," and no automatic release is made necessary when there is an attendant constantly at the controller. Apparently the Regulation as it stands is intended to apply only when there would be danger through unexpected restarting of a motor, and this was made clear by Mr. Gray when he read out his proposed amendment on Monday. An alteration made in drafting the amended Regulation on Tuesday, however, makes this point ambiguous, and the drafting will certainly need correction before it can be deemed satisfactory.

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ARRANGEMENTS FOR THE WEEK

(TO-DAY), THURSDAY, MARCH 19TH.

Royal Institution.

3 p.m. Afternoon Lecture I., on "Standardisation in Various Aspects": (1) Mechanical Engineering, by Dr. R. T. Glazebrook, F.R.S.

Royal Society.

4.30 p.m. Papers to be read:—"On Secondary β-Rays." Communicated by Prof. J. Joly, F.R.S., and "On the Measurement of the Atmospheric Electric Potential Gradient and the Earth-Air Current," by C. T. R. Wilson, F.R.S.

Institution of Electrical Engineers: Leeds Local Section.

7.15 p.m. Meeting at the University. Paper to be read:—"The Rules for Electrical Installations of the German Union of Electrical Engineers," by W. P. Steinthal.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at 25 Great George Street, Westminster. Paper to be read:—"New Alternate Current Instruments," by Dr. W. E. Sumpner and J. W. Record.

Dick Kerr Engineering Society.

8 p.m. Meeting at the Works. Paper to be read:—"Continuous-current High-tension Transmission," by H. J. Balcombe.

SATURDAY, MARCH 21ST.

Royal Institution.

3 p.m. Afternoon Lecture II., by Prof. J. J. Thomson, F.R.S., on "Electric Discharges through Gases."

Junior Institution of Engineers.

6.30 p.m. Reception at Caxton Hall, Westminster.

MONDAY, MARCH 23RD.

Institution of Electrical Engineers: Newcastle Local Section.

8 p.m. Meeting in the Armstrong College. Paper to be read:—"The Design and Use of Telephone and Telegraph Cables," by F. Tremain.

TUESDAY, MARCH 24TH.

Institution of Electrical Engineers: Manchester Students' Section.

7.30 p.m. Meeting at the Municipal School of Technology, Whitworth Street, Manchester. Paper to be read:—"Some Notes on Power Station Equipment and Design," by C. W. Crosbie.

Faraday Society.

8 p.m. Meeting at the Institution of Electrical Engineers, 92 Victoria Street, Westminster. Sir Oliver Lodge, F.R.S., will deliver his Presidential Address on "Some Aspects of the Work of Lord Kelvin." Lord Rayleigh will preside.

WEDNESDAY, MARCH 25TH.

Institution of Electrical Engineers: Students' Section.

7.30 p.m. Meeting at 92 Victoria Street, Westminster. Paper to be read:—"The Motor Converter," by H. W. Gregory.

THURSDAY, MARCH 26TH.

Royal Institution.

3 p.m. Afternoon Lecture II., by Dr. R. T. Glazebrook, F.R.S., on "Standardisation in Various Aspects: (2) Electrical Engineering."

Norwich Corporation v. the Norwich Electric Tramways Co., Ltd.—On Tuesday last the case of Norwich Corporation v. the Norwich Electric Tramways Co., Ltd., came before the Court of Appeal, consisting of the Lord Chief Justice, Lord Justice Farwell, and Lord Justice Kennedy, on the appeal of the Tramways Co. from a judgment of Mr. Justice Bray in favour of the Corporation. The appeal was brought for the purpose of determining the extent of the liabilities of the parties concerned as to the repair of the streets through which the company's tramways passed. The company had raised the point that the general Tramways Acts provided for the settlement of the dispute by arbitration before an official referee appointed by the Board of Trade, and the question was referred to the Hon. Alfred Lyttelton, who made an award in favour of the Corporation for a sum of £320, *plus* 5 per cent. and costs of arbitration, holding that the company were bound to keep the junction between the granite setts on which the line was laid and the road, which was maintainable by the Corporation, in a proper state of repair, and if they failed to do so the Corporation were entitled to do the work themselves, after giving statutory notice to the company, and to recover a reasonable sum therefor. Counsel contended that the Divisional Court, which upheld the award, was wrong, on the ground that the company were only bound to maintain and repair the part of the roads upon which the tram lines ran. After hearing both sides, their lordships dismissed the appeal with costs.

PARLIAMENTARY INTELLIGENCE

LONDON ELECTRIC POWER BILLS.—In the House of Commons on Tuesday, the proposal by the House of Lords, that the London and District Electricity Supply Bill, the London Electric Supply (Joint Committee) Bill, and the London (Westminster and Kensington) Electric Supply Companies Bill, be referred to a Joint Committee of both Houses of Parliament was considered.

The President of the Board of Trade (Mr. Lloyd George) said he had very reluctantly to move "That the House do disagree with the Lords in the said resolution." He did not think a Joint Committee was the best method for investigating the merits and the details of the Bills in question. He expressed no opinion upon the merits of the Bills, for everyone interested in the question knew that it was an extraordinarily difficult one. The question of the supply of electric power to London had been very prominent for several years past without any results being arrived at, and it was clear that no settlement was possible without some agreement between the parties engaged. Unfortunately the question had become a matter of political controversy, but he thought that the parties were now approaching towards a reasonable settlement. If, therefore, the Bills went to separate committees of both Houses, in the ordinary course, he thought the House of Commons might be in a position to consider the best way of coming to a decision by some general consent. He thought a conference might be arranged between the parties to endeavour to come to some agreement on the general principle, and his only object in resisting the motion for a Joint Committee was that he did not think it would facilitate the giving of a cheap supply of electricity in London.

The motion against sending the Bills to a Joint Committee was carried without a division.

HIGHGATE HILL TRAMWAYS.—The second reading of this Bill in the House of Lords has been postponed until April 2nd.

LIVERPOOL CORPORATION.—On Wednesday last week the Court of Referees in the House of Commons heard an application on behalf of the Bootle Corporation for a *locus* against the tramway clauses of the Liverpool Corporation Bill. At present the tramways in Bootle are worked by the Liverpool Corporation under an agreement, and the rent paid by Liverpool has been found to be insufficient, the deficiency having to be made up from the Bootle rates. The present Bill proposes to extend the tramways in Litherland, which, it was contended on behalf of Bootle, would bring more traffic over their tramways, and still further increase the cost of maintenance. The Bootle Corporation, therefore, asked to be allowed to oppose the extension unless the payment now made by the Liverpool Corporation for maintenance of the lines in Bootle was increased. After hearing arguments the committee refused the *locus*.

STANDING ORDERS.—The London and Windsor Motor Roads, Tram Roads,, and Tramways Bill has been declared not to comply with standing orders by the Standing Orders Committee, and cannot consequently proceed this Session.

Owing to the Standing Orders Committee having decided not to dispense with standing orders in respect of the Croydon Rural District Council's consent to the Croydon and Southern District Tramways Bill, it is probable that the whole measure will be withdrawn.

The Standing Orders Committee has decided to dispense with standing orders in respect of the consent of the Edinburgh Corporation to certain tramway proposals in the Leith Burgh Bill. The Edinburgh Corporation would only give its consent as the road authority upon certain terms which were deemed unreasonable by the Leith Corporation.

The Standing Orders Committee on Tuesday decided to dispense with Standing Orders in the case of the London United Tramways Bill, which proposes to construct a tramway over King Edward VII. Bridge, Kew, and in respect of which the consent of the local authority has not been obtained. Non-compliance had also been reported in the case of the West London, Barnes, and Richmond Tramways Bill, the promoters of which have also failed to produce the consents of local authorities. In this case the Committee dispensed with the Standing Orders, leaving it to the promoters to prove the consents of the local authorities before the Select Committee.

Postage Rates on Scientific Publications.—On Thursday last week the Postmaster-General received a deputation from the British Science Guild, headed by Mr. Verney, M.P., relative to the question of reducing the postage rates upon the publications of scientific societies and institutions. Sir Philip Magnus, M.P., said there were 300 or 400 technical institutions in this country to which the question was of the utmost importance. In his reply, the Postmaster-General said he felt it was impossible to meet the wishes of the deputation. Not only would the proposal result in considerable confusion in the sorting department, but he doubted whether the subsidising of scientific societies in this way would really benefit them. Further, it would require an Act of Parliament to sanction such special rates.

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THE ELECTRICAL EXHIBITION

A CONTEMPORARY has been giving currency to a rumour, which we are happy to say is incorrect, that the Electrical Exhibition to be held in Manchester next October was to be postponed until next year. We are in a position to state that this report is without foundation.

The announcement made in our issue of March 5th, that the Manchester Corporation had agreed to permit the use of Platt's Fields for the Exhibition is absolutely accurate.

The Executive Committee held its first meeting on January 27th last at their offices, 2 Queen Anne's Gate,. S.W., and one of the most important matters then dealt with was the question of a suitable site. Mr. C. S. Northcote, general manager, and Mr. W. Davenport, organising secretary, were instructed to bring forward alternative particulars as to available land in Manchester, and these, together with plans of the proposed buildings, were considered at another well-attended meeting of the Executive Committee on February 8th at the Town Hall, Manchester. It was then announced that the Parks Committee of the City of Manchester had expressed their willingness to consider an application for the use of some spare land situated on the Platt's Fields Estate, which is immediately adjoining one of the main roads leading from the City and is in the heart of one of the most important residential districts.

The Committee, therefore, made formal application to the Corporation, and after several informal meetings they considered at a meeting on March 9th a definite offer from the Manchester Corporation for the use of Platt's Fields. The offer was unanimously accepted by the Committee. After various builders' estimates had been dealt with, based upon the plans and schemes already decided upon, it was agreed that the matter should go forward.

A general meeting is being called in Manchester on Tuesday, March 24th next, with a view to adopting the resolutions of the Sub-Committee and putting same into effect. In the meantime, draft prospectus and plans of floor space available for exhibitors are being prepared, and it will materially assist all those interested in the organisation of the scheme if would-be exhibitors will kindly advise the management as to their desire to take part in the movement, which has already received sufficient promises of support to warrant an assured success.

The scheme which is being dealt with at present is on a far larger basis than the first Electrical Exhibition, held at Olympia in 1905, and organised by the trade itself. We are informed that the total floor space of the proposed building will be approximately 100,000 square feet, so that there will be room not only for a thoroughly representative display of electrical apparatus, but also for mechanical machinery and other plant to which electricity as a motive power may be readily and successfully applied.

It is hoped that the energetic and painstaking work of the Committee will be rewarded by receiving the loyal support of the industry and trade generally.

CORRESPONDENCE

THE STANDARDISATION OF FUSES.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—There are one or two misapprehensions in your Editorial comments of last week on the above Paper which we should like to correct. With regard to the ground covered by the Paper, this was not in any way dictated by the Standards Committee; the Paper was largely concerned with enclosed fuses, not because the E.S.C. were obsessed with the sinister intention of forcing rows of obese cartridge fuses into the distended jaws of consumers' distribution boards, but simply because we had dealt pretty fully with open-type fuses in our Paper on "Low-tension Thermal Cut-outs" in 1905, and because there was no published data for enclosed fuses as to the influence of fillings of various character, of the kind of metal employed, the jacket material, &c.

Your statement that various authorities prescribe 200, 100, 50, and 25 per cent. overload respectively for the fusing current of a given fuse is a strong argument in favour of standardisation; surely some definite pronouncement as to the rating of fuses would be welcome. There is also need for standardisation with regard to the method of testing, the limitation of the short-circuit current on test, &c., as the most diverse arrangements exist at the present time.

Enclosed fuses have been standardised and rendered non-interchangeable within certain limits both in Germany and America; for a detailed account of the standardisation of enclosed fuses in the latter country reference may be made to a Paper by H. O. Lacount, read before the American Institute of Electrical Engineers on September 22nd, 1905, where the necessity for standardisation is dealt with at some length. That the American standardisation has not led to an intolerable multiplicity of sizes may be gathered from a reference to the last edition of the "National Electric Code," issued by the National Board of Fire Underwriters.

We feel sure that this question may be left with confidence in the hands of the E.S.C., and trust that the results will in the future tend to lessen rather than add to the burden of the contractor, and at the same time make for increased safety and efficiency.

ALFRED SCHWARTZ.
W. H. W. JAMES.

School of Technology, Manchester,
March 16th, 1908.

To the Editor of ELECTRICAL ENGINEERING.

SIR.—I am strongly inclined to agree with your leading article of last week. It seems to me that what is wanted is standardisation of fuse-boards, not of fuses.

I attended the meeting at which Prof. Schwartz's Paper was read, but the time allowed for discussion was too short. The main point is that we require a metal or alloy that will not "splash." Copper seems to meet this requirement best, but, as Mr. Mordey pointed out, it is not possible to get wire of sufficiently small section with sufficient strength, and it is affected by heating. This was my own experience years ago. The "splashing" effect of the usual lead and tin fuse is a serious matter when highly inflammable material is about, and I have had experience of more than one fire from this cause. It is especially dangerous in motor garages, where petrol is often carelessly exposed. I find that fuse-boards which have been in use for any length of time are plentifully provided inside the case with fused metal.

As regards rating of fuses, I am of opinion that this can safely be left to the good sense of the contractor installing or maintaining an installation, and I have very little to complain of on this score. My own practice

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is to allow an overload of 50 per cent., and this I find works well generally, but one, of course, has to be guided by circumstances. The margin should be increased in the case of hotels and public buildings and places where it is desirable that the lighting should not be cut off unless really necessary.

I do not favour the enclosed type of fuse, and prefer a type that is always in view. The attendant can then readily see which fuse has blown, and replace it. Another advantage is that one soon gets familiar with the size of wire necessary for various circuits, and a very fair judgment can be made. I remember that many years ago Mr. Arthur C. Cockburn read a Paper before the Society of Telegraph Engineers, which was on very similar lines to that recently prepared by Prof. Schwartz. This Paper seems to have been quite forgotten. Mr. Cockburn advocated, I think, a fuse provided in the centre with a weight, which quickly separated the metal when it fused, and got rid of the "splashing" effect. I believe this type of fuse was used a good deal, but it seems to have dropped out for some reason. To my mind it would be of far more importance if the various makers could be persuaded to standardise their boards. In all my specifications I have to go carefully into details and to get prints, &c., and this should not be necessary.

With the present type of board I find there is a tendency for the small binding screws to loosen and the contacts to open, and this especially in buildings over railways, where more than ordinary vibration is experienced. To this cause I put down the arcing that frequently occurs between the live metal on the board and the enclosing case (when of iron): it is very difficult to get makers to realise the necessity of allowing plenty of space between the bases and the case. Lining with asbestos is not of much use, as this material is hygroscopic, and is generally fastened with metal clamps, which also causes arcing. The contacts, too, are often so close together that on circuits of 200 volts and over, if one fuse blows it sometimes blows the lot. I have often either to reject boards at the last moment, or to put up with these defects, and I know that this is not my experience alone.

In many installations under my care I have to make careful periodical inspections to see that binding screws, &c., and contacts are in good order, and this should not be really necessary.

In my experience quite 80 per cent. of blow-outs are caused at the board, and not in the line. My experience of fuses is generally unsatisfactory; when they ought to blow they don't; and when they do, the cause cannot be ascertained. I quite follow your remarks about the unsightliness of boards, if different sizes of cartridge fuses were fitted. The boards are already sufficiently ugly, and one of my clients always refers to those in his house as "torpedo boat" fittings.

S. G. C. Russell.

March 16th, 1908.

A.C. MOTOR-STARTING SWITCHES WITH NO-VOLTAGE RELEASE.

To the Editor of Electrical Engineering.

Sir,—With reference to the inquiry which is being held relating to the rules which the Home Office propose issuing regarding the use of no-voltage release switches, we are exceedingly surprised to see from the evidence reported in the technical Press, given by many of the leading engineers, that they are not aware that switches of this type for use with alternate-current motors have been on the market for the past 18 months, and that, furthermore, a great number have been installed in various mills, collieries, &c., more especially in the north, in fact, in the more recent specifications issued by at least one of the leading firms of consulting engineers in Manchester this type of switch is specified.

We have made a speciality of the manufacture of these for the past 18 months, and have supplied switches for controlling over 17,000 h.p. of three-phase motors, and have on order at the present time switches for controlling an additional 5,500 h.p. We enclose a copy of our catalogue relating to these switches, and from which you will see that we are manufacturing them in four standard sizes for 15, 50, 200, and 500 amps. per phase, suitable for mounting on switch panels, or we supply them fitted in protected iron cases or in gas- and water-tight cases as required. From the prices given you will see that the cost of installing switches having this no-voltage feature is not very much in excess of that of installing ordinary high-class cast-iron case switches.

Furthermore, as these switches are of the remote control type operated by a separate small switch, the main switch can be mounted close to the motor which it controls, the operating switch being placed in any convenient position. This frequently leads to a considerable saving in the cost of the three-core connecting cables, and in certain instances we have been able to show that it was cheaper to fit switches of our no-voltage-release type instead of switches of the ordinary ironclad pattern. In addition, there is the advantage that all our switches are of the oil-break type, with quick make and break action.

We must apologise for taking up so much of your space with this letter, but we think that, in view of the evidence which was given at the afore-mentioned inquiry, this matter is of interest to the majority of electrical engineers in this country.

Eckstein, Heap & Co.

Waverley Mills, St. Simon Street, Salford.
March 17th, 1908.

THE FUTURE OF THE TELEPHONE SERVICE.

To the Editor of Electrical Engineering.

Sir,—In your issue of March 12th, you insert a long letter on this subject from the pen of Mr. Herbert Laws Webb, who occupies the distinguished position of chief of the Contract Department of the National Telephone Company. Mr. Webb, as he has often done before, prescribes certain remedies for the telephone evils which are so strongly complained of, and he naturally advocates suppression of the flat rate tariff and the substitution of measured rates. Such a change, as calculated to extract the greatest amount of money from the pockets of telephone users, naturally suits his—*i.e.*, the company's—standpoint, but then the company's and the subscribers' interests are not identical. No amount of special pleading—and Mr. Webb's pleading is very special—can cover up the fact that those municipalities which instituted telephone systems of their own have demonstrated that a good, trustworthy telephone service, satisfactory to the subscribers, can be maintained with profit by giving telephone users the choice of a flat rate, which in different places has varied from £5 to £6 6s. per annum, and of a measured rate of £3 per annum and a 1d. for each call. No settlement of the telephone question should be entertained that does not give British users these terms. The new Post Office rates are simply outrageous. The lowest is £5 for 500 calls, and the smallest user must pay that, although he may only require to originate 50 or 100 calls per annum. In the first case he would pay, under the municipal system, £3 4s. 2d., and in the second £3 8s. 4d., as against the Post Office £5 minimum. All this could be proved before a Select Committee if the Post Office would consent to one being appointed; but they, like their colleagues of the Contract Department of the National Telephone Company, are too intent on squeezing the last penny out of the user. The Chambers of Commerce have taken up the question very energetically of late, but, personally, I do not think that anything short of a full thrashing out of the matter before a Parliamentary Committee will produce any tangible result.

I am, sir, yours, &c.,

A. R. Bennett.

Queen Anne's Chambers, Westminster, London, S.W.
March 16th, 1908.

[Mr. Bennett is not correct in designating Mr. Webb chief of the Contract Department of the National Telephone Co.—Ed. E.E.]

Royal Society.—Among the list of names of candidates selected by the Council of the Royal Society at their annual meeting for election as Fellows in May next we notice that of Mr. Dugald Clerk, who is well known in connection with researches on the thermodynamics and action of the internal combustion engine, subjects upon which he has worked at for the last thirty years, and written a large number of papers. He is at the present time a director of the National Gas Engine Co., and has also an extensive practice, both as a consulting engineer and as a patent expert. He will be the president of the Engineering Section of the British Association at the Dublin meeting this summer, and is also president of the recently-formed Institution of Automobile Engineers.

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ARTIFICIAL LOAD FOR TESTING ELECTRICAL GENERATORS

THE paper on the above subject by Messrs. R. K. Morcom and D. K. Morris, read on Wednesday of last week before the Birmingham Local Section of the Institution of Electrical Engineers, commenced with a consideration of water resistance, and pointed out the great differences in the conductivity of water obtained from different sources. Distilled water, for example, has a specific resistance of 600,000 ohms per cubic centimetre at 60° F., while the corresponding figure for Birmingham "tap" water is 13,200, and for Birmingham canal water only 435.

In an actual test tank, gradual solution of the metal electrodes causes a fall of resistance beyond that due to temperature, because the higher the temperature with a given current the less the amount of cooling water to dilute the iron solution. For a rise of temperature of 70°, approximately, 50 gallons of cooling water per kilowatt-hour are required. Where possible salt or soda should not be used to increase the conductivity, but the plant should be designed to use the most abundant local supply. A very large body of water cannot give a high resistance even when the electrodes are very far apart, and if the tank be long in proportion to its cross-sectional dimensions the extent of the electrode immersion makes very little difference to the resistance, provided that the area of the electrode is not very small compared with the cross-sectional dimensions of the water. If, however, the distance between the plates be small, then their area of opposition has a great influence on the resistance. Proximity to the side of the tank has a great effect with narrow plates in large tanks, due to distortion of the lines of flow. Part of the distortion is equivalent to shielding the back and sides of the plate. This effect gives one means of varying the load.

Another convenient method of reducing the load from a given tank is by dropping diaphragms between the plates. Various modifications of the baffle method will suggest themselves by which the resistance of the path may be increased without upsetting the cooling arrangements or complicating the tank, but the possibility of charring by excessive voltage drop in a short length must be kept in mind. The proximity of the plates to the side of the tank is also a factor in the permissible volt drop per foot of water.

It is found that where the line of flow from the electrode along the tank-side differs but little in length from the shortest line, the voltage drop per foot should not exceed 600 volts, and should be lower than that unless the walls are well insulated and free from metal. This point must be watched with high-tension work, and also in low-tension work where plates that are close together are carried near the side of the tank. A further limiting condition indicated by experience is the maximum permissible current density per square inch of an iron electrode. It will be found advisable not to run at greater densities than 1 ampere per square inch. Trouble from bubbling and rapid corrosion is likely to occur if this be exceeded.

With regard to the materials to be chosen. Wooden tanks are cheap and easy to obtain; they can, with proper precautions, be made durable and water-tight, and, as the sides can be rendered practically non-conducting, there is no difficulty in obtaining light loads. Metal tanks, on the other hand, are either expensive or perishable, and light loads are hard to obtain owing to the low resistance path afforded by the walls, unless unduly large tanks are used. Cast-iron electrodes are cheap and satisfactory, though scrap metal of various sorts may in certain cases be substituted for sake of convenience.

The following is a description of a tank which has done excellent service:—

The dimensions are 7 ft. × 1 ft. 6 in. × 1 ft., and it is used for high-tension work. The sides and bottom are constructed of good spruce, tongued and grooved; all joints are tarred and caulked. Sides, ends, and bottom are made double of 1½-in. timber, the two layers being built up at right angles. The whole is screwed together in such a way that no screw comes within ¾ in. of the water, and all timber is tarred all over. The water inlet is through a canvas hose brought over at the outlet end, and carried along the bottom of the tank for its full length. The outlet is over a sectional wire 6 in. from the end of the tank, and then through a hole in the bottom of the tank. One trouble thus avoided is the charring of the wood, which usually occurs along seams to which water has access: proper caulking prevents this. Also, any metal in the wood to which water has access corrodes and causes charring. This is prevented by using hidden screws, a hose pipe inlet, and a plain hole outlet. The hose pipe inlet obviates troublesome short circuits to earth, and the weir also provides for adjustment of water level. The double sides prevent leaking and undue bulging. For tanks of larger dimensions iron stays may be used, but these should be carried outside the tank, an obvious but often neglected precaution.

As this tank is for high-voltage work it is supported on insulating pedestals. These can conveniently be constructed of Doulton's glazed earthenware "acid tiles," built about 3 ft. high, with a rubber pad between each horizontal face to prevent slipping. The water from the outlet hole is carried to a funnel or tray just above the floor level. A lead-lined saveall is provided. The operator has a wooden platform supported on earthenware blocks, and covered by a rubber mat. The electrodes are of iron, and are well insulated from their supports, which take the form of stout wooden cross-bars which can be slid along the tank top. The plates are clipped to busbars carried at a considerable height, and the connections are so guided as to be neat and safe. Such an arrangement can be cheaply made, and gives satisfaction up to 6,000 volts.

A low-voltage tank construction can easily be deduced from the above, but probably the area will have to be obtained by using a number of electrodes in parallel, in which case, for variable loads, a suitably arranged switchboard is a great convenience. One point should not be forgotten with iron electrodes, namely, that if they are placed less than 2 in. apart there is danger of an unsteady load, and a considerable splutter from short-circuiting by rust flakes; in fact, 3 in. should be aimed at as a minimum. Sometimes, for very low-voltage work, the size of the tank available is insufficient. A useful form of load can then be constructed from metal strip submerged in water.

Strip iron ½ in. wide × 19 S.W.G. supplied in 40 ft. lengths and doubled into zigzag shape will make very convenient units for low-voltage loads. With a current density of about 25,000 amperes per square inch (the unit being immersed in moderately high resistance water) an average life of 100 hours may be expected. If, however, the cooling water is of relatively low resistance, such as canal or river water, the life is very much reduced. In actual use a unit of this form has been run at a current density in the iron winding of 52,000 amperes per square inch in canal water of a specific resistance of 440 ohms per cm.³ at 60° F., and broke down after an eight hours' run. Under these conditions the rapid wasting of the strip caused a gradually falling load. It is very convenient, when using these units, to have a small water load in parallel for fine adjustments. Obviously the relatively short life and lack of facility of adjustment are the chief disadvantages of this form of load.

The convenience of the water resistance for absorbing a test load can be enhanced by providing a suitable apparatus for producing inductive load. Choking coils for this purpose have hitherto been constructed by placing a suitable winding on an iron core having a small and sometimes adjustable air-gap. The object of the air-gap has been to render the out-of-phase magnetising current as large as possible. In the choking coils to be described below no air-gap at all is used, but the iron is instead worked at a flux density so high that its permeability is quite low, and the magnetising current is correspondingly large. As compared with ordinary choking coils, this construction has two distinct advantages. The flux density can be very much greater than is practicable with the older coils (three to four times). The induced voltage per turn is, therefore, correspondingly increased, and the necessary number of turns reduced. Also the magnetic reluctance is so uniformly distributed all round the magnetic circuit that the magnetic leakage is very small, and every turn of the winding is equally utilised.

On account of the high flux density it is important, in order to avoid eddy currents, to use the thinnest laminations and to reduce hysteresis by employing the best iron. As is well known, heavy iron cores cannot be worked at 50 cycles for long at flux densities exceeding, say, 8,000, without very special means being taken for cooling them, and at the flux densities which are being used in these new coils described in the Paper, such cooling is an essential condition. Cooling the core is not that the iron itself may be rendered cool, but that it shall not impart too much heat to the windings which surround it. The loss in the iron itself is, in fact, very substantially reduced by a rise of temperature of the core, partly on account of the reduced hysteresis, but much more by the increased resistance of the iron and consequent reduction of the eddy current loss, which, in cores worked at very high flux densities, is otherwise disproportionately large.

Two methods suggest themselves for working such high flux density choking coils continuously without overheating. The whole coil and winding may be immersed in water kept in circulation and slowly flowing to waste. The limbs of the iron core may be surrounded by coils of flat copper tube, closely fitting, in which water is continually flowing.

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In cases where the voltage permits it, there is great advantage in the first method. Not only does it provide a satisfactory means of getting rid of the heat in the core, but it allows of the use of very high flux densities in the winding. Copper for the windings may even be dispensed with altogether, and the coil wound with iron strip worked at current densities which would be high even for copper if not specially cooled. Such coils are in the highest degree economical to construct and prove perfectly

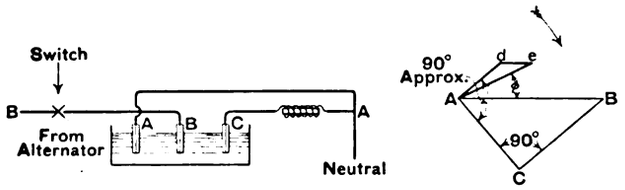


FIG. 1.—COMBINED WATER LOAD AND INDUCTIVE LOAD.

AB = Total voltage to neutral.
AC = Voltage across choking coil.
BC = Voltage across series resistance.
Ad = Current in choking coil and series resistance.
de = Current in shunt resistance
Ae = Total current

satisfactory if the voltage does not exceed 1,000–2,000. For voltages much higher than these, or where a more durable apparatus is necessary, it is preferable to use water-cooled cores of the type described above.

To test a 1,000-kw. set at 0·8 power factor requires approximately 1,250 kilovolt-amperes, and 750 kilovolt-amperes of idle current, or three 250 kilovolt-amperes choking coils. With the special cooling described above, these inductive coils can be constructed on cores not exceeding in size those which would be used for three 25-kw. transformers.

Exceedingly low power factors can be obtained with this apparatus ranging down to that representing a lag of about 89° in the larger sizes. The lower the power factor the less the energy which has to be got rid of in the inductive coils, and consequently the higher the figure at which such coils may be rated. The relation between impressed terminal voltage and current (r.m.s.) taken by the coils, depends upon the magnetisation curve of the iron used in the core, as well as on the wave-form of the current itself. At high flux densities a relatively small drop in voltage reduces the current almost to nothing. It is characteristic, therefore, of these choking coils, that while they work well over a wide range of current, yet their range of voltage is small.

It is not practicable to have special inductive loads made for every voltage and current of the machines which may have to be tested. It is therefore of the greatest importance to provide means whereby the voltage as well as the current of an inductive load may be regulated while the power factor is maintained at a specified value of, say, 0·8. The most satisfactory method of arranging for such regulation is by means of water resistance arranged in such a manner that the inductive coil current is shunted by an in-phase component of current in a water load, while, at the same time, resistance may be put in series with the choking coil (see Fig. 1). By shifting the plate B towards A or C, the double adjustment may be conveniently effected at one time. Adjustment is also obtained by raising or lowering one or more of the plates. The inductive coil may be either immersed in the tank, or may be in a separate place according to the method used.

Further variations of voltage and current may be obtained by the well-known methods of paralleling the coils, or changing from star to mesh connection or both, used always in conjunction with the above combination of water loads. Since the change from star to mesh coupling reduces the voltage for which the inductive set is suitable and increases the current by $\sqrt{3}$, it is convenient to make the next step down in voltage correspond to the paralleling of three equal sections of the winding, since this will again give a step $= \sqrt{3}$. The next step, again, would then be by changing from star to mesh, the coils remaining still in parallel. In this way an extreme range of voltage of as much as 9 : 1 may be obtained with a three-phase set, each of whose windings is subdivided into three parts only, while throughout this range the set can be worked, if required, at constant kilovolt-amperes and core flux density. For testing at reduced loads the correspondingly smaller kilovolt-amperes are obtained by working the cores slightly at lower flux density. For economy in design it is best to use choking coils wound for the lowest voltage, which will satisfy the purpose for which the coils are required. If they are wanted for testing three-phase generators at a moderate power factor, it will be found that the necessary coil-voltage is not more than one-third to one-half of the terminal voltage of the machine under test.

To extend the range of the set the sections of the combined load may be coupled in mesh or delta connection. In this way the current capacity is increased as $1 : \sqrt{3}$, while the voltage limits are correspondingly reduced. To deal with yet lower voltages and higher currents, it is convenient to subdivide the windings on the coils each into three sections as described above. These, when paralleled and star-coupled, give a set of volt-ranges one-third of those first available, and consequently reduced as $\sqrt{3} : 1$ from the second arrangement in which the apparatus was delta-connected and all the windings on each core were in series. Lower voltages still can, of course, be obtained by delta-coupling the third arrangement; and, if advisable, by further subdivision of the coils. The combination of coils and water-loads described here is thus of a very flexible nature, and well suited to deal with the variety of generators which may have to be tested commercially.

The kilovolt-amperes of an inductive load being fixed, the winding must be so chosen that the following conditions are satisfied: (*a*) It must carry the required current without undue heating continuously, or, in special cases, for a given short period; (*b*) its number of turns must be such that, when carrying this current, a back E.M.F. equal to the required terminal voltage is obtained; and (*c*) there must at the same time be enough ampere-turns operating on the coil's magnetic circuit that the requisite high flux density is obtained. If the coil is above a very small size, and not required for short-time rating only, the core must be cooled.

The use of these coils worked at such high flux densities gives rise to a current-wave whose peak is about 10 per cent. higher than that of an equivalent sine-wave of current. That is, in calculating the ampere-turns available for producing the maximum of flux density the r.m.s. ampere-turns must be multiplied by about 1·56; so that the value of H is about 1·96 × the r.m.s. ampere-turns. The approximate field is therefore roughly obtained by doubling the r.m.s. ampere-turns. The distortion of wave-form is, however, not very great owing to the very high flux density, and therefore uniformly low permeability, which occurs.

The most suitable design of choking coil is in many cases that giving the *least power factor*. This factor is the ratio of copper and iron losses to the total kilovolt-amperes of the choking coil.

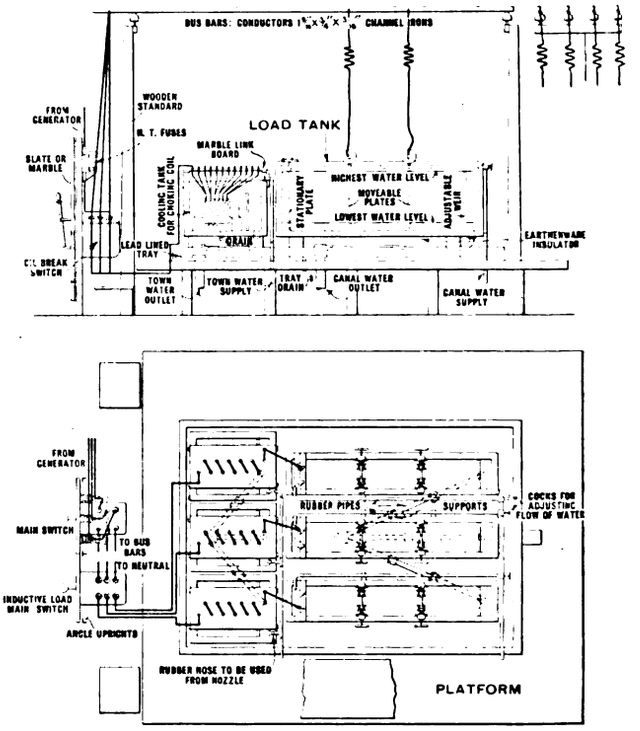


FIG. 2.—SUGGESTED DESIGN FOR ARTIFICIAL LOAD, INDUCTIVE AND NON-INDUCTIVE, SUITABLE FOR 1,000 K.W. AT 1,000 TO 6,000 VOLTS.

The losses depend on the square of the current and on some similar function of a not widely varying flux density, while the kilovolt-amperes are proportional to current and flux density. Thus there will be a point at which the power factor is a minimum which occurs at a higher flux density the larger the coil.

It is difficult to generalise as to the best method of combining the details, but the authors append a suggestion for a working

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plant on lines which have been found very satisfactory in practice over a large range of conditions (see Fig. 2). The inductive coils here shown are cooled by immersion in suitable tanks in which water is circulated, as also in the main load tanks by a system of pipes clearly indicated.

DISCUSSION.

Mr. J. P. KEMP (Birmingham) said that for high-voltage tests he had found a water load to be the only suitable form where large amounts of energy had to be dissipated. With wooden tanks, however, he had experienced trouble, the troughs had caught on fire, and the water leaked out. In Manchester, at the Stuart Street Station, he had used for three-phase, 6,500 volt work, a circular iron tank 6 ft. in diameter and 4 ft. deep, with the outer electrodes symmetrically spaced at 120 degrees, and about 7 in. away from the neutral element. The water was introduced in the centre at the bottom of the tank, and flowed away over a weir at the top. With this particular tank 4,000 kw. had been successfully absorbed for over six hours. The outer body of the tank also formed part of the neutral element, and as this was substantially earthed there was no possible danger from shock. With wooden tanks, however, there was considerable risk of men receiving a shock from the body of the tank or even from the water. As a permanent adjunct to a central station, a suitable water load was very desirable, for it enabled one to perform various adjustments to valves, governors, &c., and there was no question about its advantage and superiority over the temporary arrangements frequently provided for official tests. The main point of interest in connection with the Paper was the method devised for obtaining loads of varied power factor Up to the present, although a variety of inductive load tests were often called for in specifications, he did not know of any case in which they had actually been carried out.

Mr. J. M. WALSHE (Birmingham), referring to Mr. Kemp's description of the circular metal tank, said that it would be quite impossible to use this with Birmingham canal water at 6,000 volts, as the maximum load would be too great. With low resistance water, it was necessary to have a long narrow tank. Three tanks each 6 ft. long, 1 ft. deep, and 6 in. wide, had been found quite large enough for 950 kw. at 7,500 volts, and the load could be reduced to 40 kw. at the same voltage. This range would not be possible with metal tanks using canal water. A point in connection with the use of small tanks is that the water supply must be reliable and regular, as owing to the decrease of resistance with the rise of temperature of the water there would be danger of a heavy overload if the supply were to fail. With tanks of small capacity the rise of temperature is very rapid. An open drain should be fitted under the weir, so that in case of a failure of the water supply, the level of water in the tank would fall, and the resistance of the water remain about constant.

Mr. KEMP here explained that he quite agreed with Mr. Walshe that it was impossible to use canal water in small metal tanks for 6,000 volt tests. In the tests to which he had previously referred, he had used town's water; under these conditions he had found it possible to vary the load from 40 to 4,000 kw., simply by varying the immersed area of the electrodes, the amount of water remaining constant; as a precaution against failure of the water supply and the consequent increase of load he had used a drain pipe at the bottom of the tank; the amount of load on the tank was, however, under perfect control, and could be readily adjusted by means of a small motor operated from the switchboard.

Mr. R. A. CHATTOCK (Chief Electrical Engineer, Birmingham Corporation) said that the authors had stated that the voltage drop per foot of water should not exceed 600. If this applied to low-tension current, he thought it a very low figure. He considered that the limit of current density of one ampere per square inch of plate was too high. In stationary water boiling would occur in a very short time with probably ½ ampere per square inch. He recalled some tests in which he had used two plates placed in a canal. The conditions were 100 kw. load at 1,000 volts single-phase alternating current, the electrodes were 15 ft. apart, the immersed area of each being 10 square feet. One could feel the effect of the electric current at least 50 ft. away, and fish were killed within a radius of 20 ft. As a danger signal, whilst the test was going on, a small raft was moored between the electrodes, from which two iron plates were suspended in the water 18 in. apart; a 100-volt lamp was connected to these plates, and the drop in pressure was sufficient to light this up He had tried a single-phase test with a metal tank as one pole, and a rod in the centre of the tank as the other, and the result was practically a short circuit. Using the same tank and two rods, one for each pole, gave quite satisfactory results. He had had trouble with wooden tanks owing to deterioration of the wood allowing the water to leak and causing charring on the outside; he had also known the wood to catch fire if this was allowed to go on.

Mr. F. FORREST (Birmingham) thought that in the design of tank with sliding electrodes, some mechanical means of adjustment was desirable. He wondered that no serious attempt had yet been made to utilise the power wasted in works test rooms, and suggested that it might be possible by using a system of storage cells and a wide range booster. It might also be possible to utilise the hot water from the testing tank to feed the boilers.

Mr. J. D. COALES (Birmingham) referred to the form of wave obtained with choking coil employing high flux densities as described, and suggested that when an alternator was tested on such an inductive load, the "drop" might be exaggerated unfairly, owing to the concentration of the demagnetising reaction with a small part of the cycle where it was most effective.

Dr. W. E. SUMPNER (Birmingham) said that the Paper was clearly divided into two distinct parts, a practical portion dealing with water loads and tank construction, and a more theoretical portion bringing forward a new feature in connection with the design and construction of a load suitable for taking current at a given power factor. The novelty consisted of using a choking coil with a closed iron magnetic circuit and working it at very high flux densities. The current wave in a transformer having a closed magnetic circuit consisted of a shoulder and a peak. At very high flux densities the peak would be increased, while the shoulder would be less pronounced. This would result in a zig-zag wave of current very like a series of triangles. A sine wave was approximately a triangle with the peak rounded off, so that the resulting wave would essentially differ only very slightly from a sine curve. The use of these choking coils would thus have no unusual effect on the alternator.

Mr. N. B. ROSHER asked if the authors had fully considered the use of wire resistances. He had had experience with these years ago, and had found them to work well. They could be mounted on frames in units, and were very convenient for connecting up to test-room terminals. One advantage was that they could be used for testing generators after final erection, as a sufficient number of resistance units could easily be sent out from the works for the purpose.

Mr. A. E. GOTT was particularly interested in the portion of the Paper dealing with water resistances. As an illustration of the high resistance of pure country water, he mentioned an experiment made, previous to a dissipation test, on an ordinary oil barrel filled with water. Lead plates were used, each with two square feet immersion. When brought to within only three-quarters of an inch of each other, 100 volts only gave 2 to 3 amps. The addition of two or three ozs. of acid enabled him to dissipate 60 h.p., with the plates a safer distance apart. He gave the capacity of a barrel as 20 h.p. for one hour before boiling. He advocated water cooled open wire resistances. In his opinion, insulated water tanks would not be tolerated under the new Board of Trade regulations, a point which seemed to have been overlooked in the Paper.

Prof. GISBERT KAPP (Birmingham University), referring to the question of insulation, said that it was not sufficient to earth the tank. It was not possible to get a better earth than canal water, and yet it was possible to get a shock from the water. The tank itself should be earthed, but surrounded by a platform supported on insulators and covered with a rubber mat. He would like to ask whether the authors had had any experience with earthenware, which appeared to possess the advantages of both wood and metal tanks with the drawbacks of neither. He had found them to work very well for small loads. He would also like to ask the authors if they had observed the actual power factor of a resistance consisting of iron plates in water. He believed that this was not quite unity, but that the water load took a leading current. Electrolysis was continually going on and producing a film of gas on the plates, and thus forming a condenser.

Mr. R. K. MORCOM, in reply, said that one of the criticisms on the water resistance had been that it was possible to take a shock from the water. He had never experienced any trouble of this kind. The necessary precautions were quite simple. There were objections to using the hot testing water in boilers. Ordinary canal water would require to be softened before it could be used in this way, and by the time it had passed through the water softeners it would have lost a great deal of heat. If the water were softened previously it would not be so suitable for testing, and any lost waste would be expensive on account of the chemicals used. He had carefully considered the question of utilising the power usually wasted in the test room. But there were many difficulties in the way. Tests were carried out, using all sorts of pressures and currents and at odd times. Mr. Chattock said that he had trouble owing to the liability of wooden tanks to fire. Previous to this, Mr. Chattock had expressed the opinion that a drop of 600 volts per ft. was not so much as might be employed. In his experience it was only by using a moderate drop per ft. of water that it was possible to avoid charring the wood of the tank. The objection to porcelain tanks, of which Prof. Kapp had spoken, was mainly that of expense. Prof. Kapp had suggested that a water resistance acted like a capacity. In their tests they had noticed this, as they found it necessary to use a small amount of induction in conjunction with the water load in order to get unity power factor, but he had not attached much importance to this, as the accuracy of the readings had been questioned. He did not believe that the

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factory inspectors would take exception to the insulated tank. They really had a very good earth in the overflow water flowing into the canal.

Mr. D. K. Morris thanked the audience for their interest in the Paper. Mr. Coales had drawn attention to the wave form of the current taken from the alternator by a choking coil of their new type, and had suggested that this was of an unusual shape Dr. Sumpner had explained how this did not mean a wave differing materially from a sine wave. It was of great importance that the inductive load did not produce a different kind of load from that occurring in practice. Considering that only 3 or 4 per cent. of the current wave was sufficient to bring the flux over the knee of the saturation curve, it would be seen that practically the whole of the current wave corresponded to the region of low permeability, where, as was well known, the variations of permeability were not great. Thus the current wave was not far from being such that its rate of change was a copy of the volt wave, and the reactions in the generator for which the test was being carried out were therefore entirely normal. A slight distortion of wave shape was, however, quite proper in such tests, for this would occur in practice when a load of bad power factor arose.

TRANSATLANTIC WIRELESS TELEGRAPHY

At the Royal Institution last Friday a very crowded audience listened sympathetically to the story of the Marconi Company's Transatlantic service of wireless telegraphy. The lecturer, Mr. G. Marconi, sketched the history of the past six years, beginning with the erection of the Poldhu station and the reception of the first Transatlantic signals in December, 1901. This feat, it is well known, was accomplished by aid of a kite air-wire and coherer; the lecturer now divulged that the wave-length was 1,200 ft., that the power at Poldhu was 15 kw., that the spark length was about an inch and a half, and that the discharge capacity was one-fiftieth of a microfarad. The following year saw the erection of a large station at Glace Bay, Nova Scotia, and, also, many alterations at Poldhu, the wave-length, for example, being raised to 2,600 ft. In December, 1902, Glace Bay transmitted to Poldhu easily, but the signals from Poldhu were too weak for communication.

The Cape Cod station shortly afterwards got also into touch with Poldhu, sometimes using no more power than 10 kw. The *Times* Press messages in the spring of 1903 proved a failure on account of insulation breakdowns at Glace Bay, followed by a series of miscellaneous accidents. The experiments inaugurated in connection with the repairs led to many important improvements, so that in the end new stations were planned on each side of the Atlantic. Some of these experiments had to do with the aerials, which at these large power-stations are enormous structures. For instance, it was found that by adding wing-like wire extensions to the Poldhu inverted pyramid aerial, good signals could be transmitted 550 miles (to Fraserburgh) with a power of only one kilowatt, the wave-length being 14,000 ft. It is to be noted that waves of great length and small amplitude carry best; such waves seem to be less strongly absorbed by ionised air than shorter waves of greater intensity. The new stations that were erected in consequence of these and other experiments were situated at Clifden, Ireland, and at Glace Bay. The Glace Bay new station had a large aerial 220 ft. high extended horizontally by 200 wires 1,000 ft. long at a height of 180 ft. The wave-length was designed for 12,000 ft., and the sending capacity was 1·8 microfarad, the spark-length being $\frac{3}{4}$ in. Signals were received at Poldhu day and night throughout the spring of 1905. The signals were faint, and were only one way. To improve the signals new directive aerials were planned for both the new large stations—that is, the horizontal extension of the main vertical air-wire system was concentrated in the direction pointing away from the station to be communicated with. Another improvement was the substitution of an air-condenser for the glass condenser hitherto used. This avoided the losses due to dielectric hysteresis, as well as reduced the expense of repairs to dielectric punctures, though, of course, the condenser becomes of gigantic proportions. At the end of May, 1907, the Clifden station was finished. Its wave-length was 12,000 ft., and its capacity of 1·6 microfarad was charged to 80,000 volts. Good signals were exchanged with Cape Breton from the very first. At this period experiments were proceeding at Poldhu with new and powerful apparatus for generating continuous or semi-continuous electrical oscillations. These trials showed so great an improvement over the existing spark apparatus that it was decided to instal sets at Clifden and at Glace Bay. The new apparatus consists of a metal disc capable of rotation on high speed, nearly touched by two spheres or discharge balls, one on either side of the disc near its periphery. The disc and each ball are severally connected to a condenser having a self-induction coil in series with it. These three oscillatory circuits are connected together at the free ends. A high-tension continuous-current supply is introduced into these circuits at the two spark balls. Oscillations occur in the principal circuit—that is to say, the condenser and inductance connected to the disc, whenever a spark passes from either ball to the disc. If the disc were stationary, a flaring arc forms, and no oscillations are produced, but if the disc is in rapid motion, the formation of an arc is made impossible. The discharge is thus neither the mere oscillatory spark nor the arc. Efficient cooling of the metal parts is necessary, and the inductances in the various branches should be equal. Frequencies as high as 200,000 per second are easily reached. A disadvantage of producing perfectly continuous oscillations is that some method of interrupting the received waves is necessary at the receiving end to make the signals legible. The machine just described lends itself excellently, on the other hand, to the production of regularly broken streams of oscillations. A form now in use possesses a disc having a large number of knobs near the periphery at each side of the disc. The sparks on each side take place, of course, at the knobs. The result is that a signal dash is heard in receiving instruments as a sustained, clear, musical note. One great advantage of this is that the note enables the receiving operator to exercise now a discrimination between atmospheric discharges and true signals such as was never before possible. The lecturer, pasing to the story of the actual performance of these great stations, stated that from the date (October 17th, 1907) of establishment of a commercial service, the transoceanic intercommunication have never been interrupted for more than a few hours. Long interruptions had occurred in the land-line services—one, for instance, of 17 hours at Clifden. Snow had caused many delays at the Canadian end by breaking land-lines, but the aerial wires of a "wireless" station afford no footing for snow, because slightly warmed by the oscillatory currents, and thus have suffered nothing. Transmission was at first slow, but is now quicker, and in a few months duplicate and improved plant will be installed, such as will enable rapid sending to become the rule, and will enable the full power of the mechanical plant already in position to be brought into play. The messages are sent by day as well as by night. There are bad periods, of course. In the morning or in the evening, when the part of the atmosphere traversed is only partially illuminated, the signals may become weak or even disappear. Perhaps this is due to reflection or refraction of the waves at the boundary between illuminated and non-illuminated air. If all the space is illuminated or all is dark, signals are, as a rule, good. Thus it is probable that the morning and evening bad periods would not be noticeable in transmission from north to south or *vice versâ*. Signals are sometimes weakened by the intervention between the stations of storm areas. On the other hand, the signals are abnormally strong on some nights. The lecturer here commented on the animosity shown by certain sections of the technical press towards his efforts to establish successful Transatlantic wireless telegraphy. They appeared to exist, he said, not for encouraging all electrical advances, but for protecting the interests of the cable companies; their outbursts would prove very amusing reading some ten years hence. In conclusion, he thought wireless telegraphy would provide a cheaper transoceanic service than cable, but whether a better or worse one remained to be seen.

The New Telephone Charges.—In accordance with his promise a short time ago, the Postmaster-General on Wednesday last week, received a special deputation from the north of England, on the subject of the new telephone rates. The proceedings were private, and were carried through in a more or less informal conversational manner. The Postmaster-General was accompanied by Mr. H. Babington Smith, Secretary of the Post Office, Sir R. Hunter, Solicitor to the Post Office, and Mr. A. M. J. Ogilvie, of the telephone department. Representatives were present from the Chambers of Commerce at Manchester, Sheffield, Newcastle, Glasgow, Bradford, and Birmingham.

Workmen's Compensation.—Before Judge Shiress Will, K.C., in the Salford County Court last week, two cases of workmen's compensation were heard at the instance of the British Westinghouse Electric & Manufacturing Co. It appears that in both cases the employee had been injured whilst working on the company's premises at Trafford Park, and awards of £1 per week had been made. The company, however, had since found the employees in question light employment at a wage of £1, and the applications were now made to reduce the amount of the award for injuries. After hearing arguments, the judge reduced the compensation in one instance to 10s. per week, and in the other to 10s. 9d. per week, giving leave for the men to apply to the Court should the company cease to afford them light employment.

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ELECTRIC LIFTS

A PAPER dealing with the subject of electric lifts was read on March 11th by Mr. H. D. Wilkinson before the Association of Engineers-in-Charge at the St. Bride's Institute, London. The electric lift, the author said, is not a cheap machine as regards capital cost, but it possesses advantages in control, simplicity of working, lowness of running costs, and safety. It is now almost rare to find a new passenger lift put in with cage rope control, this type of control being almost entirely confined to goods lifts. The cage switch method of control has come in almost supremely for passenger lifts. Indeed, in very many passenger lifts the full automatic or push button lift is to be found. All electrically-driven lifts in this country have a worm and worm-wheel reduction between the motor and driving drum or sheave. Worm-wheels are now sometimes made with the rim and teeth of phosphor bronze affixed to a centre of cast-iron. The worm and worm shaft are invariably a solid forging of mild steel. The author then alluded to the double-screw system for lifts of heavy duty, by which thrust bearings are rendered unnecessary. A double worm—one right and one left-handed—on one shaft is cut from a solid steel forging, and these gear into two worm-wheels mounted above them, arranged tandem, and in mesh with each other.

For lifts doing heavy loads at slow speeds, such as those required for raising vehicles to upper floors, say of 1 ton capacity and over, the reduction is further increased by the use of spur gearing, in addition to the worm. The coupling flanges connecting the motor shaft to the worm shaft are especially large in diameter and wide in face to take the brake, which consists of cast-iron shoes, fitted with hard wood blocks, pulled up to the face by spiral steel springs. In some brakes a solenoid is so disposed that when excited by the supply current it exerts a force in opposition to the springs, thus releasing the brake.

The necessary operations which have to be provided for in the gear of all electric lifts are as follows :—For starting the lift : (1) the motor armature connections to be made for the required direction of the running; (2) the brake released, current applied to motor through starting resistance; (3) starting resistance gradually cut out; (4) accelerating winding (if any) cut out; (5) field weakened for speeding above normal (if required). For stopping the lift : (1) current cut-off motor, and brake applied; (2) starting resistance quickly cut in, with which operation the normal condition of the shunt field is restored and the acceleration coils (if any) are cut in again ready for a fresh start. Preceding the first of these operations in stopping, a slowing down device is introduced in some high-speed lifts before actual stopping takes place. The gear has also to provide for the following contingencies :—(1) It must not be possible to put current on the motor armature till all the starting resistance is in. (2) It must not be possible through any cause for the brake to remain off or the supply current to remain on the motor when the attendant has put over to the "off" or stopping position. (3) A mechanically-operated device, worked either by the drum motion or the cage, must be provided to automatically perform the attendant's duty in stopping the lift at the top and bottom floors should he fail to do so. (4) In passenger lifts or goods lifts in which an attendant may travel, there should be a further over-wind prevention device in the form of a knock-off switch cutting off the supply mains from the entire electric gear.

The author then took these conditions in order, considering in the first place the cage-switch system as applied to passenger lifts. The duty of the cage switch is simply to close pilot circuits exciting the up or down solenoids on the reversing switch. By this means only small wires are brought into the cage and small currents are dealt with. In systems in which the reversing switch is in the form of two separate switches independently operated by the respective solenoids, it is essential to provide an interlock so that both switches cannot act together. Where a single switch is employed for reversing, the solenoid plungers act upon the ends of a rocking-bar pulling the switch over one way or the other for the up or down direction. This arrangement, of course, requires no interlock. In lifts up to about 7½ h.p. a separate main switch is not necessary, the reversing switch being provided with suitable contact surfaces and quick break to take the arc. The reduction of arcing at main switch contacts is in some systems effected by splitting up the break into a number of parts. When this is done gun-metal or copper contacts, carrying 5 amps. per break on 400 volts, do not need magnetic blow-outs. On double-break switches carbon contacts are most suitable with magnetic blow-out on breaks exceeding 10 amps. at 400 volts. Copper in combination with carbon is suitable where the surfaces are of sufficient area. The starting rheostat is operated electrically in some systems, and by mechanical means in others. The electrically-operated starter has a simple solenoid action, in which the motion of the switch arm is regulated by means of a dashpot to the proper slow rate of movement required. The switch is generally drawn up to cut out resistance, and is given a quick fall to the bottom position by gravity. An objection to this form of rheostat is that the action takes place quite independently of the load on the motor. The lift may be much overloaded, but the solenoid starter takes no account of that and cuts out resistance at the same rate as under normal conditions. Consequently, before the armature has commenced to move it may be getting very nearly all the line voltage, and only the fuses remain for its protection.

The mechanically-operated rheostat is worked by the motion of the gear, so that resistance is not cut out until the motor begins to revolve. If the cage is so overloaded that the motor will not start, the armature current cannot exceed that definitely set to pass with the total resistance in circuit. The principle of gradually cutting out starting resistance is not so good as that of allowing an interval between each step for the motor to gain speed. The ideal condition for the motor is to wait on each resistance step until it has gained the speed and back E.M.F. corresponding to that step. In starters operated on this principle, the electromagnet is made of elongated shape, so as to present the pole face to a number of movable magnets which close the resistance units in succession. The magnets are at different distances from the pole face, and therefore are not all lifted together, but in succession, as and when the excitation of the magnet is augmented. This rises in proportion to the back electromotive force of the motor, thereby causing the units to be cut out at intervals depending on the rise of potential and speed of the motor. In another starter of this kind for lift work the resistance steps are operated by separate solenoids, which are set to come into action successively and automatically as the back E.M.F. of the motor rises. Three steps at most are required to bring the motor to normal speed instead of a number of contacts, as in the ordinary starter. In the event of an overload, the motor will not move on the first step, and succeeding steps will therefore not be cut out, thus protecting the armature from excessive currents.

In drum drives the means for prevention of overwinding is usually worked from the drum motion. This is usually a switch cutting-off current and releasing the brake in cage-switch systems. It is most important that nothing should delay the brake being immediately applied on the cessation of current. No passenger lift should be without two independent means for automatically arresting the motion of the cage in the event of its failing to stop at one or other of the terminal floors. In the drum system a slack-rope safety device is also necessary. The cage in descending may meet with some obstruction to check it. In that event, unless stopped, the motor would continue to wind up the balance weight and pay out slack rope on the cage side, a state of danger for the cage if it became released. The slack rope usually operates a weighted lever previously held out of action by the ropes when taut, which, thus freed, opens the safety switch, cuts off current, and applies the brake in the same way as is done by the limit switches. The slack rope device acts on both cage and balance weight ropes, so that in case the cage passed the first limit at the top floor, this stop would act when the balance weight touched the bottom. In a friction-drive lift the ultimate limit should be set to act before the cage or counterweight touches bottom. In this system of drive it is impossible to overwind should every automatic fail. If the cage should overrun the ultimate limit on the up journey, the balance weight will touch bottom, slacking the lifting rope slightly, so that it slips on the driving sheave. A similar action takes place if the cage touches the bottom buffers. The particular safety devices applicable to the drum drive are not applicable to the friction drive. But there are always three devices applicable, namely (1) the striking gear putting cage rope or cage switch to the off-position, (2) the knock-off tappet, and (3) the final safety action of slip in the driving sheave.

The author then drew particular attention to the amount of clearance or distance of overrun allowed between the top of cage suspension and the overhead gear when the cage is at the top, or between bottom of cage and bottom of well hole pit when the cage is in the lowest position. If possible there should be a clearance at top and bottom of not less distance than half the height of the cage. Coming now to the brake, it is most important that the excitation of the releasing solenoid should be instantly interrupted when the cage switch is put to the off position. If the excitation is derived from the main circuit, made alive by the main switch, the breaking of the latter will not interrupt it, as it will still be maintained by the voltage the motor continues to generate until stopped. Particular care is, therefore, necessary to see that the connections are made across the line, and suitably interrupted. The de-excitation of the brake magnet and the application of the brake should in no way be dependent upon the main switch or reversing switch coming off. The electrically-released brake is a very suitable one for electric lifts. If current fails or is intentionally shut down, the brake is applied. What would happen if the brake failed to be applied when the cage switch was put to the off position? The cage, either loaded descending or light ascending, will then continue its travel till the limit switch interrupts the main supply current. But under these conditions of out-of-balance load the motor is not being driven by the supply cur-

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rent, but by the load or balance weight, as the case may be. It is probably generating a voltage equal to the supply or a little higher, and the current is extremely small, perhaps even supplied from motor to line. Consequently, the interruption of the main circuit will not arrest the cage. With the friction drive the rope would slip on the driving sheave upon the bottoming of cage or balance weight. There would be a slight impact on the buffer springs, but no danger, and absolute protection against running into the overhead gear. With the drum drive the ultimate protection would be the slack rope device coming into action after bottoming of the cage or balance weight. The bottoming of the cage would have the same final effect as in the friction drive, but the bottoming of the balance weight would have a somewhat different effect. The rope on that side would become slack, and the slack rope device would come into action, cutting off the main supply. The driving power would also cease upon the balance weight bottoming, but there would be some momentum in the cage and winding gear to be expended before the system came to rest, and if the clearance was small the possibility of fouling the top gear would have to be taken into consideration.

A slowing down device coming into action some little distance before the cage reaches the top or bottom floors is very useful to lessen the momentum of the cage when it is approaching the limits, especially in high-speed passenger lifts running at over 250 ft. per minute. The slowing down device used by one maker, which also gives the half speed on a two-speed lift, is brought into action by the ordinary use of the cage switch, and automatically by a pilot limit switch opened by a striker on the cage. It is effected by an extra field connected across the brushes. The limit device of the same maker on being operated disconnects a pilot circuit, thus opening the main switch and cutting off the supply of current, at the same time short-circuiting the armature through a resistance, bringing it promptly to rest, even though the ordinary brake be out of adjustment. Another maker employs a slowing down device by the re-insertion of the starting resistance and a dead resistance across the armature.

The shunt wound motor is most suitable for lift work on account of its approximately constant speed under varying loads. But when starting on load there is considerable weakening of the field owing to armature reaction with the heavy starting current. It is therefore a very great assistance to starting to have a series winding in addition to the shunt, which prevents the field strength falling in the first few seconds. The series winding should give about 15 per cent. extra excitation, and should be short-circuited automatically by the controller as soon as the starting resistance is all out. This prevents any check upon the proper normal speed of the motor. The shunt field should in every case be such as will give full excitation, the series excitation being additional to this. Series motors are not suitable for passenger lifts owing to the variation in speed with load, and the liability to reach an excessive speed on light loads. These motors are, however, very suitable for crane and hoisting work, where it is an advantage to be able to raise small loads at high speed, while heavy loads can be raised equally well at a slow speed. This advantage outweighs the loss of energy in regulation in the form of variable resistance in circuit with the motor. With regard to the rating of motors, the author had found that motors were quite satisfactory for busy lifts that will test at full load for one hour continuously with a maximum rise of 70° F., and stand an overload of 100 per cent. for one minute without flashing over or series sparking.

In the course of his paper, the author also referred to the uselessness of the no-voltage release for lift-work, and to the advisability of interlocking the gates so that the motor could not be started until all gates were closed, and further so that a gate could not be opened until the cage was level with the floor.

The Discussion was opened by the Chairman, Mr. E. G. Rivers (Chief Engineer of His Majesty's Office of Works), who thought, with the author, that in general there was far too little clearance allowed in both top and bottom positions between the cage and the fixed gear or girders. He also agreed with the author's recommendation of the insertion of a slowing-down device before the end of travel is reached. Mr. F. Broadbent said that owing to the low efficiency of the worm-gear, which was less than 50 per cent. if the gear was self-sustaining, there was a tendency to use spur-gearing with two brakes. Mr. Watkinson had noticed that in some of the slides of gears shown by the author, the worm was at the top; this would mean that the worm wheel makes half a revolution before any grease gets to the worm, whereas if the worm were below, it was greased almost at once. He thought it was a mistake to consider that a worm-gear was self-sustaining. A ball governor operating a brake was, in his opinion, a suitable safety device to use with lifts. Mr. J. T. Mould thought that the coils of brake magnets should be compound wound, as this admitted of a smaller shunt coil and more certain action. To prevent the cage from attaining an excessive speed in case of failure of supply, he thought a ball governor or an excess voltage relay should be used to actuate a brake. The method of inserting resistance in series with the armature to reduce the speed, would, in his opinion, be unsatisfactory, as, if the motor were generating, this would increase the speed. With regard to gate switches, if the main switch were a solenoid switch, this solenoid could be put in series with the gate switches, and then the solenoid would not operate until the gates were all closed.

To show the superiority of the electric lift as regards working cost, Mr. A. Day gave the following figures for the comparative working costs of two lifts under similar conditions of travel, load, &c. For the electric lift, the costs amounted to £3 18s. 6d. for one quarter, and for the hydraulic lift £18 10s. for the same quarter. Mr. Stevens thought that a properly designed worm gear should be self-sustaining, and that any form of non-self-sustaining gear was unsatisfactory. With regard to the wear of bearings, he thought that large surface cast-iron bearings well provided with oiling devices were better than small surface phosphor-bronze bearings. He was a strong advocate of the friction or Vee drive, as, directly the tension on the cables was released, the drive ceased. He thoroughly agreed with the author as to the uselessness of the no-voltage release in a great many cases. Mr. Wilkinson replied, and answered a few questions put by some of the speakers.

"Credenda" Conduits.—A recent visit to the works of the Credenda Conduits Co., of Scholefield Street, Birmingham, has convinced us of the fact that this newly-established branch of Tubes (Ltd.) has made an energetic start, and is in a position to supply all sizes of tubes and fittings for immediate delivery. Although the company supplies a well-finished conduit of both light and heavy gauge for socket joints, and a "continuity" nipple, the speciality of the Credenda Company is a solid-drawn weldless tube of the highest quality and finish for screwed work. The tube is made at the works of the parent company, Tubes (Ltd.), but the screwing and enamelling is carried out at the Credenda Co.'s works, where the fittings are also manufactured. Following the usual practice, the tubes are dipped in the enamel, which is kept at a suitable temperature, and after they have been allowed to drain off, they are stoved. The surface obtained is an excellent one; the finished tube appears as smooth and bright as a bicycle tube, and the enamel does not crack, even when the tube is sharply bent. The screw gauge of the Engineering Standards Committee is employed. All sizes of tube from ½ in. to 2 in. outside diameter are manufactured and stocked. For the couplings, elbows, and bends, the same solid-drawn tube is used; other fittings are made of malleable castings. A useful and well-got-up catalogue has been prepared, in which almost every conceivable fitting is included, and full dimensions are given. The company has now also taken up the manufacture of watertight fittings to Admiralty specification.

Private Telephone Lines.—The Master of the Rolls, Lord Justice Fletcher Moulton, and Lord Justice Buckley, sitting in the Appeal Court on Wednesday, had before them an appeal by the National Telephone Co. against a decision of Mr. Justice Swinfen Eady in the Chancery Division of the High Court, as to whether the company was bound to pay royalties in respect of private telephone lines. We reported the previous action in Electrical Engineering, Vol. I. p. 567. The point in dispute was as to whether private lines came within the exemptions of Section 4 of the Telegraph Act of 1869, where the line was used other than in connection with the business premises and private residence of a subscriber. Mr. Justice Swinfen Eady held that they did not, and that royalties must be paid on such lines. Sir Robert Finlay, K.C., Mr. Danckwerts, K.C., and Mr. H. H. Gaine were for the appellants, and the Attorney-General, the Solicitor-General, and Mr. Casserley appeared for the Crown. Sir Robert Finlay, for the company, contended that the provision stating "that no charge was to be made" showed that it was never contemplated that private wires should be confined to connecting different parts of the premises of the same occupier. He admitted, however, that if in the case of theatrical agents the apparatus were used for the purpose of putting hotel people in communication direct with the theatre that would not be covered by the exception. The Attorney-General, in supporting the judgment of Mr. Justice Swinfen Eady, contended that these private wires must be used strictly for the private business of the lessee. To bring the wire within the exception the dominant factor was that the line was to be for the private use of the lessee. The moment the line was used for the private use of two or more persons they got outside the exception. Lord Justice Buckley said he understood the learned counsel's argument to be that if he telephoned to his servant to send him a pair of boots it came within the exception, but if he telephoned to his bootmaker to make him a pair of boots that did not come within the exception. The Attorney-General replied that that was his contention. The Master of the Rolls inquired of Sir Robert Finlay what he would say if the Court held that the proper construction of the company's licence was such as to include private wires when used only by the subscriber between his works and residence, for instance. Sir Robert Finlay said the Crown had never taken this view before, and he would like to consider it. The case was then adjourned.

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STEAM TURBINES

A PAPER was read on the subject of steam turbine engineering by Mr. S. L. Pearce, Chief Electrical Engineer to the Manchester Corporation, before the Manchester Association of Engineers, on March 7th. The preliminary part of the Paper dealt briefly with some of the elementary principles which form the basis of turbine design, and passed on to consider the work of early inventors and the development of the many types of the modern steam turbine. Descriptions of some of the leading examples of the different types were given, commencing with the De Laval and Riedler-Stumpf types as examples of the simple impulse turbine. The next type considered was the compound impulse type. In turbines which may be said to be compounded for pressure, the pressure drops by as many stages as there are revolving wheels, successive expansions of the steam taking place in the fixed diaphragms through which it passes from admission to exhaust. The two best known forms of this type, the Rateau and Zoelly turbines, were dealt with at some length, and an American design, the Hamilton-Holzwarth, was also referred to as falling within this class. In the type of impulse turbine compounded for velocity, the whole of the initial pressure of the steam is expanded and converted into kinetic energy in the first set of fixed guide vanes or nozzles. The high velocity, however, instead of being taken up by one single wheel, is exhausted in stages by passing through several alternatively moving and fixed vanes. The number of stages will again depend on the admission and exhaust pressure, and the best pre-determined velocity of steam for each stage; but in the case of the turbine "compounded for velocity," the total number will be remarkably small as compared with the previous type. The compounding of the Riedler-Stumpf turbine practically brings this turbine under this classification.

In the "Electra" turbine, a single impulse wheel is used as in the De Laval type, but relatively low speed is obtained by utilising successive impingements of the steam against the one wheel. The peripheral speed of the wheel is from 260 to 330 ft. per sec.

In the next type of turbine, which is compounded both for pressure and velocity, each stage consists of a set of expanding nozzles, and two, or more, rows of moving blades alternating with fixed blades. Between each stage is fixed a diaphragm with expanding nozzles. The total expansion of the steam therefore takes place in stages in the successive expanding nozzles, the kinetic energy developed at each expansion being absorbed as it passes through the successive moving and fixed blades of each stage.

The best known example of this class is the Curtis turbine, both in its vertical form as made in America and by the British Thomson-Houston Co. in this country, and in its modified horizontal form by the A. E. G. Co. in Germany.

The action of the Curtis is as follows:—Steam leaving the first set of expanding nozzles is directed against the first set of revolving blades, passing outwards through the row of fixed blades it impinges against the second row of revolving blades, finally emerging in the space at the end of the first *stage*. Entering the second set of expanding nozzles in the fixed diaphragm a further expansion of the steam takes place prior to the second stage cycle of operations, and so on to the end of the fourth or fifth stage.

In the second general class, the re-action turbine, there are practically no examples of a really pure reaction turbine, as most turbines commonly known as reaction machines are, in reality, combined impulse and reaction turbines. The chief example is, of course, the Parsons' turbine, in which stationary deflecting or guide vanes direct the steam against the blades of the running wheel. In the stationary vanes the whole of the energy of the steam is not converted into kinetic energy, so that on emerging from the guide vanes the energy of the steam is only partially kinetic. That part which is kinetic is utilised in imparting energy to the moving vanes as in an ordinary impulse turbine. The portion of the steam emerging from the stationary vanes which is not kinetic expands in the moving vanes, and by this process of expansion further helps to drive them forward. There is therefore a combined effort —partly impulse, partly reactive. Mr. Pearce referred to the various modifications which this turbine has undergone from time to time, and some of the troubles which were experienced with the early patterns. The differences in the designs of various makers who hold licenses under the Parsons' patents were indicated, including the retention of the double flow principle, discarded by Mr. Parsons in 1890 in the turbines of the Westinghouse Co.

In a comparison of the various types described, of which the De Laval, Zoelly, Curtis, and Parsons types may be taken as representative, it was pointed out that for electrical or any other work requiring large units, the former need not be considered seriously.

Taking, then, the latter three, it may be stated that as regards the first two an efficiency (made up of nozzles and vane efficiency) of 70 per cent. may be attained in practice, although 65 per cent. is more likely to be the actual figure, with a possible efficiency of some 80 per cent. The chief losses are condensation of steam, leakage from stage to stage, disc friction, eddy currents, and vane friction. The Curtis may have a slight advantage over the Zoelly in that whenever a leakage from stage to stage does take place, the losses are collected at the end of the main stages, and the steam may be usefully expanded in the following stages. On the other hand, leakage troubles with the Curtis may become as serious as they are with the Parsons type unless there is a steam-tight joint between the stages. With the Parsons type a possible efficiency of 83 per cent. may be reached, but in practice 65 per cent. is rarely exceeded, owing to the serious "leakage" factor. From the point of possible efficiency therefore the Parsons type stands well, but it is thought that in actual conditions there is not sufficient difference to warrant a decided opinion on the respective types.

As regards mechanical construction the balance of advantages may be said to be in favour of the impulse type. On the score of steam consumption the Parsons type has little to fear.

The chief drawback attached to the Parsons type of turbine is a mechanical one—viz., the risk or alleged risk of blade stripping. Blade stripping may result from four causes:—Inrush of water at starting up; distortion of the shaft, due to variable superheat, and consequent unequal expansion; variable vacuum, due to inefficiently designed condensing plant, and whipping of the rotor shaft, due to the extreme length. With properly arranged steam-piping and adequate trapping arrangements, inrush of water may be entirely avoided.

Apart from the economics of the question, it is not desirable to carry an excessive amount of superheat on the Parsons type of turbine. The author found on his visit to the Continent that almost every accident that had happened was traceable to the variableness of the superheat where excessive superheat was used. A moderate superheat of say not exceeding 125° F., should preferably be used with the Parsons type of turbine.

Variable vacuum should not occur with properly designed condensing plants. Unfortunately there have been some bad examples of this, resulting in variable vacua, and consequent excessive end thrusts on the shaft, causing fouling of the blades in an end-on direction. Whipping of the shaft is almost entirely unknown now, especially in the Willans type, for the reason that they have been able to shorten the rotor shaft.

The author then made a brief comparison between turbines and piston engines. He pointed out that the losses in the piston engine due to initial condensation and valve leakage were absent in the turbine, and that turbines had a decided advantage owing to their ability to expand the steam almost entirely down to condenser pressure. The turbine scores over the reciprocating engines also in that the frictional losses are reduced to a minimum by the absence of the many bearings

Regarding the losses incidental to turbines and not present in steam engines, the expansion of steam behind a piston is regular and smooth, while the expansion of the steam in a turbine used to give it kinetic energy with which to act on impulse blades is the reverse of a smooth and regular process. There is, therefore, a loss due to friction and eddies. There is, further, the loss incurred in the nozzles and guide vanes. Friction and eddies will produce heat, but at the same time they lower the efficiency of the turbine. The greater part of this heat may be given up to the steam, but the loss resulting from the friction and eddies remains, and constitutes the chief losses in the steam turbine.

The use of superheated steam improves both types of prime movers. In the case of a piston engine as a means of reducing initial condensation, in the case of the turbine as a means of reducing the fluid friction.

The following tables bring out the difference effected in such cases:—

Turbines.

Degrees of superheat, F.	13	50	70	100	150	200	260
Per cent. reduction of steam consumption...	6·1	8·0	9·5	14·0	19·0	23·0	24·5

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Piston Engines.

Degrees of superheat, F.—	30	40	50	100	150	225
Per cent. reduction of steam consumption	7·8	8·65	12·0	20·5	13·0	33·1

Other points, some of them of a minor character, others important, which show in favour of the turbine as against the piston engine may be summarised as follows:—Less oil consumption, less staff required, less wear and tear, less housing space, floor space, and height, less cost of foundations, and less vibration.

The square feet of floor space per kw. for sets of 3,000 kw. capacity and over, may be put down at 0·35 square feet for piston engines, and 0·1 square feet for turbines. As a practical example, the author has been able to lay out the extension engine-room at Stuart Street for four times the capacity in turbine plant that would have been available for reciprocating plant; and by the utilisation of boiler units capable of evaporating 40,000 lb. per hour, the boiler-house lay-out can be made to keep pace with the engine-room.

Comparing the efficiency of the turbine with the piston engine from the thermo-dynamic point of view, it may be frankly stated that the latter will show to be the more efficient. The thermo-dynamic efficiency of the non-condensing engine is generally taken to be some 10 to 15 per cent. higher than the condensing engine, on account of the practicability of the more complete expansion of the steam in the former case. The difference is not present in the case of a non-condensing turbine. As a matter of fact, its efficiency is practically independent of the pressure range—at any rate in the Parsons type. From this it is inferred that, considered as a *heat engine* only, the turbine is inferior to the extent of some 15 per cent. From this, unbiased writers on the subject have inferred that were it not for the fact that the efficiency of a piston engine falls off as the back pressure increases, a practical disadvantage which results from its inability to expand down to very low pressure for the reasons previously given, the turbine would not have made the strides it has done. This is quite apart from the equally important question of initial outlay, which to the engineer responsible for large electrical undertakings has so vital an influence on the costs at which energy can be produced.

The author does not consider that any advantage can be shown for the steam turbine as against the piston engine for sizes of 500 kw. and under. On the other hand, given ample supplies of cooling water, for capacities above this figure, and especially for the larger units of 3,000 -5,000 kw., the turbine is pre-eminently the prime mover to be adopted for electrical work in our present state of engineering knowledge.

In the concluding portion of the Paper some notes were given on marine turbines, and appendices were added containing tables of particulars of the principal turbine installations from 3,000 kw. and upwards, and some historical notes on the development of the steam turbine. The following table on estimated comparative costs of running of turbine and reciprocating plant of 1,800 kw. capacity was given:—

	Turbine.	Reciprocating.
Capacity	1,800 kw.	1,800 kw.
Cost per B.O.T. unit—Oil	·0018	·006
,, ,, ,, ...Brushes	·0062	·00005
Repairs and maintenance per annum per set	£126	£162

Institution of Electrical Engineers.—The following is the result of the ballot for new members at the Institution on Thursday:—*Members:* T. Boyden, C. Koettgen, F. L. McKeever. *Associate Members:* W. W. Alston, E. J. Cox, J. H. Crossley, G. K Field, F. R. Marsh, S. W. Melsom, W. H. Perrow, T. H. Relton, C. R. Shaw, W. Winkworth. *Associates:* G. A. S. Atkinson, W. Frain, Captain A. Gardiner, R.E.

Electricity in Horticulture.—According to the *Western Electrician* (Chicago) a gardener named H. F. Hughart, of Minneapolis has been making some interesting tests on the effects of electric light on the growth of lettuce. Recently Mr. Hughart planted a bed of lettuce plants 2 in. high. At one end of the bed he placed an arc light, which was turned on each day at sunset, one-half the bed being shielded from the light by a curtain. A subsequent investigation was made, and it was found that in the dark bed the lettuce was 7½ in. high, while that under the electric light was 8¾ in. The heads under the influence of the electric light weighed 40 per cent. more than those grown with only the sun's rays for light. It is reported that classes in botany at the Minnesota State University are interested in the experiment, and tests will be made with other plants.

ELECTRIC SIGNS

THE Kevan Signs Co. have some attractive electric advertising signs on view in their showrooms in Charing Cross Road. The simplest of these consist of a concave metal reflector faced with a circular glass cover, on which is the advertisement. A single 16 c.p. lamp is sufficient even for a 24 in. diameter sign, and this may be provided with an automatic thermal "blinker," if necessary. The reflectors are made of thin hardened steel sheet, with a highly polished surface of nickel. The glass used for the cover has a granulated milky appearance, and has a rough surface inside, which has the effect of diffusing the light to such a degree that an equal illumination all over the sign is obtained. The high reflecting properties of the glass also cause the sign to show up well in the daytime. For instance, a letter or words cut out on a coloured metal sheet show up white in the daytime, but can be made to show up any colour at night by placing a coloured screen behind the white glass. Rectangular signs constructed in a similar way to the above, and containing from 3 to 12 lamps, according to the size of the sign, can also be obtained. One form of a rectangular sign for the interior of a window is left open underneath, so that the lamps inside can assist in the general lighting of the window. The speciality of the Kevan Company is their "Movable" sign, by which some beautiful colour effects are obtained. The body of this sign is well provided with reflectors, and the concave cover is of plain ground glass. The letter, word, or other advertisement, is cut out in metal, and suspended behind the glass cover. The single lamp in the interior is surrounded by a rotating cylinder, the wall of which consists of a mass of coloured transparent pieces of gelatine or similar material. Other devices, such as pieces of perforated metal, are also attached to the cylinder to obtain varied effects. The coloured light is partly projected direct on to the ground glass cover, and partly reflected from the mirrors in the body of the sign. By a very careful arrangement of the coloured transparent material and the other devices, a wonderful cloud-like moving effect, and a beautiful blending of colours is obtained, which cannot fail to attract attention. The cylinder is rotated either by means of a clock-work spring motor or an electric motor. Some signs of this description have recently been supplied by the Kevan Company to the Great Western Railway. In one of these the outline of a ship is silhouetted against a suitably coloured moving cloud-like background, and a very striking effect is obtained. Some of these larger signs are provided with 25 c.p. lamps, but only a single lamp is necessary, owing to the diffusing property of the glass used, and the careful arrangement of the reflectors.

X-Ray Dermatitis.—It is stated that Mr. T. J. Oliver, who for fifteen years has been in charge of the electrical department at the Leeds General Infirmary, has become a victim to X-Ray dermatitis, it having been found necessary to amputate one of his arms.

Hire of a Generating Set.—On Friday last, in the King's Bench Division, Mr. Justice Darling and a special jury had before them an action by Messrs. Williams & Sons against the Beckenham Urban District Council to recover a sum of £759, the balance of an account delivered for goods sold and delivered, and the hire of generating sets from October, 1906, to April, 1907, at £125 a month. Defendants had an option to purchase, but did not exercise that right. Defendants counter-claimed for £417, on the ground of insufficient output of the machinery. A verdict was entered for the plaintiffs for £500 and costs.

The British Association.—The Council of the British Association for the Advancement of Science has nominated Professor J. J. Thomson, F.R.S., Cavendish Professor of Experimental Physics in the University of Cambridge, to be president of the meeting of the Association which is to be held at Winnipeg next year. The investigations carried on by Professor Thomson in the Cavendish Laboratory, and by the distinguished men of science who first worked under him and received inspiration from his researches, laid the foundation for the new views held by chemists and physicists as to the electronic constitution of matter and the remarkable properties of radio-active substances. In 1894 Professor Thomson was awarded one of the royal medals of the Royal Society, and to this was added in 1902 the Hughes medal, in recognition of his contributions to the advancement of electrical science, especially in connection with the phenomena of electric discharge through rarefied gases. Two years ago he was the recipient of the Nobel Prize for Physics. It is understood that provision will be made by the Canadian Government in the estimates for the coming financial year, for a grant of twenty-five thousand dollars (£5,000) by the Dominion Parliament towards the expenses of the Association's visit to Winnipeg. The City of Winnipeg itself proposes to make a grant of five thousand dollars (£1,000). The week of the meeting will probably be from August 25th to September 1st, 1909.

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EXTENSIONS OF GENERATING PLANT AT WOLVERHAMPTON

New Turbo-Generators for Power Supply

IT is only natural that the general appreciation of the advantages of electrical works driving and other applications of electrical power which have been so marked a feature of industrial progress during recent years should show themselves in such an important manufacturing town as Wolverhampton by a considerable increase in the power-load. That this has been so is evident from the extension of plant intended primarily for power supply, which were formally inaugurated on Monday evening at the Corporation Electricity Works. The complete scheme for dealing with the increased power demand involves the laying of a considerable length of special new power mains, as well as the provision of 2,000 kw. extra plant capacity in the station. The question of power supply has been dealt with quite separately from the existing lighting and tramway system, and although the whole of the older plant is continuous current, alternating-current distribution at 6,000 volts was decided upon for the new power scheme, and three-phase machines were for the first time introduced into the station.

Before describing the new plant in detail it is interesting to consider a few figures showing the growth of the power-load during the last five years. The following table gives details of the motors connected, and shows also how the load-factor has varied and the generating costs have steadily come down:—

Year ended March 31st.	B.H.P. of motors connected.	Load factor per cent.	Generating costs (not including distribution and management, &c.) in pence per unit.
1904	500	17·3	·811
1905	660	20·5	·561
1906	873	22·0	·506
1907	1,539	21·3	·477
Dec. 31, 1907	1,960	20·5	·471

The last line only gives the state of affairs at the end of 1907, so that by the time the three remaining months of the financial year are complete, the change will be even more marked. The power-load even now has overtaken the traction-load, as is shown by the fact that for the nine months in question the units sold for power numbered 1,298,040 as against 1,160,152 for traction.

An entirely new system of three-phase power mains is being laid. In the case of one of the largest prospective consumers, Messrs. Bayliss, Jones & Bayliss, a special pair of 6,000-volt three-phase feeders has already been laid, and a converter station of a capacity of about 1,000 kw. will be established at their works. A new power ring main will serve the works of Messrs. Thomas Parker, Ltd., and several other large power consumers. A sub-station containing rotary converters will be put down on Messrs. Parker's premises, which, in addition, to serving the works, will also supply a portion of the ordinary network in that district. Amongst other new 6,000-volt power mains will be one to the Chillington Tool Co.'s works.

It would be of interest, if space permitted, to trace the alterations in the system of supply which have taken place from time to time since the opening of the station in 1895 by the late Lord Kelvin. The method of distribution originally employed was what was at one time known as the "Oxford" system, with continuous-current generation at 2,000 volts and running machinery and batteries in the transforming sub-stations. This, however, gave place later to an ordinary three-wire system, with 440 to 460 volts between the outers, and at the present time only one of the original 140 kw. 2,000-volt machines is to be found in the station, and this is now used for arc lighting.

As will be seen from the plan in Fig. 1, the new generating plant, which consists of two Willans-E.C.C. 1,000 kw. turbo-alternators, with condensing plant and boilers, is housed in a prolongation of the east end of the boiler- and the engine-rooms, about 58 ft. in length. The actual extensions carried out only form part of the total projected scheme, the scope of which can be seen from the site plan in Fig. 2, where the positions of the six further turbo-generators and fourteen further boilers projected are shown dotted. The details of these future developments are, of course, more or less vague at present, but as far as has been decided, the units are to be of 2,000 kw. capacity each. In looking at this plan, one cannot help being struck by the fact that the area shown occupied by the turbine plant of a capacity of 14,000 kw. complete with boilers is little, if any, more than that of the original engine- and boiler-house containing plant of 3,230 kw. capacity driven by reciprocating engines. The new plant comprises, in addition to these turbo-generators, boilers, &c., and H.T. switchboard, a pair of converter sets placed at the other end of the old engine-room, which, as further explained hereafter, form the electrical connecting link between the new and the old plant.

A section of through the new part of the engine- and boiler-rooms, showing the relative positions of the new boilers, generating sets, condensing plant, exciting sets, and switchboard, is given in Fig. 3, and the appearance of the turbo-alternators themselves is shown in Fig 4. Each set has a full rated output of 1,000 kw. at 6,600 volts 50 cycles, with a power-factor of 0·85 when running at a speed of 1,500 r.p.m., and is also guaranteed to withstand an overload of 50 per cent. for two hours without bye-passing steam to the low-pressure section of the turbine. The guarantees of steam consumption, all of which, with the exception of some of the figures for overloads, have been realised in tests, were as follows—

Temperature of condensing water.	Steam consumption in lb. per kw. hour (saturated steam). Half-load.	Full load.	50 % overload.
71° F.	19·6	17·13	18·05
74° F.	19·8	17·3	18·2
80° F.	20·0	17·55	18·4
85° F.	20·6	18·07	18·8

The efficiencies guaranteed for the alternators are given below:—

Power factor.	Full load.	50 % overload.
1·00	89½ %	94 %
0·85	89 %	92¼ %

We understand from the manufacturers, however, that somewhat higher efficiencies have been shown on actual test, when the following figures were obtained on non-inductive load:—

Half-load.	Three-quarter load.	Full load.	50 % overload.
89·5 %	92 %	94 %	95 %

The turbines are of the standard Willans-Parsons type, the construction of which was described at some length in Electrical Engineering, Vol. I., p. 959, and are of similar design to the machines illustrated in the article in question, except for their smaller size and the fact that it has not been thought necessary to fit the electric gear to the governor for altering the speed from the switchboard. The governors are guaranteed to keep the speed constant within 1½ per cent. up to 50 per cent. overload.

The alternators, which were made by the Electric Construction Company, are of interest as representing

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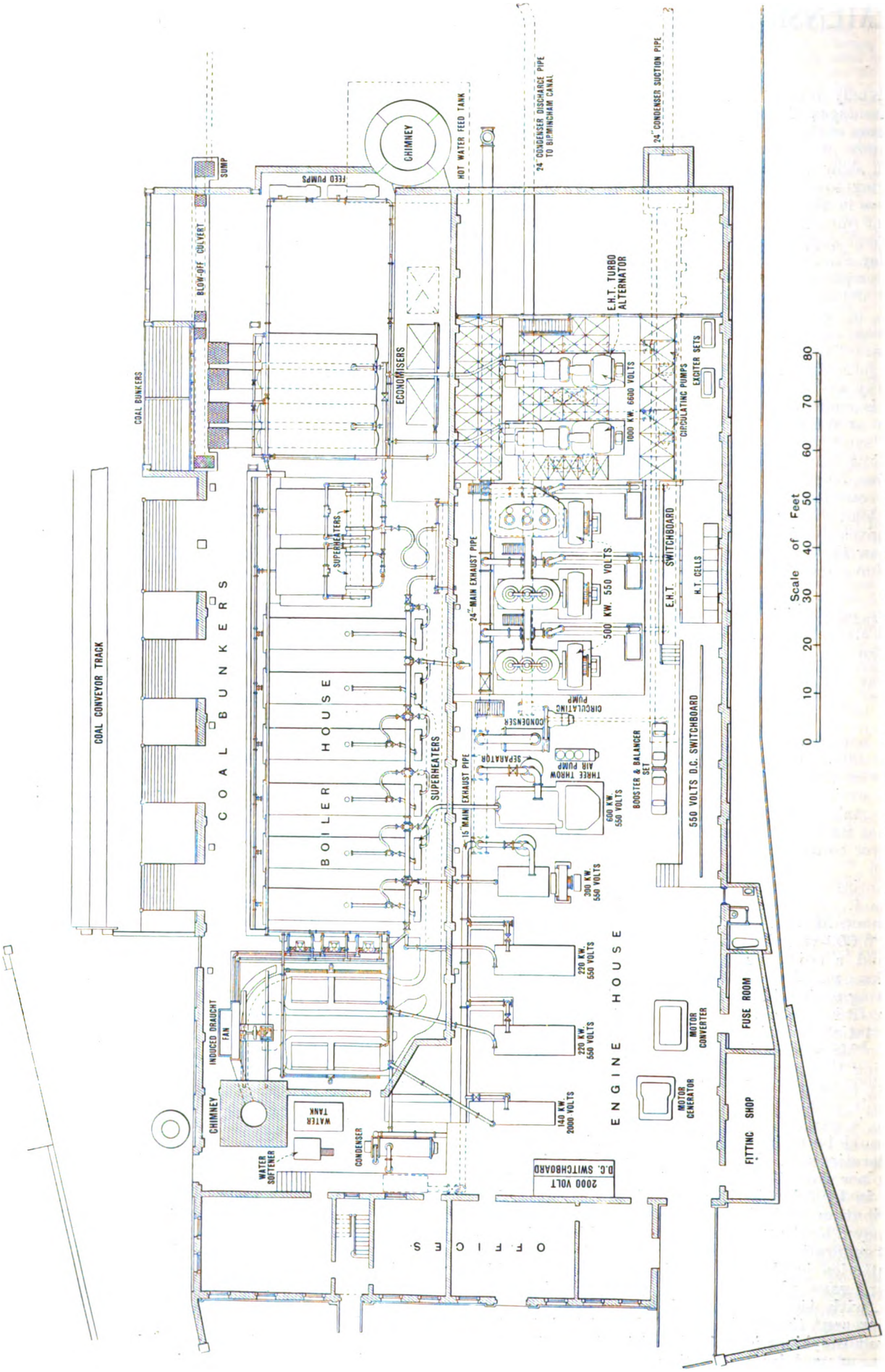


FIG. 1.—PLAN OF GENERATING STATION, SHOWING NEW EXTENSIONS.

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a design which has not been seen before, as they are the first turbo-alternators to be delivered by this firm. The main point of difference from some other designs is the construction of the rotor, in which solidity of construction, simplicity, and smoothness of surface to avoid unnecessary windage resistance appear to have been the principal objects kept in view.

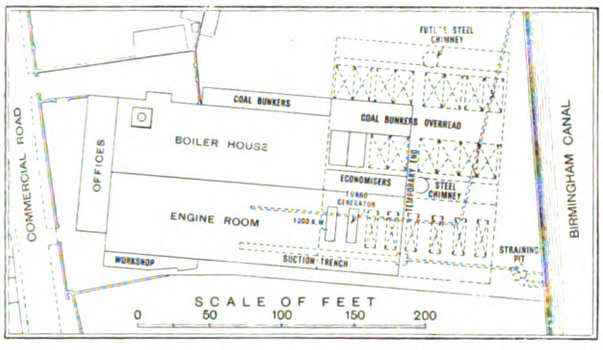


Fig. 2.—Sketch Plan Showing Proposed Future Extensions of Electricity Works.

The rotor is of the cylindrical smooth-core type, with distributed windings in open slots, and the actual core consists of a solid block of steel weighing about 4 tons. A special feature of the design is that the ordinary Continental practice of radial slots is not adopted, the slots being sunk in the direction shown in the sectional drawing given in Fig. 5. One of the advantages of this method is that the former wound coil can be placed directly in the parallel slots without disturbing the form of the coil. The winding in each slot is sub-divided into two or three sections, according to the depth of the slot, and each section is kept in position by phosphor-bronze wedges. The end connections of the field coils are secured by strong steel plates and phosphor-bronze keys, as shown in the drawing, and each element is thus supported individually. The field winding consists of flat strip wound on edge and compressed after having been placed in position.

This arrangement is not only particularly strong mechanically, but is capable of being very accurately balanced, and when once balanced there is little possibility of the distribution of weight altering.

The machine is protected by the strong cast-iron frame of the stator. This is provided with air suction and delivery openings, and cold air is drawn in at the base and ends of the machine and discharged from chimney-shaped openings at the top. This scheme of ventilation is very favourable to noiseless running.

The stator winding does not differ materially from other designs of turbo-alternator, but it should be said that the arrangement of the end connections is particularly neat, and at the same time great care has been taken to secure them rigidly in place, a question to which too little attention was paid in the early days of high-speed machinery. Each coil is held in position by two strong brass brackets, as shown in Fig. 5. Speaking generally, the machines strike us as compact for their output, and the attention that has been paid to their balancing is shown by their remarkably quiet running and freedom from vibration. It is evident that although they may be the first machines of their make to be run in a generating station, they are in no way to be classed as experimental.

The condensing plant was also supplied by Messrs. Willans & Robinson, and, as shown in Figs. 3 and 4, each set has its own condenser immediately beneath it. In contradistinction to the method sometimes adopted of coupling up the condenser rigidly to the exhaust flange of the turbine, and mounting the condenser body on springs to take up expansion and contraction, the condenser is mounted rigidly on its foundations, and an extensible "concertina" joint is placed between the turbine and condenser. This joint can just be distinguished in Fig. 4. The air pumps are of the three-throw Edwards type, gear-driven by continuous-current motors of the enclosed ventilated type, running off the 460-volt 'bus-bars. These motors were supplied by Messrs. Thomas Parker, Ltd

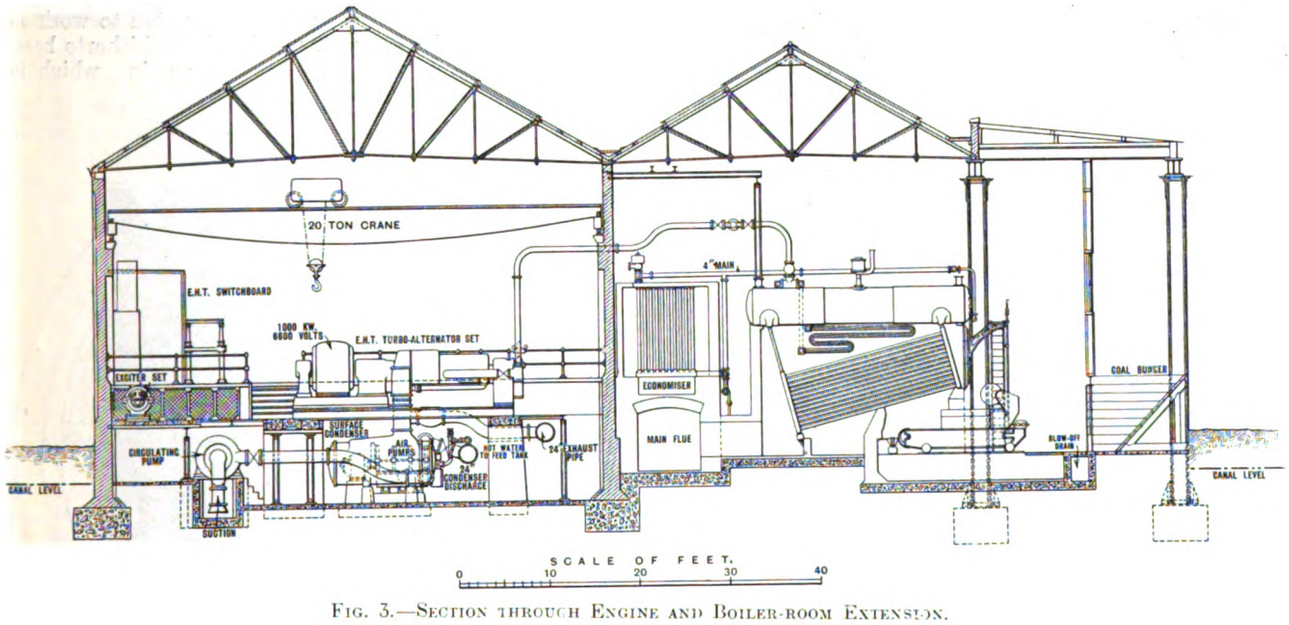


Fig. 3.—Section through Engine and Boiler-room Extension.

The position of the circulating pumps is shown in Fig. 3. They are of the Rees Roturbo type, of a capacity of 200,000 gallons per hour, supplied by Messrs. Thomas Parker, Ltd., and driven directly by their continuous-current motors. This form of pump, which is also in use in some of the other condensing plant in the station, is of rather different design from the ordinary pattern of centrifugal pump, and is calculated to obtain good efficiency over a much large range of volume and head when driven at a constant speed. It is claimed to be a true "turbine" pump, in that the rotor has a strong turbine effect due to the water passing through it. This effect is obtained by making the rotor of large

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capacity for storing water, which is maintained by rotation at a practically constant internal pressure independent of the external head. By an application of the "Venturi" law this pressure is transformed and utilised with but little loss, and instead of throwing away the surplus speed energy of the water discharged, when the head of delivery is reduced, this energy is extracted from the water before it leaves the pump casing. Condensing water is obtained from the adjoining canal, so that cooling towers or ponds are not required.

A view of the new boilers is given in Fig. 6, and details of their arrangement are seen in Fig. 3. They are two in number, and are of Messrs. Babcock & Wilcox's standard water-tube type, with internal superheaters and without thermal storage vessels, and they are fitted with the last pattern of this firm's chain-grate stoker. The evaporative capacity of each boiler is 20,000 lb. of water per hour, and they are constructed to work at a pressure of 160 lb. per sq. in., but have hitherto been worked at a pressure of 135 lb. per sq. in., which is the pressure of the older boilers to which their steam range is interconnected in the manner shown in Fig. 1. It has thus been possible for these boilers, which have been erected for some months, to supply steam to the

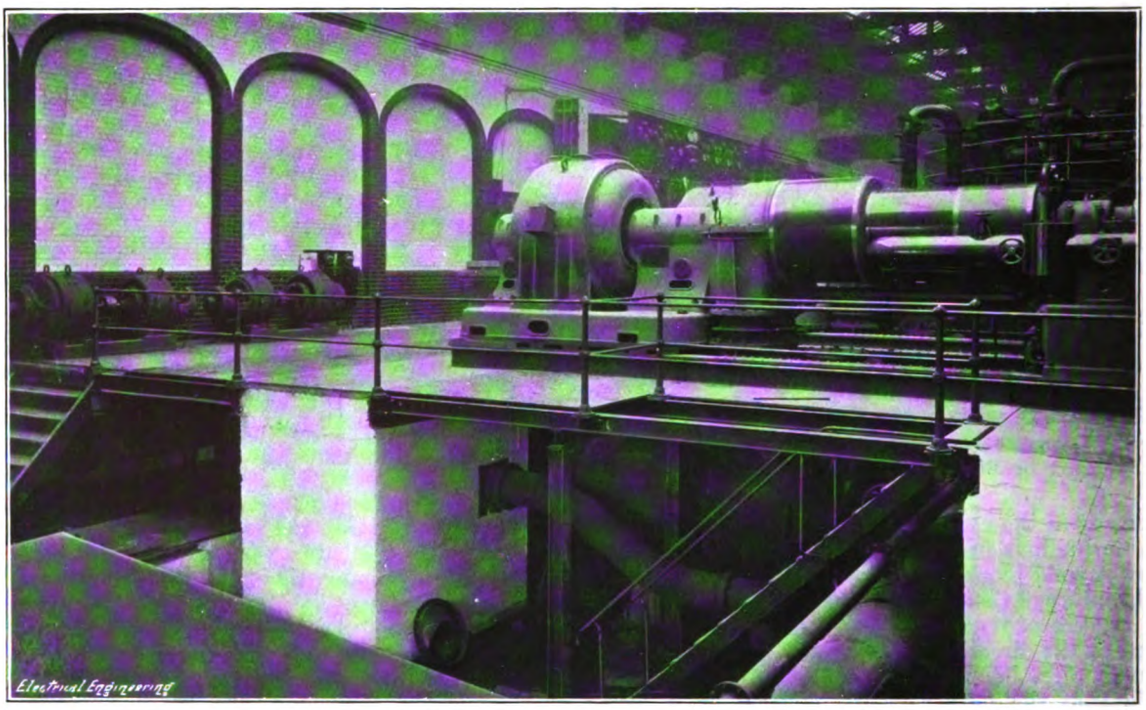


FIG. 4.—WILLANS-E.C.C. 1,000-KW. TURBO-ALTERNATORS AND MOTOR-DRIVEN EXCITERS.

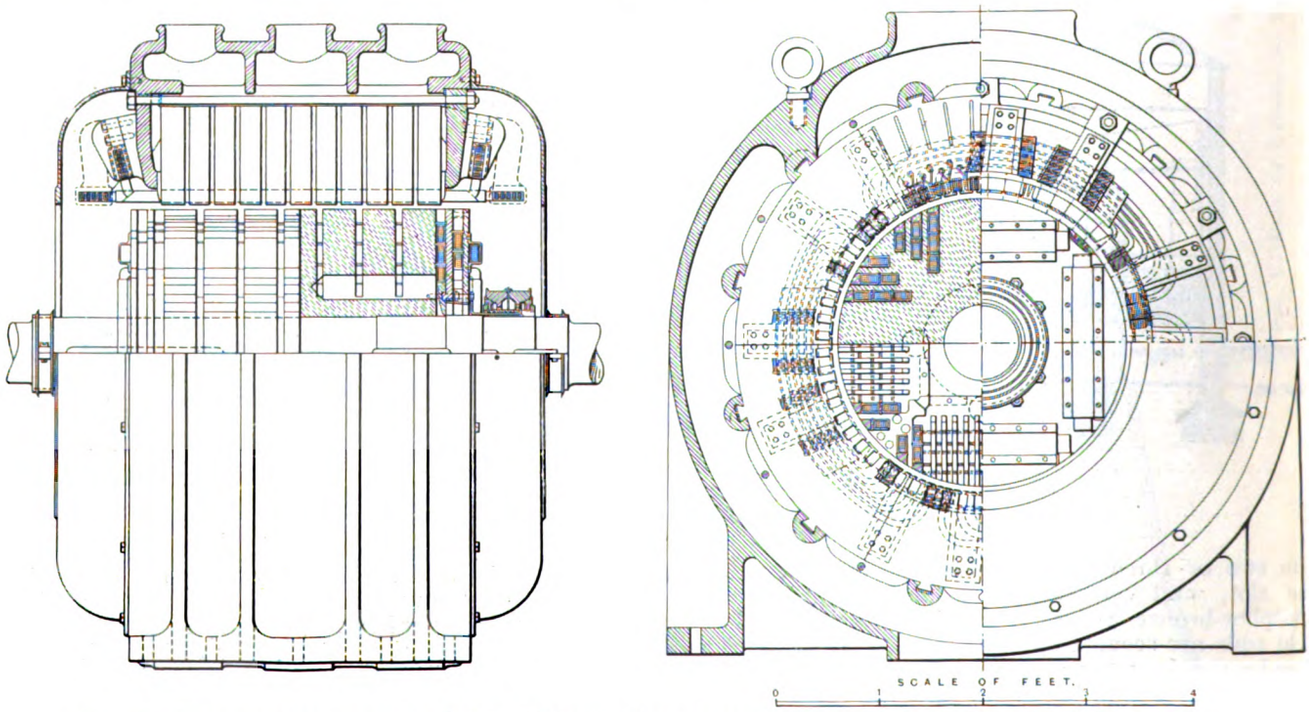


FIG. 5.—SECTIONAL ELEVATIONS OF E.C.C. 1,000-KW. TURBO-ALTERNATOR, SHOWING GENERAL CONSTRUCTION AND ARRANGEMENT OF WINDINGS.

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older plant to assist in this last winter's load. The arrangement of the economisers, which were supplied



Fig. 6.—New Boilers.

by Messrs. E. Green & Son, in the flues behind the boiler is seen in Figs. 1 and 3. Although the present position of the coal-bunkers is opposite the boilers, provision has been made in the design of the boiler-house extensions for the addition of overhead bunkers at the time when the second row of boilers is added, and the steel-work which has been put in was designed to carry their weight. An entirely new chimney shaft has been constructed for these boilers. This is constructed of steel plate, and is entirely self-supporting without stays. The diameter at the base, where it is surrounded by a circular feed-water tank, is 15 ft., and the diameter at the top 8 ft. The height above the fire-grate level is 175 ft., and natural draught only is used. The contractor for the chimney and tank was Mr. J. Thomson, of Dudley. No new coal-conveying plant has been required. The boiler feed-pumps are electrically driven, and are of a special type developed by Messrs. J. Thomas Parker, Ltd.

The excitation of the alternators is supplied from a pair of motor generators, either of which is of sufficient capacity to supply both sets. These consist of standard four-pole motors running off the 460-volt continuous-current bars, driving similar generators each of an output of 375 amperes at 80 volts. As shown in Figs. 1, 3, and 4, they are placed along the wall opposite the turbo-generators.

Although primarily intended for power supply through the special three-phase feeders referred to already, arrangements have been made whereby the new plant can be employed to some extent for the ordinary lighting or traction load of the station by means of converting plant. These converting sets are shown in Fig. 7. The machine to the left is a 500 kw. "motor converter" of the La Cour type, supplied by Messrs. Bruce Peebles & Co., and the other machine is a synchronous motor-generator of the same capacity made by the Electric Construction Co. Both these machines run direct on the 6,600-volt three-phase circuit, and convert to 460 to 500 volts on the continuous-current side. This latter set runs at 600 r.p.m., and has an overload capacity of 25 per cent. for four hours, and 50 per cent. for one hour. Both sets have their starting gear arranged close to them, as shown in Fig. 7. The E.C.C. set is started up from the continuous-current side by means of a totally enclosed oil type starting switch. The starting switch has a slow motion arrangement of the ratchet type, by means of which each section of the resistance is cut out by one stroke of the hand lever. The switch is fitted with a no-voltage release, which will release the switch from any position during the starting-up operation or from the full-on position. In-

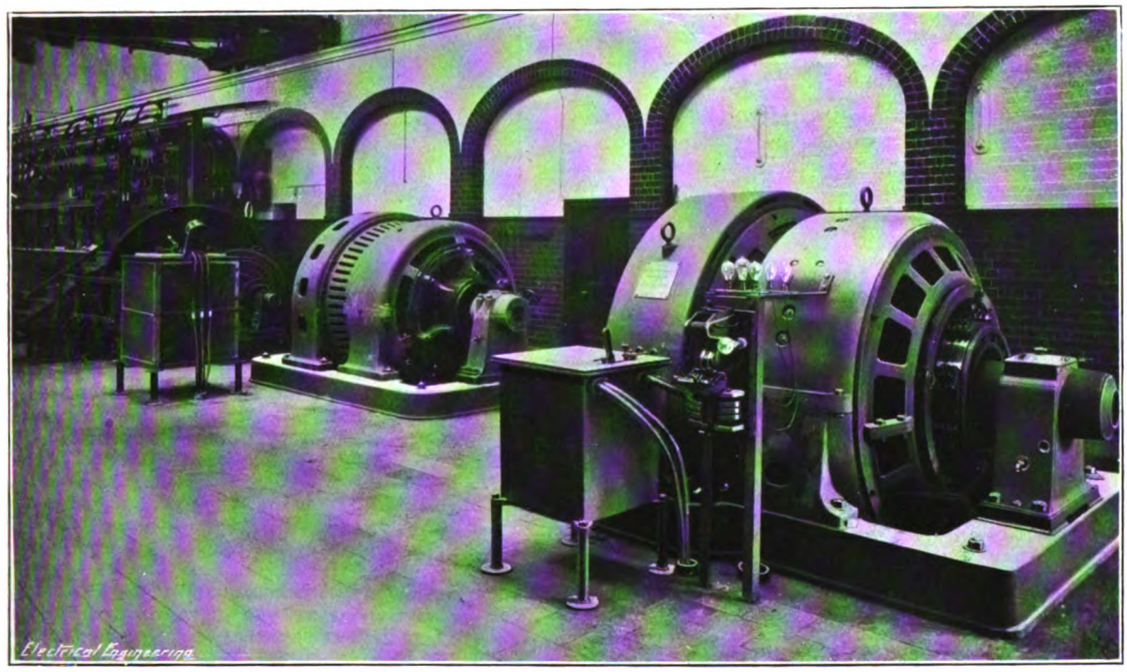


Fig. 7.—500-kw. Motor-converter and Synchronous Motor Generator Sets.

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dicating lamps are provided on the starter, so that it can be seen from a distance whether the starting switch is on or off. Arrangements are made whereby the excitation of the synchronous set can be varied within considerable limits in order to be able to control to some extent the power factor of the system. This set is, of course, always started up from the continuous-current side. It will be noticed that both sets are arranged with the frames as close together as possible without any intermediate bearing.

The new high-tension switchboard which forms a part of the extensions, was also supplied by the Electric Construction Co. It is placed in a low gallery with a glass floor by the side of the continuous-current board. All high-tension apparatus is contained in cells separated by a passage-way behind the board itself. The actual board consists of eight slate panels, comprising two generator panels, a panel devoted to each of the converter sets, three power feeder panels, and a panel upon which are mounted the synchronising instruments, and also some of the switches and instruments belonging to the exciter circuits. All the instruments were supplied by Messrs. Everett, Edgcumbe & Co. The arrangement of the switchgear contains several points of interest, and we propose to give a fuller description of some of the details in our next issue. Although not at present installed, a Tirril regulator is shortly to be adopted for regulating the voltage, and we understand that a similar method of regulation is about to be applied to the continuous-current circuits for keeping the voltage at feeding-points constant.

In relation to rapid increase of the power load at Wolverhampton, the following particulars of the prices charged for lighting and power are of interest:—

Lighting.—Private residences, churches, chapels, and charitable institutions, 4d. per unit; hotels and public houses, 2½d. per unit; theatres and music halls, 3d. per unit; shops, &c., 5d. per unit for first hour's use per day of maximum demand, and 2d. per unit for all consumed in excess thereof; special rate for lighting to power consumers, up to 10 per cent. of total power consumption for lighting at power rates.

Power.—Consumers of energy for power purposes using motors for 50 hours per week and upwards, 1d. per unit; consumers of energy for power purposes using motors less than 50 hours per week, maximum demand system. 2d. per unit for first two hours per day, ¾d. after; large consumers—300,000 units per year, ⅞d. per unit; larger consumptions, ⅞d. to ⅝d. per unit.

Before concluding, we wish to express our thanks to Mr. C. E. C. Shawfield, Electrical Engineer to the Corporation, who gave us facilities for inspecting the new plant, and kindly put at our disposal the drawings and photographs from which some of the accompanying illustrations were prepared, and also to Mr. H. A. Howie, his chief assistant. We are also indebted to the Electric Construction Co. for supplying us with drawings and technical details relating to the alternators and switchboard, and to Messrs. Thomas Parker, Ltd., for information relating to their portion of the contracts.

The following is a list of the principal contractors and sub-contractors for the different parts of the work, together with the amounts of their respective contracts:—

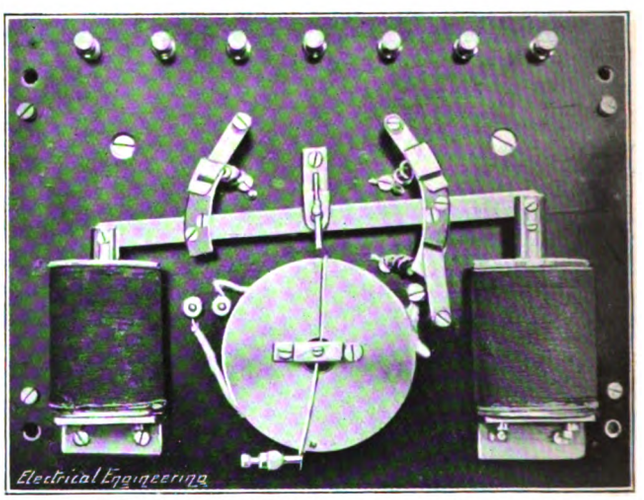
Steam turbo-alternators and condensing plant, Messrs. Willans & Robinson, Rugby, £12,514; Sub-contractors, alternators, The Electric Construction Co., Wolverhampton; Sub-contractors, circulating pumps, Messrs. T. Parker, Wolverhampton; switchboard, The Electric Construction Co., Ltd., £987; cables, Callenders Cable and Construction Co., Ltd., London, £4,000; boilers, economisers, and feed pumps, Messrs. Babcock & Wilcox, London; £5,197; sub-contractors, economiser, Messrs. E. Green & Sons, Wakefield; sub-contractors, feed pumps, Messrs. T. Parker, Ltd., Wolverhampton; buildings and foundations, Messrs. H. Gough & Sons, £4,550; steel chimney and feed-water tank, Mr. John Thompson, Dudley, £833; valves, Messrs. J. Hopkinson, Huddersfield, £220; steam pipes, Messrs. Foster Bros., Wednesbury, £200; feed-water pipes, Messrs. John Spencer, Ltd., £70; floor plates, Messrs. T. Bridges & Sons, Wolverhampton, £157; exciters, Messrs. T. Parker, Ltd., Wolverhampton, £416; motor converter, Messrs. Bruce Peebles, Edinburgh, £1,405; motor generator, The Electric Construction Co., £1,484; switchboard platform, The St. Pancras Ironwork Co., London, £130; voltage regulators, The British Thomson-Houston Co., Rugby, £420.

The inauguration of the plant took place on Monday evening, when a large number of persons were present at the Electricity Works at the invitation of the Corporation. The proceedings commenced with a reception by Mr. Gough Allen, chairman of the Electricity Committee, and after a few speeches handsome souvenir keys were presented by Mr. Shawfield to the Mayor, Mr. F. Evans, and to Mr. Allen, by means of which the formal ceremony of putting the new plant to work was accomplished by unfastening the large padlocks which had been affixed to the steam valves, &c. The company then reassembled in the offices, where supper was provided, and a number of toasts were honoured. Councillor Gough Allen presided, and spoke of the great extensions in the use of electrical driving and their effect on mitigating the smoke nuisance. Mr. Shawfield referred at some length to the boom in power supply which had led to his recommending these extensions, and emphasised the importance of supplying power at a low price. Mr. Shawfield finally proposed the contractors, and Mr. E. J. Fox (Messrs. Willans & Robinson) responded.

AN AUTOMATIC TRANSFORMER SWITCH

IN connection with the extending use of the types of small transformers described in Electrical Engineering, March 6th, p. 351, the following particulars of an automatic switch, which has been patented by Mr. P. Good, will be of interest. The switch is manufactured by Messrs. Knapton, Bagnall & Co., of Charlton, and its appearance, with the cover removed, can be seen in the accompanying illustration.

The shunt coil shown on the left-hand side is connected across from the supply mains to the low-pressure mains, through the



Automatic Switch for Cutting-out Small Transformers to Avoid No-load Losses.

switch shown on the left-hand side. As soon as a lamp is switched on anywhere in the house, it allows current to pass through this coil, which, attracting its core switches on the transformer, and at the same time cuts itself out of circuit. During the time current is passing in the house mains the needle on the main coil is deflected; as soon as the last light is switched off this needle comes into contact with the screw which connects the second shunt coil across the mains, this in its turn attracting its core switches off the transformer, and cuts itself out of circuit.

We understand that in addition to the separate form of switch with a sheet-iron cover, the switches are sometimes arranged in the same cast-iron cases as the transformers.

Presentation of a Portrait of Ampère to the Institution of Electrical Engineers.—At the meeting of the Institution of Electrical Engineers on Thursday last, the President announced that the Société Internationale des Electriciens had notified the Institution through their President that they are presenting the Institution with a portrait of Ampère, in commemoration of the visit of the French Society to this country in 1906.

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"AMERICA REVISITED"

Lecture by Sir William H. Preece

SIR WILLIAM H. PREECE, K.C.B., F.R.S., delivered a lecture on "America Revisited, 1907," at the Institution of Electrical Engineers last Thursday. He has visited the United States four times—in 1877, 1884, 1893, and 1907. His first visit was made in company with the late Sir Henry Fischer to investigate the telegraphic system on behalf of the British Post Office. He reported on the success of the telegraph sounder in the States, and the result was the great development of its use in this country. On his return from this visit, Sir William Preece also brought back with him the first Bell telephone to make its appearance in Europe. During his last visit in 1907, Sir William was the guest of Mr. Andrew Carnegie on the occasion of his dedication of the Carnegie Institute to the city of Pittsburg.

The lecturer stated that one of his first impressions when he reached the country was the extended use of the telephone in the hotel at which he was staying, where arrangements existed enabling any visitor to use the telephone in his bedroom to communicate on the trunk lines; there were 813 telephones in the hotel. Another application of electric power was the driving of the vacuum cleaning apparatus, which is laid on by means of permanent pipes to every room in the building, so that by means of a flexible hose this process can be used for cleaning the room. He remarked on the large number of isolated generating plants in New York, exhausting steam into the atmosphere from the tops of the lofty buildings, in spite of the fact that the whole of the public electricity supply in New York is in the hands of one enterprising company, who do the work as well as it can be done. The lecturer then referred to the large building presented by Mr. Carnegie as a home for the engineering societies, the Engineering Club, and the McGraw building. The first of these accommodates the Institutes of Electrical Engineers, Mechanical Engineers, and Mining Engineers, and welcomes other engineering institutions as its tenants. It is a thirteen-storey building, and a floor is allotted to each institution. In addition, there is a large auditorium seating 1,000 people, and two smaller meeting rooms. Sir William spoke enthusiastically of the comfort and convenience of the thirteen-storey Engineers' Club, and the eleven-storey McGraw building, in which the *Electrical World*, *Street Railway Journal*, *Engineering Record*, and *Chemical and Metallurgical Industries* are published.

A large number of lantern slides were shown illustrating these buildings and other points of interest, and also a few of the technical schools of the Carnegie Institute in Pittsburg. The lecturer said there was a remarkable difference between the United Kingdom and the United States in their attitude to education. Here we expect the Government to do everything, whilst there they expect the millionaire to do it. In the United States there is no supreme Board of Education or Minister of Education. Every State had its own system, and the work of university training and technical education was the result of private munificence. Pittsburg, for instance, had already received $4,000,000 from Mr. Andrew Carnegie, who had placed the management of the institution in a splendid board of trustees, who were all Pittsburgers. The Institute covers four acres, and another 32 acres given by the city have been allotted for the technical schools. The present buildings have only been adapted for first-year students, but as the course will be four years, additional buildings are being erected, and there will be accommodation for 1,500 students. The present buildings provide for about 4,000. In connection with the opening ceremony, Sir William delivered an address on "The Connection between Science and Engineering," and he received the degree of LL.D. from the Western University of Pennsylvania. The lecturer added that he would be dealing with the question of technical education in America, in a Paper shortly to be read before the Society of Arts.

The output of Pittsburg in electrical and allied manufactures in 1906 aggregated $131,100.000, divided as follows:—Electrical and Auxiliary Manufactures, $45.000.000: Air Brakes, $10.000.000; Underground Cable and Wire, $71.000,000; Railway Switches and Signals, $5.100.000. The greater portion of this was turned out by the Westinghouse Company.

The following statistics relating to telegraphy show the progress made at the time of each of Sir William Preece's visits:—

	1877.	1884.	1893.	1907.
Mileage of wire ...	300.000	433,726	769,201	1,321,199
Offices open	11,660	13.600	21,078	24,760
Messages ..	28,500,000	40,000,000	66,591,856	148,804,000
Capital ...	$60,500,000	$80,000,000	$123,000,000	$140,000,000
Income ...	—	—	$24,978,440	$32,856,406

The result of his 1877 visit has already been mentioned. In 1884, he said, the only novelty was the Delany's Multiplex, which was subsequently introduced into the British Postal system. In 1893, the chief improvement noticeable was the large introduction of underground lines, in which, however, Great Britain had been considerably in advance, for in this country underground wires were started in 1837. America, on the other hand, had to be forced by fierce legislature enactments to place their wires underground. An advantage which the United States had over this country was that they had what might be called a better message load factor in the telegraphic service owing to the difference in time of three hours between New York and San Francisco, so that the period of maximum traffic during the day is extended. In 1907, the Wheatstone automatic working had been greatly improved by Mr. Barclay, the Assistant General Manager of the Western Union Telegraph Co. A typewriting machine was employed for punching the tape, but the receiving instrument recorded in bold Roman type at the rate of 100 words per minute. Whilst Sir William was in New York, one circuit in Poston cleared off 1,097 messages in nine hours. The system has been adopted by the Western Union Co., in preference to the Buckingham or Murray systems, and the following circuits were at work from New York: Chicago, six; Boston, two; Philadelphia, two; Buffalo, one; St. Louis, one; Pittsburg and Atlanta were about to be added. As the operator need not know the Morse code, a typist can work the machine, and this added very materially to defeat the recent strike of the Western Union operators last year, as a number of female operators were available to carry on the work after a very short training. The system, he added, is very accurate; on a Chicago circuit 800 messages were sent with only two repetitions.

Recently the telegraph companies revised their tariffs, and this resulted in an average increase of 2 per cent. in rates. There was no outcry against this as there would have been in England if the Post Office had ventured to raise the rate—in spite of the fact, said Sir William, that in Great Britain the Press, with its ruinous rate of 2d. per 100 words cost at one time £600,000 per annum, and the railway companies have a free service over the whole Post Office system. The income for the year ended March 31st, 1907, on the Post Office telegraph system in this country was £4,369.227.

Turning to telephony, the lecturer gave the following statistics of the growth of the Bell system in the United States:—

	1884.	1893.	1907.
Miles of wire	115.255	440,793	7,468,905
Telephones	162,787	552,720	3,553,418
Subscribers	123,625	232,140	2,741,367
Exchanges...	1,325	1,351	4,889

He also made comparisons as follows between the telephones in use in New York, Chicago, and Philadelphia, and some of the principal European cities:—

	Population.	Telephones.	Telephones per 100 population.
London ...	6,580,616	130,101	1·98
New York ...	3,437,202	279,047	8·12
Paris	2,660,559	62,370	2·34
Berlin	1,888,848	83,824	4·43
Chicago ...	1,698,575	126,436	7·44
Vienna	1,674,957	27,541	1·64
Philadelphia..	1,293,697	95,914	7·41

It appears that in America the maximum size of the multiple sections is 10,000 jacks, and that the same process is about to be followed as here—namely, to erect larger exchanges in which the ordinary subscribers' multiples are dispensed with, so that all calls are treated as junction calls. This system, introduced by Mr. J. J. Carty in New York under the name of the Partial Multiple Board, was introduced in London by Sir John Gavey, and is in use at the London Central Telephone Exchange. The lecturer said it was gratifying to find that the automatic visual signal has become universal, and he himself claimed that he was the original user of it in the Newcastle Exchange of the Post Office in 1880. He admitted, however, that its use on the central battery system with glow lamps was different to his original system of needles, but contended that the principle was the same in both cases. Incidentally, Sir William referred to the large increase in power required for telephone switchboards, stating that a 10,000 multiple board on the C.B. system required 500 amperes on the average, and 2,000 amperes on emergencies. He did not have an opportunity to inspect the automatic switchboards, but does not believe in them except

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for small private branch or local exchanges, as they make the fallacious assumption that the lines are always in working order, and the called subscriber always at his post; actually, he said, they cost more to work than manual boards, as they require highly-paid technical attention. Sir William spoke much in favour of the toll rate of charging in place of the flat rate. In America it appears that the number of conversations per day per circuit is six. He referred to the large increase in the number of lines per route. Lead-covered paper cables are made carrying 600 circuits. Even pole lines carry 600 pairs of lines instead of 40, by the employment of aërial cables. Loaded lines on the Pupin method much increased the capacity of underground work, and there is a good working system of circuits from New York to Philadelphia, which are nearly 100 miles apart. A convenient use of portable telephones in restaurants was mentioned by Sir William Preece, the arrangements being that the guest can have a telephone at his table connected from a wall socket just the same as a portable lamp. In this way, he said, "You can eat, drink, and converse at the same time with your wife at home or your partner at the office."

The next section of the lecture referred to the "telharmonium," invented by Dr. Thaddeus Cahill. The keyboard is like that of a piano or organ, but each key is a simple switch which completes an electrical circuit, and operates a relay. The action of the relay is to lift a balanced strip of wood along which are fixed contact pieces, closing the circuit of one or more of the 144 inductor alternators which form part of the machine. Each of the alternators consists of rotating toothed wheels driven by a 185-h.p. continuous-current motor. The waves of current corresponding to the various notes and superposed harmonics, which can be modulated over a large range by means of stops so as to reproduce more or less accurately, the music from various instruments, are transmitted by underground cables to large Bell receivers.

The lecturer then gave tables referring to the position of electric lighting in greater New York in 1907, which he compared with statistics for London. The city of New York is made up of five boroughs :—

	Population in 1900.	Area in square miles.
Manhattan	1,850,093	22
Bronx	200,507	39
Brooklyn	1,266,582	66
Queen's	153,000	124
Richmond	67,021	37

The New York Edison Co.—Total Installation, April, 1907.

	Manhattan.*	Bronx.*	Yonkers.	Brush.*	Total.
Customers... ...	54,185	2,352	1,311	88	57,936
Meters	68,035	3,254	1,461	—	72,750
Glow lamps ...	2,535,026	121,195	35,786	2,242	2,744,491
Arc lamps	33,602	1,898	456	314	36,270
Heating appliances	739 kw.	51 kw.	5 kw.	—	795 kw.
Storage batteries.	4,296 ,,	15 ,,	1 ,,	—	4,312 ,,
H.p. motors ...	144,750	2,452	550	10	147,762
16 c.p. equivalent	4,931,529	168,549	50,072	5,091	5,155.241

* City of New York.

London Electricity Supply.

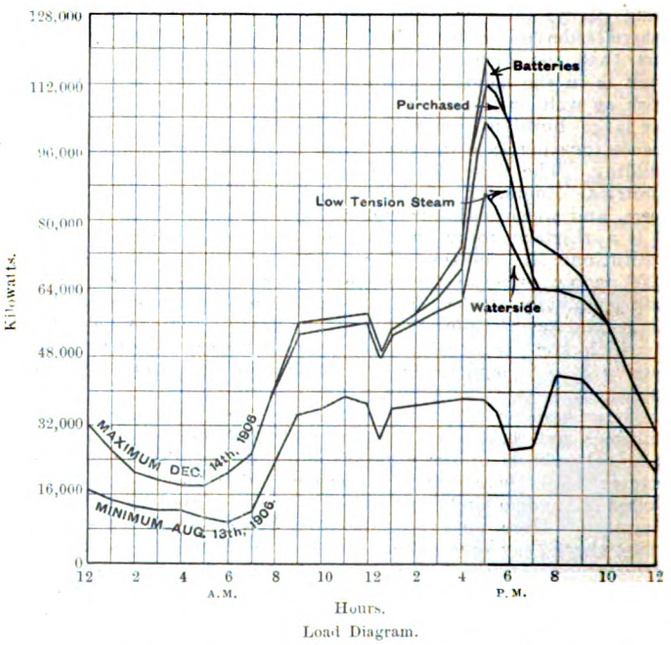
	Borough Councils.	Companies.	Total
Plant installed	54,197 kw.	141,055 kw.	195,252 kw.
Maximum load	34,911 ,,	88,338 ,,	123,249 ,,
8 c. p. lamps connected	2,328,253	5,953,982	8,282,235
Units sold	51,179,778	127,063,504	178,243,282

The Edison Co. supplies on a three-wire continuous-current system at 2×120 volts. It has four generating stations :—Duane Street; East 12th Street; West 26th Street; and 140th Street, Bronx; in addition to the large modern station at Waterside, in which current is generated at 6,600 volts three-phase, and transformed to 2×120 volts continuous current at 15 sub-stations. This Waterside station has now been duplicated, and the two stations combined will have a capacity of 150,000 kw. 8,000 kw. is the size of unit adopted for the latest turbo-generators. While Sir William was in New York, a 5,000-kw. and 4,000-kw. reciprocating set failed at the same time in two stations working in parallel, but the only result was a perceptible diminution of pressure for some minutes in the upper part of the town.

The diagram below shows the loads on a summer and winter day. There is, the lecturer added, another allied company supplying two-phase current, 60 cycles, and 7,500 volts, which is stepped down in motor-generator sub-stations. It has occasionally helped the Edison Co.'s Waterside station over sudden high peaks. An instance of this is shown in the maximum curve, December 14th, 1906, in which the Waterside station supplied up to 86,400 kw., the four low-tension steam stations took the peak up to 102,400 kw., 7,500-volt supply from the United Electric Light & Power Co., supplied power necessary to increase the output to 112,000 kw., and the batteries made the top of the peak. Curtis turbines are largely used, and Sir William quoted some tests of a 8,000-kw. machine in Fisk Street station, Chicago, which gave 14,132 kw., with a steam consumption of 13·13 lb. per kw. hour, the steam pressure being 194 lb. per square inch, superheat 150° F., and the vacuum 29·31 in. This was on a 24-hours' test, made by Messrs. Sargent & Lundy, consulting engineers, of Chicago. The tariff charged by the American companies includes free replacement of lamps. Reference was also made to the electrical testing laboratory under the direction of Dr. Clayton Sharp, in which, in the year ending April 30th, 1905, thirteen million lamps were tested.

Incidentally, Sir William Preece referred to the fact that the Engineering Standards Committee is about to take up an investigation of the efficiency of the new metallic-filament lamps with a view to framing a specification and getting out standards. We trust that Sir William is not quite correctly informed in this instance, for it is far too early to standardise the metallic-filament lamps.

There are now three great railway systems worked electrically



Load Diagram.

The New York Edison Co. Waterside Station.

in New York, which have merged into one system, called the Interborough Rapid Transit Co. These railways are the Metropolitan Street Railways, the Elevated Railways, and the Subways. The New York Central and Hudson River Railroad has also equipped some of its suburban and main lines electrically. The Metropolitan Street Railways means the surface tramway system of New York and Bronx. It includes about 500 track miles. Although its earnings are considerable, Sir William said that its finances have been strangely "ping-ponged," and disastrous panic has followed since his visit. The service in Manhattan is on the metallic circuit conduit type, which has been so satisfactorily followed by the London County Council, and the northern section is overhead trolley, much of which is single track. There are over 200 miles of conduit track. The pavement is either asphalt, granite sets, or wood blocks, and the last seems the most favoured, in spite of its expense. Two generating stations in Manhattan transmit alternating current at 11,000 volts, three-phase, and 25 cycles, to a sub-station, where it is transformed down to the line pressure. The units are 3,500 kw., with reciprocating engines, and the load factor, it was said, varies from 60 to 65 per cent.

The Elevated railways frequently carry one million passengers per day, and the motive power was completely changed from steam to electricity in 1903. This increased the carrying capacity by 33 per cent., and the working costs were reduced from 55 per cent. to 45 per cent. of the gross receipts. They are

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supplied by a generating station equipped with three-phase alternators, driven by reciprocating engines. The pressure in this case is also 11,000 volts and 25 cycles per second, and the line current is supplied from sub-stations at 625 volts. The third-rail system is used with track return. The units in the station are 5,000 kw., and the net output reaches 700,000 kw.-hours per day. Each six-car train consists of four motor-cars and two trailers, and each motor-car has two 125-h.p. motors.

The Subway has four lines, which extend from one end of Manhattan to the other; two of the lines are for local stopping traffic, and two for express service. There are 48 stations, 23·57 miles of subway and elevated structure, and 72·61 miles of single track. The construction of the Subway has been described in a Paper recently read before the Institution of Civil Engineers, an abstract of which appeared in our last issue. The power-house is on the Hudson River, and its capacity is 100,000 h.p. There are six sections, each complete in itself, with its own chimney, and each served by 12 boilers, and all the boilers are on the floor level. The plant includes eleven 5,000-kw. reciprocating sets, generating at 11,000 volts, 25 cycles, and four 1,250-kw. turbo-alternators, at 60 cycles, for lighting. The conversion to continuous current at 625 volts is performed in eight sub-stations with rotary converters. The third-rail system with track return is employed. The local stopping trains are made up of five cars, three being motors, the express trains are made up of eight cars, five being motors, and three trailers. The latter run at a 2½-minute headway. The motor-cars have two 200-h.p. motors on one truck. The electro-pneumatic block interlocking automatic signal system is used on the Subway, similar to that which has been introduced in the underground railways in London

The New York Central and Hudson River railroad is being equipped for electric traction as far as South Croton (a distance of 34 miles), on the Hudson section of the line, and to White Plains (a distance of 24 miles), on the Harlem section. There will be four tracks throughout, so as to separate the suburban from the through traffic. Current is generated at 11,000 volts 25 cycle three-phase, and is distributed to eight sub-stations, where it is transformed with transformer and rotary converters to a current of 660 volts continuous for the third-rail system. An under-running system is employed for collecting current, and the return is by the track rails. There are two power-houses, one at New York and one at Port Morris, which are identical in design, and each of which will have a capacity of 30,000 kw., with room for considerable extensions. The capacity of the coal bunker in each case is 3,500 tons, and Roney mechanical stokers are used. The generating sets are 5,000 kw. Curtis turbines, and the exciters are independent turbo-generators of 150 kw. capacity, supplying continuous current at 125 volts, and having a battery of 74 cells for 1,200-amperes capacity as a regulator and standby. The switchgear is contained in a separate building from the engines and boilers, at a distance of 40 ft. from the main building, in order to secure absolute safety from fire. The battery also is placed in this building. The locomotives weigh 95 tons, and carry four series-wound motors, one on each driving axle, giving a maximum of 3,000 h.p. The armatures are mounted directly on the axles, and the field magnets are attached to the locomotive frame. The locomotives are designed to accelerate at 1·5 ft. per second, and to drive a train, weighing 500 tons, 60 miles an hour. Sprague's multiple system is employed for the suburban service, and the motor-cars have two motors of 200 h.p. each, and one bogie. Tests made by the railway company at Schenectady on an experimental line of six miles, showed that the time required to reach the speed of 50 miles an hour in the case of steam locomotive was 203 seconds, and in the case of electric locomotive 127 seconds.

Only nine lines in the lecture were devoted to wireless telegraphy. "As a business," Sir William Preece says, "it is frosted out." Considerable trouble apparently arises from the American Morse alphabet being slightly different from the European code.

Bequest to Dundee College.—In memory of the late Lord Dean Guild, Mr. T. L. Peters, his sister, Mrs. Garden, and Miss Mary Peters have bequeathed a sum of £4,000 to University College, Dundee, for the erection and equipment of an electrical engineering laboratory. The conditions of the gift are:—(1) That the laboratory shall be regarded and accepted as a gift to University College, Dundee, and that it shall be vested in the trustees designated in the deed of gift of endowment and trust of University College; (2) that the College shall provide an adequate site for it, and shall maintain the laboratory in a state of efficiency, and shall carry out in it the purposes for which it is intended, as defined above; (3) that the building shall be a separate structure apart from the other buildings of the College, and that the name of our late brother shall be permanently associated with it.

ELECTROCHEMISTRY AND ELECTRO-METALLURGY

IN the *Chemiker Zeitung* of March 11th there is a note comparing aluminium with copper for conveying electric currents (cf. ELECTRICAL ENGINEER, February 13th, p. 244). It is remarked that in a good many cases in Canada and the United States, aluminium is employed for carrying the current in place of copper. For example, the Canadian Niagara Power Co. use aluminium leads to convey electricity to Buffalo. This fact is, of course, of particular interest, seeing that the United States is the land where the bulk of the copper is electrolytically refined, and therefore the metal so produced has a higher conducting power than less highly refined copper.

Now whether aluminium is cheaper to employ than copper depends upon the ratio between the price of the one and the other. When the ratio of the price of copper to the price of aluminium is greater than 0·54, then the employment of aluminium has an advantage over that of copper. Recently the price of aluminium has dropped by 33⅓ per cent., being at present about 2s. per kilo., while the price of copper is about 1s. 3½d. per kilo. At these prices aluminium has an advantage over copper. That is to say, weight for weight and price for price, aluminium has a greater conducting capacity than copper. One of the chief disadvantages in the employment of aluminium was the difficulty experienced in soldering and welding, it being necessary to join the sections by means of clamps. This appears now to have been overcome by the process of M. U. Schoop (ELECTRICAL ENGINEERING, Vol. II., p. 598). By means of this method an ordinary soldering lamp can be used to join wires of ⅛ inch diameter, and by means of an oxy-gas flame quite thick sheets can be welded. The flux used, it will be remembered, is an alkali metal chloride solution, *e.g.*, potassium chloride. It is only necessary to brush this solution on the parts to be joined, bring them together, and then to play the flame upon the part. Or for heavier work the flux is dusted upon the surfaces, which are then heated. The present price of aluminium and the new welding process now point to the possibility of aluminium entering into severe competition with copper, and gradually ousting it for conducting purposes. According to *Electrochemical and Electrometallurgical Industry*, of March, a company has been formed in Zurich with a capital of 1,000,000 francs to exploit Schoop's welding process.

In alkaline accumulators one of the chief drawbacks when charging is the manner in which the electrolytic froths. Edison finds that if the solution is carefully filtered through purified bone charcoal that this tendency to foam is very much lessened. He supposes that the frothing is caused by the presence of small quantities of animal matter or organisms, and that these are removed by the filtration. *Centralblatt für Accumulatoren und Galvanotechnik*, March 5th, 1908.

Ebstein, *French Patent*, 337855, describes the formation of iron plates by the Planté method. The plates, 95 × 215 cm., are first dipped into sulphuric acid of sp. gr. 1·4 (1 per cent. water to 1 acid) for one hour. They are then dipped into water, and allowed to dry in a warm current of air for one hour. They are then allowed to hang in the air at ordinary temperature for 24 hours, and then placed in a bath of potassium hydroxide, sp. gr. 1·17, between two nickel plates. The nickel plates are separated 3 millimetres from the faces of the iron plate. Now a current of 0·5 ampere is passed for 24 hours. At the end of this time the plates had a discharge capacity of 0·1 ampere hour. If instead of drying the plates with hot air they were subjected to a current of steam before being charged the capacity of the plate increased about 50 per cent. As the potential difference is only 0·1 volt, these plates hardly seem likely to come into use on a commercial scale.

The last number of the *Revue d'électrochimie et d'électrometallurgie* has an article upon the "Electrochemical Industries of Norway." In the first place it is mentioned how well equipped Norway is for electrochemical works, owing to the cheap water power which it possesses. Reference is then made to the production of nitrogenous fertilisers by the electrical oxidation of the atmospheric nitrogen, to the manufacture of calcium carbide, and to the new works of the British Aluminium Co. at Stangfjord. Then there is the Vadheim Electrokemike Fabriken, which manufacture metallic sodium and sodium peroxide. Metallic zinc is also prepared by the electrothermic reduction and distillation of zinc ores. Mention is also made of the proposed works of the North Western Cyanamide Co., Ltd., where calcium cyanamide is to be manufactured.

Heavy Tramway Damages.—On Friday, in the King's Bench Division, a plasterer named J. Neal was awarded £800 damages for injuries received in the accident upon the South Metropolitan Electric Tramways and Lighting Co.'s system at Sutton on Easter Monday, 1907. Another claim arising out of this accident was heard this week, when a coach builder named H. J. Sayer was awarded £300 to himself, £50 for his wife, and £10 for his child.

A compositor named Hiram Pickles, aged 63 years, has been awarded £275 damages against the Halifax Corporation for injuries caused by being thrown off the foot-step of a car as he was entering it. Damages to the extent of £785 were claimed.

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ELECTRICAL SCIENCE

British and American

Electric Discharges through Gases.—The second of the course of lectures on this subject was delivered by Prof. J. J. Thomson on Saturday last at the Royal Institution. In the first lecture Prof. Thomson considered the conductivity of the air and the negative charge on the surface of the earth. With respect to the latter some interesting experiments, said the lecturer, would be made by Mr. C. T. R. Wilson to determine whether the charge on a sphere could be made to oscillate by the action of a spark. Short periodic magnetic disturbances had been detected, the period of vibration being only 1-7th of a second, and it was thought that these magnetic disturbances might be due to electric oscillations on the earth's surface, set up by the action of lightning, as 1-7th of a second was the time taken by light to travel round the circumference of the earth. Returning to the conductivity of air, Prof. Thomson showed by experiments that air exposed to radium was ionised and contained a sufficient number of charged particles to cause it to conduct. Röntgen rays had the same effect. The air in the neighbourhood of a flame, an arc, or an incandescent body would also conduct. The conducting particles produced in the air by such ionising agents could be removed by filtering through a glass-wool plug or by electrical means. Thus if the ionised air were passed between two conducting plates, with a difference of potential between them, the negatively charged particles went to the positive plate, and the positively charged particles to the negative plate, the air being thus filtered of its charged particles and rendered non-conductive. In a gas under the influence of an ionising agent, these particles were being constantly produced in pairs; but they also tended to recombine, a negative particle uniting with a positive particle, the resultant particle being neutral and of no use for conduction. A steady state of conductivity was obtained when the number lost by recombination was equal to the number produced by the ionising agent in an equal interval of time. The rate of recombination was proportional to the square of the number of particles present, and the conductivity of a gas thus decreased at a diminishing rate. This rate of recombination had been measured, and it had been found that if there were 1,000 particles of each sign in 1 c.c. of gas, one pair recombined in every second. This was a faster rate than could be accounted for by collision, and therefore the oppositely electrified particles actually attracted one another. With regard to the conducting property of a layer of gas under the influence of an ionising agent, if the potential across the layer were increased, the current increased up to the point when every charged particle produced was being used to convey current. After this the current could not be increased until the gas broke down, and a spark passed. If the thickness of the layer were increased, the current was increased, as more charged particles were available to carry the current, and if the thickness of the layer were doubled, the maximum current (*i.e.*, the current when all particles produced were being used) was doubled. The maximum current was proportional to the mass of the gas between the electrodes. The lecture was illustrated by a series of delicate experiments.

Discharge of Electricity from Pointed Conductors.—In the February number of the *Physical Review*, J. Zeleny gives the numerical results and a general account of his experiments on the discharge from steel needle points or conical points. Positive and negative discharges are considered, and the relations between current, voltage, minimum potential and diameter of the points, are studied. His preliminary experiments showed that selected commercial sewing needles behaved in the experiments in a consistent manner; but the electrical data proved to be a function both of the diameter of the point and of the angle of taper towards the point. The author reduces his results to air temperature 22° C. and barometric pressure 74 cm., and gives many tables and curves enabling any future experimentalist to compute the discharge potential and current from the dimensions of the needle to be used. Some of the results can be expressed by formulæ. For instance, if V is the applied voltage, M the minimum voltage required to start a current, and d the diameter in millimetres of the point of an ordinary needle (angle about 12°), then the positive current C is given in amperes by

$$C = 2{\cdot}58 \times 10^{-13}(1 + 0{\cdot}519d)V(V - M)$$

for voltages between 3.000 and 9.000. In this formula M, the minimum potential required to start a current is represented by the relation

$$M = 2590 + 4750d$$

where d has the same meaning as before.

A similar formula is given for the negative discharge to a plate at the same distance 1·5 cm. as the above experiments on positive discharges, but the experimental results accord less closely with this formula. Another series of experiments on carefully prepared conical brass points of exactly 12° taper, gave, under the same circumstances as used with the needles, the following formula for the positive discharge :—

$$C = 2{\cdot}49 \times 10^{-13}(1 + 0{\cdot}176d^3)V(V - M),$$

where, it will be noticed, the diameter of the end of the cone is raised to the third power. The range of this diameter in the cases investigated by the author was from 0·060 mm. to 1·09 mm. Here $M = 1980 + 5200d$. The negative discharge was too irregular to yield a formula. Incidentally the author observed, when working with steel needles, that tufts of iron oxide formed at their tips when the positive discharge was occurring. The formation of oxide was much smaller in the case of the negative discharge.

Continental

Electrical Measurement of Small Lengths.—In the course of some work in standardising an electrodynamometer for Professor Lippmann, A. Guillet noticed the extreme delicacy of the instrument for any change of mutual position of the coils. This led him to an electric method of measuring small displacements, particulars of which are given in the *Comptes Rendus* for March 2nd. A flat coil C is mounted midway between two flat coils A and B, all three coils having their axes in the same line. When A and B are strictly equal and opposite, the mutual potential of $A+B$ and C is zero. Any slight displacement of C produces a finite mutual potential Δm and induces a current in C. The induced current is proportional to the inducing current, to its frequency, to the conductivity of C, and to Δm. Displacements may be readily compared by reducing the induced current to a standard value by means of resistances. The displacements are then proportional to the resistances so introduced. The sensitiveness appears to be almost unlimited. With an inducing current of 0·3 ampere and a frequency 10, and with a resistance of 100 ohms, the author obtains a deflection of 30 cm. on the scale for every micron (0·0001 cm.) traversed. C is rigidly attached to the structure whose expansion or displacement is to be measured.

Counting Alpha-Particles with the Spinthariscope.—Crooke's spinthariscope has been put to a novel use by E. Regener, who communicates the result of a census of α-particles to the *Verhandlungen* of the German Physical Society for February 15th. He conceived the idea of counting the impinging particles which produce the appearance of a sparkling midnight sky, and comparing the number so obtained with that calculated from other data. In this preliminary report, he shows that a satisfactory agreement is arrived at. He used a polonium preparation as a source of α-rays, and a zinc sulphide screen, magnified 60 times and faintly illuminated, as a detector. A surface only a few mm. in diameter was picked out by means of a screen, and the detector was so adjusted that only one impact had to be recorded every second or two. The counting was done by means of a Morse recorder afid a stop-watch. In one such experiment, in which the surface was 0·325 sq. mm., and the distance 1 cm., 393 impacts were observed in 462 seconds. The total number of α-particles emitted per second by the preparation ranged from 1,511 to 2,281. The saturation current indicates 2,200 such particles, probably as valent helium atoms. The author hopes to count the particles electrically by means of a string electrometer.

Wave Length of Roentgen Rays.—The new and somewhat revolutionary atomistic conception of energy developed by Planck, according to which all quantities of energy are multiples of a quantity which is numerically equal to the energy of charge of a single electron, has already proved fruitful in photoelectric phenomena. It is now applied by W. Wien to an interesting calculation of the wave-length of Roentgen rays, and the results are given in No. 5 of the Göttingen *Nachrichten*. According to Planck, the elementary quantity $\epsilon = hc/\lambda$, where h is the radiation constant ($6{\cdot}548 \times 10^{-27}$ rays per second), c the velocity of light, and λ the wave length of the radiation. Another value of ϵ is the kinetic energy of an electron constituting a secondary X-ray, and generated by a Roentgen pulse. This must, if Planck's law is correct, be equal to the energy of the pulse itself, and so we get the relation $\lambda = 2hc/mv^2$. All the constants of this equation are known. For a velocity $= 8 \times 10^9$, and a specific charge $e/m = 4{\cdot}69 \times 10^{-10}$, the wave-length λ comes out as $6{\cdot}79 \times 10^{-9}$ cm., which agrees fairly well with Hagn and Windt's diffraction value $1{\cdot}3 \times 10^{-8}$ cm. Obviously, only the fastest secondary rays must be taken into account.

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THE INTERNAL STRUCTURE OF METALS

A LECTURE on the above subject was delivered on Tuesday, March 10th, before the Manchester Section of the Institution of Electrical Engineers by Mr. W. Rosenhain, Superintendent of the Department of Metallurgy in the National Physical Laboratory. The lecturer began by explaining the manner in which materials are examined under the microscope, briefly describing the methods of grinding, polishing, and etching specimens and the modes of illumination which are used, and went on to describe the typical crystalline structure of a pure metal. The manner in which a molten metal solidifies, and the growth of mutually interlocking and interpenetrating crystals from numerous centres of crystallisation in a cooling metal, were then dealt with, and in this connection the lecturer explained how largely the mechanical properties of a metal depended upon the manner in which these crystals grow, thereby explaining the influence of such factors as casting temperature and the presence of minute quantities of foreign bodies, occurring either at impurities or purposely added. The typical structure of binary alloys was then discussed; the general character of the "eutectic" body frequently found in such binary alloys was explained, and its influence upon the mechanical properties of the alloy was described. Passing on to the subject of the mechanical deformation and ultimate fracture of metals, the lecturer described the observations made by Professor Ewing and himself some nine years ago, which resulted in the discovery of "slip-bands" and a recognition of the manner in which metals undergo deformation by the slipping or sliding of the elements of each crystal over one another, each of the crystals of the metal thus accommodating itself to the new shape imposed upon it by the circumstances of the deformation. In connection with the subject of slip bands, Mr. Rosenhain referred to the semi-plastic condition, which, in iron and steel, follow upon plastic deformation; Muir's work on the recovery from this state produced by exposure to the temperature of boiling water was referred to, and from these facts an explanation was advanced of the causes which lead to the well-known phenomena of fatigue in edge tools, and the recovery of their cutting power after rest. In the last part of the lecture, the various modes of fracture of iron and steel under tension, shock, bending, and alternating stresses were described, and the microscopic features of the fractures illustrated by a series of sections of actual fractures, also obtained by the aid of the electro-embedding process. The lecturer laid great stress on the importance of the systematic investigation of fractures, more particularly of failures occurring in actual practice, since in that way the most useful information could be obtained as to the characteristic behaviour of the materials under various circumstances not readily reproduced in laboratory tests. Special reference was made to the manner in which metal fails under the effect of alternating stresses; the crystalline appearances of the fractures produced in this way was explained on the basis of deformation by slip, and the view that vibration or alternating stresses could cause metal to "become crystalline" was characterised as an entirely groundless and most improbable assumption.

The microscopic study of metals might, he said, find some direct electrical applications; the connection between the microstructure of alloys and their electrical resistance and their resistance temperature coefficient was given as one instance, while in another direction it was pointed out that there was certainly some connection between the magnetic properties of iron and its micro-structure, material showing high permeability and low hysteresis losses generally having a large crystalline structure: there appeared to be some resistance to the magnetic flux at the inter-crystalline junctions, but this was a subject deserving of much further investigation before any definite conclusions could be reached.

METALLIC FILAMENT INCANDESCENT LAMPS

AT a meeting of the Electrical Contractors' Association, on Thursday last, Mr. L. Gaster read a short Paper on Carbon and Metallic Filament Lamps. Mr. Gaster commenced by saying that many years ago it was realised that a higher working temperature for the filament was necessary in order that a larger proportion of rays from the violet end of the spectrum should be emitted. The carbon filament could not stand high temperatures, and, moreover, was seriously affected by fluctuations in the applied voltage. By employing a high temperature in the process of manufacture, the graphite filament, which was a slight improvement on the carbon filament, had been produced. The first commercial metallic filament was the osmium filament, but this was both expensive and difficult to manufacture. The next to come to the front was the tantalum filament, and this metal had the advantage that it could be drawn out to a fine wire. There were now on the market 16 c.p. tantalum lamps which consumed only 1·5 to 1·7 watts per candle, and using these lamps on alternating-current circuits of 50 cycles frequency only reduced the life to about 10 per cent. below that on a direct-current circuit. The next lamp was the Tungsten or Wolfram lamp, for which there were three distinct manufacturing processes. These lamps were suitable for either alternating or direct-current circuits, but as the filament was soft at high temperatures, the lamps must burn in a vertical position. One of the latest developments in lamp manufacture was the Z filament (Zircon Wolfram) lamp; the filaments in this lamp were kept under tension by spiral springs of tungsten, and would burn in any position. A 35-c.p. lamp of this type consumed only 1 watt per candle, and was suitable for either alternating or direct-current. With regard to the economy to be obtained by the use of metallic filament lamps, Mr. Gaster said that if the price of electricity were less than 2d. per unit, it was not economical to use metallic filament lamps, but with a charge of 5d. per unit, for example, the extra cost of the lamps would be compensated for in less than 100 hours. In conclusion, Mr. Gaster referred to the advisability of using lamps of not more than two voltages in one installation when lamps in series were necessary, and also to the need of suitable shades and fittings to harmonise with the new lamps.

In the discussion which followed the Paper, the Chairman, Mr. C. L. Troup said that it was his experience that no metallic-filament lamp would burn at an angle. With regard to shades, he thought that the old-fashioned gallery with three screws and removable shades was better than the screwed-on shade. Mr. Rawlings referred to the unnecessary use of high candle-power lamps where small candle-power lamps would do. Mr. Rashleigh Phipps said that he had found 2 or 3 per cent. overrunning had serious effects on metallic-filament lamps, and recommended using 105 volt lamps on 100 volt circuits where the voltage fluctuation was bad. Mr. E. L. Berry alluded to the necessity of using a larger section of conductor when wiring for low voltage lamps, on account of the increased effect of a drop in voltage, and the larger current taken.

CATALOGUES AND PAMPHLETS RECEIVED

EXHIBITION STANDS AND LIGHTING.—A booklet from the Franco-British Electrical Co. illustrates a system of decorative electric lighting, which consists of crystal festoons and fittings arranged to take lamps of small candle-power. The arrangement is particularly adapted to exhibition stands, &c.

PORTABLE WATTMETERS.—A new list has been issued by the Union Electric Co., of portable wattmeters of the moving-coil type of Messrs. Hartmann & Braun's manufacture. These instruments are suitable for either continuous or alternating currents, and in most cases are arranged for more than current range. A dead-beat action is secured by the use of an air-damping arrangement, and a conveniently arranged mirror under the scale avoids parallax errors. A series of suitable resistances for the pressure circuit is listed, including special star-connected resistance for obtaining an artificial neutral point for three-phase measurements.

SMALL TRANSFORMERS FOR METALLIC FILAMENT LAMPS.—A leaflet from Messrs. Johnson and Phillips gives particulars and prices of this firm's small transformers for metallic filament lamps, which were described in Electrical Engineering, March 5th, page 354.

SWITCHES.—Messrs. A. P. Lundberg & Sons announce in a newly-issued leaflet that after considerable experiment they have adopted a combined construction of mica and vitreous porcelain for the insulation of the current-carrying parts of their well-known "Pivot" switches, which has several advantages over the system previously employed.

Obituary.—We regret to have to announce the death at Bournemouth, on Saturday last, at the age of 81, of Mr. William Ormiston Callender, the original founder of the well-known firm of Callender's Cable & Construction Co. The late Mr. Callender was born at Leith, but settled in London in 1866. He was at that time connected with the paving industry, and as manager of the Val de Travers Co. was instrumental in introducing asphalte for street-paving in London. In 1879 he patented an insulating material in which Trinidad bitumen formed the chief ingredient, and this material has become widely known as a dielectric for underground mains, under the name of "vulcanised bitumen." The Callender's Bitumen Telegraph & Waterproof Co., of which the present company is the successor, was founded in 1882 to develop this invention. Mr. W. O. Callender ceased to take a part in the working management of the company's affairs in 1893, but remained an active member of the Board until 1903, when he resigned his seat as director, but was apointed special director of the company. The funeral took place on Tuesday.

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A NEW UNIVERSAL PHOTOMETER

A NEW form of portable photometer, adapted for measurements both of luminous intensity and illumination, which has been designed in America by Dr. C. H. Sharp and Mr. P. S. Millar, is described in the *Electrical World* (New York).

A plan and elevation of the instrument, showing the interior arrangement, is given in Fig. 1. The body of the instrument is a hardwood box about two feet in length, having a hinged

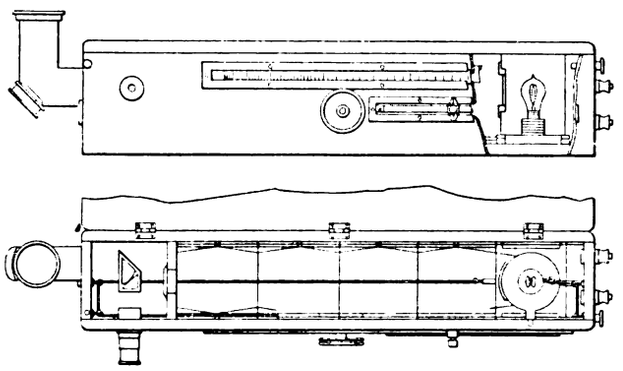


FIG. 1.—SIDE ELEVATION AND PLAN OF PHOTOMETER.

cover so that the entire interior is accessible. The movable part is the comparison lamp, and not the photometric device. The lamp is mounted within a circular metal housing, and is carried on a platform arranged to slide in a track lengthwise of the box. The movement is effected by means of an inelastic cord which passes around pulleys and cones to a drum which can be turned by a large external knob. The variable distance method has the great advantage that its indications depend upon a known law, and that consequently a scale can be made from calculation and not as a result of various trials. The scale from which the indications of the photometer are read consists of translucent celluloid, and is set in a longitudinal opening in the side of the box. In order to prevent external light from having access to the interior of the box, this scale is covered with a long shutter, which can be opened by means of an external knob at the rear of the box. To facilitate taking readings in dark places, a hole is cut in the side of the housing carrying the comparison lamp, so that when the shutter over the scale is raised, the light from the lamp falls on the scale and illuminates it brightly, and the pointer, being inside the box, casts a shadow on the brightly lighted scale. The light from the comparison lamp falls on a milk glass plate, which fills a window in the partition near the end of the box.

Errors due to stray light reflected from interior portions of the instrument, which are difficult to prevent, even by lining the apparatus with black velvet, are avoided by the use of a very simple system of moving screens, which are shown in

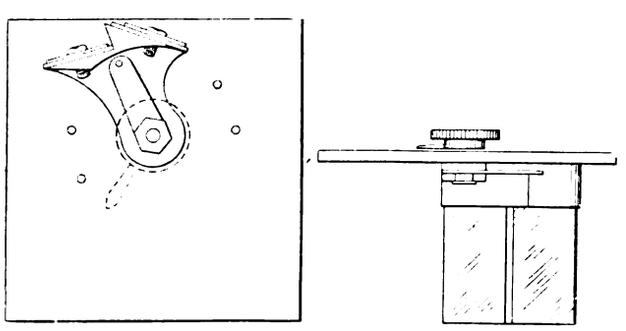
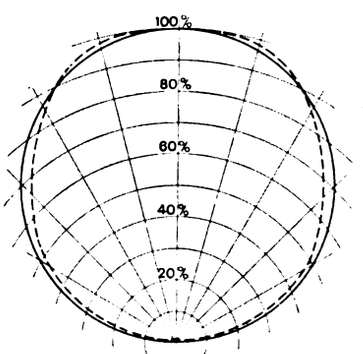


FIG. 2. DIAGRAM OF SCREEN SYSTEM.

Fig. 2. The screens are of fibre, of such size as practically to fill the box. They have apertures sufficiently large to permit the rays of the lamp to pass unobstructedly, and are supported by two longitudinal brass rods, being attached to each other and to the lamp carriage by light cords. When the comparison lamp advances, its housing pushes the screens successively along ahead of it, and when it recedes, the cords pull the screens one after the other into their original position.

The photometric device is a modified form of the Lummer-Brodhun arrangement. By the addition of another totally reflecting surface, rays from opposite directions are brought to the sight tube. The elbow tube at the end of the box has a number of important functions to perform. It fits friction-tight on a collar fastened in the end of the box, and hence may be turned about a horizontal axis and set at any angle, which angle is indicated on a semi-circular scale on the end of the box. The use of a tube of this description furnishes the simplest means of measuring illumination or light coming from any direction. In the elbow of the tube is fixed a reversible plate, one side being a diffusely reflecting surface used in the measurements of candle-power, and the other a mirror used in connection with a test plate on the end of the tube for measuring illumination. In measuring candle-power, the diffusely reflecting surface is turned toward the inside of the tube, and the end of the elbow tube is open, the tube serving to screen off stray light from the plate. The distance between the plate and the source of light must be known.

The photometer being portable and the elbow tube adjustable to any angle, this arrangement lends itself to determinations of the vertical distribution of luminous intensity of light sources, and is also applicable to the measurement of the candle-power of street lamps, either close at hand or at a considerable distance. To measure general illumination, the translucent illumination test plate is slipped on to the end of the tube, and the plate at the elbow is reversed, making its mirrored side effective. The illumination on any required plane can then be measured, the light having unobstructed access to the test plate. It has been found that the test plate of translucent glass, ground on its upper surface so that its power of regular reflection is



Theoretical Curve (full). Curve for Test Plate (dotted).

FIG. 3.—CURVE SHOWING ERROR OF TEST PLATE.

destroyed, is well adapted to the purpose. The criterion for the complete diffusion effect of the plate is that its brightness shall vary directly as the cosine of the angle of incidence of the light upon it. The deviation from this law is shown by the curve of Fig. 3. The error so introduced in the measurement of diffuse illumination is ordinarily negligible.

The scale may be an equal-part scale, or a direct-reading scale. It has been found to be most convenient to make the scale direct-reading in foot-candles. The same scale is equally applicable to the measurement of illumination and of candle-power. The foot-candle scale in question has a range from 0·4 to 20 foot-candles. This range would, of course, be increased considerably by using a lamp of different size, but the range given with any one lamp cannot be considered sufficient to meet all the conditions which are present in practical work. The change from one comparison lamp to another is an inconvenient operation. Recourse has been had, therefore, to the use of absorbing screens. Two of such screens are used, one of which transmits substantially 10 per cent. of the light falling upon it, while the other transmits only 1 per cent. of the light. These two screens are attached to a movable holder, which is not indicated in Fig. 1, but is shown in detail in Fig. 2. By turning the milled head, which is exposed when the cover of the photometer box is lifted, either screen may be interposed between the prism and the milk glass window, or between the prism and the elbow tube, or both screens may be turned to such a position that they intercept no light. Evidently, when the screens are used, the total range of measurement, with but one comparison lamp, is from 0·004 foot-candle to 2,000 foot-candles, within which range all measurable lights and illuminations can be said to fall.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published March 12th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from abroad.

1907 Patents

4,031, V. A. FYNN. Improvements in the starting and operation of single-phase induction motors of the split-phase type, with two or more inducing windings. Former methods of obtaining the necessary phase displacement between the applied E.M.F.'s for the two or more windings, such as the insertion of inductance or capacity in series with one winding, only permitted of a displacement of less than 90°. According to the present invention, a phase-displacing circuit is provided, containing two or more elements of differing impedance, one of which is an inducing winding of the motor. An E.M.F. derived from one of these elements and differing in phase from the E.M.F. of the supply is combined, either directly or indirectly, through a variable ratio transformer, with the E.M.F. of supply, and by this means an E.M.F. of a suitable value and with any desired phase displacement from the supplied E.M.F. can be obtained, and applied to the other inducing winding of the motor. The induced member may be an ordinary short-circuited armature, a squirrel-cage rotor, or an armature with slip-rings and external variable resistances. The starting torque and power factor of the motor are improved by the above method of starting. Several modifications are described in the specification. Sixteen claims, eighteen figures.

4181, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*) A method for the prevention of electrolysis by alternating currents, of iron pipes, lead-covered cables, &c., buried in the earth. For instance, in the case of the leakage currents of railway systems, the negative half-wave of the alternating current does not completely neutralise the electrolytic effect of the positive half-wave, and electrolytic corrosion results. The present method consists in superimposing upon the alternating current a uni-directional current of such intensity (about 1·5 per cent. of the main alternating current) as to neutralise completely the electrolytic effect. The negative wave is thus made slightly larger than the positive wave. The auxiliary uni-directional current can be obtained from the main supply by means of a mercury valve, rotary transformer, or other suitable device, or from a different source of supply as a battery. Six claims, one figure.

4,211, CROMPTON & CO., MACFARLANE, AND BURGE. A motor generator for transforming continuous current to higher or lower potential. The machine consists of a single armature with a ring winding, and a single commutator. Auxiliary brushes on an axis at right angles to the axis of the main brushes (in a two-pole machine), are provided, and these auxiliary brushes are connected together. The lower pressure current is taken out from or fed in at one main brush, and the auxiliary brush connection. In order to obtain a symmetrical distribution of the potential round the commutator, the main poles are split into two parts, each part being provided with a winding. The armature flux has no path through the yoke of the machine and the necessary symmetry of the flux and potential is obtained. Applied to the case of a rotary converter, the ring-wound armature is provided with slip rings to take in or give out the alternating current. The poles are split as described above. In both the above cases the field circuit providing the motoring flux is quite separate from the field circuit providing the generating flux, and in the case of the rotary converter, the direct-current voltage can be regulated by varying the generating field, the power factor on the alternating-current side being kept at unity by making an inverse variation of the motor field, as it is only necessary that the total flux should remain constant. One claim, four figures.

5,506, B. T. LAMME. An alternating-current series commutator traction motor, supplied with current from the low-voltage winding of a transformer, has a local circuit of low resistance and under certain conditions the motor may act as a direct-current generator and send current through this circuit. In order to prevent this action, the series field winding is shunted with a choking coil of high inductance and low resistance compared with the series field winding. Any direct-current that is generated flows through this shunt and not through the series winding, and consequently does not produce a strong enough field to cause any considerable generating effect. If the resistance of the series field winding is very low, a resistance can be inserted in series and the shunt connected across both. By providing the choking coil with taps, it can be used as a means of reducing the regenerating action of the motor when the car is running down hill. This regulating action can be made automatic, by causing the current generated (and which is returned to the line) to flow through a solenoid, which solenoid operates a plunger increasing a gap in the choking coil core with increasing current. The inductance of the choking coil is decreased, and more current is shunted from the motor series field. Four claims, five figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Summaries of the more important of these patents will appear in our next issue.

1907 Patents

4,123, STONE. Systems for wireless telegraphy.
4,333, WEBB. Selective continuous wave telegraphy.
4,397, ECKSTEIN & HEAP. Circuit breakers.
4,425, SCOTT. Time limit circuit breakers.
4,470, LAUTENBACH. Electric power plants.
5,012, COOK. Electrical protective apparatus.
5,087, SUTTON & SUTTON. Automatic fire alarms.
5,154, COWPER-COLES. Manufacture of projectiles and other hollow objects.
5,506A, LAMME. Operation as generators of alternating current series commutator motors.
5,508A, LAMME. Operation as generators of alternating current series commutator motors.
5,513, SIEMENS BROS. DYNAMO WORKS AND BOLTON. Relays or cut-outs.
7,663, TAYLOR. Vibrators for siphon recorders.
7,718, SMITH. Fire and temperature alarms.
7,982, BLACKMORE. Electric magnetic separators.
8,284, THIELLET AND DENARD. Electric accumulators.
9,912, HAWKINS. Record-slips for meters.
13,354, DRIVER. Method of attaching filaments to the leading-in wires of incandescent lamps.
16,447, COREY. Switch mechanism.
17,094, DYMOND (*American Electric Chain Co.*). Process for the manufacture of chain.
17,097, ALLGEMEINE ELEKTRICITÄTS GES. Switch mechanism for electrically-propelled vehicles.
18,403, STOKES. Surface traversers for use on railways and tramways.
18,681, SIEMENS BROS. DYNAMO WORKS AND HOLMES. Electric arc lamps.
18,843, GUDGEON. Electrical switch applicable to railway signalling.
19,340, SIEMENS & HALSKE AKT.-GES. Signalling telegraphs.
19,558, SIEMENS BROS. & CO. (*Siemens & Halske Akt.-Ges.*). Electrical locking apparatus for railway signalling.
20,600, HEITMANN AND YOUNG. Wedges for the slots of dynamo-electric machines.
21,467, ELEKTRIZITÄTS AKT.-GES. VORM. SCHUCKERT & CO. Maximum demand indicators.
22,722, ASKLING. Ignition devices for reversible internal-combustion engines.
22,833, CONRAD. Armature windings.
23,319, HARTMANN & BRAUN AKT.-GES. Frequency meters, speed indicators and relays.
24,923, DUGASZ, KALDOR AND SZENDE. Telephonic communication between railway trains.
26,622, CUMONT & COMPAGNIE DE SIGNAUX ELECTRIQUES POUR CHEMINS DE FER. Railway signal mechanism.

1908 Patent

796, AUBERT AND AUBERT. Electrically-controlled apparatus for igniting and extinguishing lamps.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patent

26,642, CREIGHTON. Devices for protecting electrical systems.

1908 Patents

2,824, FALKENTHAL. Apparatus for producing ringing currents in telephone systems.
3,159, FREY. Link-suspension device for incandescent bodies.
3,592, GRAMMONT AND ROUTIN. Electric servo-motors.
3,701, "POLYPHUS" ELEKTRICITÄTS-GES. Electrical method of transmitting photographs.
3,986, ALLGEMEINE ELEKTRICITÄTS-GES. Electrically-driven rolling-mills.
4,052, HERRENSCHMIDT. Processes of melting in electric furnaces.

Expiring Patent

The following Patent expires during the current week, after a life of fourteen years:—

5,863 of March 21st, 1894. HENRY REASON. Fuse boxes for supply mains, so constructed that when the lid covering the box or compartment containing one fuse is opened, the other lid covering the box containing the fuse on the other side of the mains cannot be opened. One claim, seven figures.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. * = Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ld.	10	7	5/-*	11—12	
Do. 4½% Cum. Pref.	10	4½	4½	10—11	
Do. 6% Cum. Second Pref.	10	6	6	10—10¾	
Do. 4½% Debenture, Red.	Stock	4½	4½	100—103	
Bromley (Kent) E.L.& Power Co., Ld.	5	2½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	95—98	
Brompton & Kensington E. S. Co., Ld.	5	10	10	7½—8½ xd	−¼
Do. 7% Cum. Pref.	5	7	7	6¾—7¾ xd	−¼
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4*	97—100	
Ch. Cross, W. E. & City E. S. Co.	5	5	5	4⅝—4⅞ xd	−⅛
Do. 4½% Cum. Pref.	5	4½	2¼	4¼—4½	
Do. 4% Deb. Red	Stock	4	4	97—100	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½	4¼—4½	
Chelsea Electric Supply Co., Ltd.	5	4½	4½	3— ½ xd	−⅛
Do. 4½% Deb. Red	Stock	4½	4½	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	5*	10—11	
Do. 6% Cum. Pref.	10	6	6*	11½—12½	
Do. 5% Deb. Red	Stock	5	5	122—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	102—103	+1
City of Durham E. P. Dis. Co.	5	4	4	3—3⅜ xd	
Do. 5% Pref.	5	5	5	4¼—4⅜ xd	−⅛
County of London Elect. Sup. Co. Ld.	10	5	4*	7⅞—8¼	
Do. 6% Cum. Pref.	10	6	6*	11—11½	
Do. 4½% Deb. Red	Stock	4½	4½	105—108	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	97—100	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	¼—1¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	60—70	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4⅜—5½	
Do. 5% Cum. Pref.	5	5	2/6*	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½	94—97	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6½—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½	92—95	
Kensington & Knightsbridge E. L. Co.	5	10	10	7¾—8¼ xd	−¼
Do. 4% Deb. Red	Stock	4	4	96—99	
Kens. & N'tng Hill E.L. Cos. Db. Rd.	Stock	4	4*	99—103	
London Electric Supply Corporation	3	4	4½	1½—1⅝ xd	−⅛
Do. 6% Pref.	5	6	6*	4⅜—4½ xd	−⅛
Do. 4% 1st Mort. Deb. Red	Stock	4	4*	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6½	5—5½ xd	−¼
Do. 4½% Cum. Pref.	5	4½	4½	4⅜—5¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D.	100 & 500	4½	4½	98—101	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4*	9¼—10¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	10*	6½—6⅝ xd	−¼
Do. £2 Pm.	5	8	10½	5¼—6⅛ xd	−¼
Do. 5% Pref. (fully paid)	5	5	5*	5⅛—5⅜ xd	
Do. 10/- Pm	5	5	5	5⅛—5⅜ xd	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7½	11—12	
Oxford Electric Co., Ltd.	5	7	7½	5½—6 xd	−⅛
Do. 4% Deb. Red.	Stock	4	4½	93—95	
St. James and Pall Mall E. L. Co. Ld.	5	10	10½	7½—8½	
Do. 7% Non-Cum. Pref.	5	7	7½	6¾—7	
Do. 3½% Deb. Red.	Stock	3½	3½	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	½—1½	
Do. 4% Deb. Red	Stock	4	4½	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2⅜—3⅛	+⅛
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅝—⅞	
Do. 7% Cum. Pref.	1	7	7½	1¼—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½	101—104	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1½—2¼	
Do. 5% Cum. Pref.	5	5	2/6*	2—2½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½*	90—93	
Westminster Elec. Sup. Corp., Ltd.	5	12	10½	7¾—8¾	
Do. 4½% Cum. Pref.	5	4½	4½	5—5½	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb	Stock	4	4	89—92	+1
Central London	Stock	4	3½	63—66	−1
Do. 4% Preferred	Stock	4	4	82—84	
Do. Deferred	Stock	4	2½	42—45	−2
Do. 4% Debentures	Stock	4	4	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4	81—84	
City and South London Cons.	Stock	2½	4½	37—39	−1
Do. 4% Perp. Deb.	Stock	4	4	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5	114—117	
Do. 5% Perp. Pref. 1896	Stock	5	5	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5	110—113	
Great Northern & City Pref. "A"	10	4	11 xd	1—1½	−¼
Gt. Northern, Piccadilly & Brompton	10	4	4	5½—6½	
Do. 4% Perp. Deb.	Stock	4	4	87—90	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1	35½—36½	−½
Do. 3½% Preference	Stock	3½	3½	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½	76—79	
Do. 3½% Convertible Pref.	Stock	3½	5½	71—74	
Metropolitan District	Stock	nil	—	9¼—10½	
Do. 6% Perp. Deb.	Stock	6	6	108—113	
Do. 4% Deb.	Stock	4	4	70—75	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pr. Guar. by U. E. Rs. Co.	Stock	3	3½	44—48	
Underground Elec. Railways Co of London 5% Profit Sug. Sec. Notes	Various	5	5	40—44	
Whitechapel and Bow 4% Deb.	Stock	4	4	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-	⅝—¾	
Do. 5% Cum. Pref.	1	5	5	1⅛—1⅜	
Do. 4½% Deb. Red.	Stock	4½	4½	94—96	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6*	4¼—4½	−⅛
Do. 5% Perp. Deb.	Stock	5	5	97—100	
Do. 4½% 2nd Deb.	Stock	4½	4½	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4⅜—4⅝	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4	98—101	

NAME.	Amount of Share.	Dividend Paid. * = Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%			
Dublin United Trams Co.	10	6	6*	12¼—13¼	
Do. 6% Pref.	10	6	6	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	¾—1⅜	
Do. 4% Deb.	Stock	4	4	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5	91—94	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5	7—8	
Do. 4% 1st Mort. Deb. Red	Stock	4	4	82—86	+1
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½*	87—92	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5	⅜—½	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½	97—99	
National Elec. Construction Co. Ltd.	1	10	2/-	½—¾	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅜—1⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	¼—⅜	
Do. 3½% Mort. Deb.	100	3½	3½	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9d*	¼—⅜	
Do. 5% Cum. Pref.	1	5	5	⅜—½	
Do. 4½% Deb. Red	Stock	4½	4½*	93—96	
Provincial Tramways Co. Ltd.	10	3½	4	4½—5	
Do. 6% Cum. Pref.	10	6	6	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	1/1½	¾—1½	
Do. 4% Deb. Red.	Stock	—	4	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5	78—75	+3
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1½	
Do. 6% Cum. Pref.	5	nil	—	3—3½	−⅛
Do. 4½% 1st Deb. Red	Stock	4½	4½	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	3½	54—57	
Do. 6% Pref. Ord.	Stock	6	6	97½—99½	
Do. Def. Ord.	Stock	1¾	1¾	13½—14	+½
Commercial Cable Co., 4% Deb. Red.	Stock	4	4	87—90	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3½—3¾	
Do. 10% Cum. Pref.	5	10	5/-*	8¾—9¼	
Do. 4½% Debs.	50	4½	4½	99½—102½	
Direct United States Cable Co. Ltd.	20	4½	4½	13⅝—14½	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4	98—101	
Do. do. (Mauritius Sub.)	25	4	4	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12⅜—13½	
Do. 4% Mort. Deb. Perp.	Stock	4	4	99—102	
Eastern Telegraph Co.	Stock	5⅜	5	130—135	
Do. 3½% Pref.	Stock	3½	3½	83—86	
Do. 4% Mort. Deb.	Stock	4	4	100—103	
G. N. Tel. Co. (Copenhagen)	10	20	5*	31—33	
Indo-European Telegraph Co. Ltd.	25	13	65/-	54—57	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	
National Telephone Co., Ltd., Pref.	Stock	6	6	107—109	
Do. Deferred	Stock	5½	6	108—110	+1
Do. 6% Cum. 1st Pref.	10	6	6	10—12	
Do. 6% Cum. 2nd Pref.	10	6	6	10—12	
Do. 5% 3rd Pref.	5	5	5	5⅜—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½	97—99	
Do. 4% Deb. Red.	Stock	4	4	101—103	+½
West African Telegraph Co. Ltd.	10	4	4/-	10—10½	
Western Telegraph Co., Ltd.	10	7	6½	12⅜—13⅝	
Do. 4% Deb.	Stock	4	4	98½—101½	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅛—⅜	
Do. 6% Cum. Pref.	1	6	7½d	⅜—⅝	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅜—3⅝	
Do. 6% Pref.	1	6	7½d	1⅞—1⅞	
British Insulated & Helsby Cables, Ltd.	5	10	4/-*	6¾—7¼	
Do. 6% Cum. Pref.	5	6	6	5⅝—6⅛	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½	101—104	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½	84—88	+1
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—⅜	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	+1
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅜	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½	77—80	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10⅜—11⅜	
Do. 5% Cum. Pref.	5	5	5	5⅜—5⅝	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½	106—108	
Consolidated Electrical Co., Ltd.	1	3	8½d*	⅞—1	
Crompton & Co., Ltd.	3	5	5	1½ 2⅛	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5	92—95	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1⅜—1⅝	
Do. 6% Cum. Pref.	1	6	7½d	1⅛—1⅜	
Do. 4½% Deb. Red	Stock	4½	4½	99—102	
Edison & Swan United "A." £3 paid	5	4½	2/6	⅜—1	
Do. do. (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5	87—90	
Electric Construction Co., Ltd.	2	—	—	¼—½	
Do. 7% Cum. Pref.	2	7	—	1½—1⅝	
Do. 4% 1st Mort. Deb.	Stock	4	4	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5	7⅜—8½	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15	11—12 xd	−⅜
Do. 4½% Cum. Pref.	5	4½	4½	4⅜—5¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	106—108	
I. R. & G. P. Co., Ltd.	10	10	10	15½—16½	+½
Do. 4% Deb. Red.	100	4	4*	99—101	
Tel. Const. & Maintenance Co.	12	15	5*	31—33	−2
Do. 4% Deb. Bds. Red.	100	4	4	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6	3½—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4	4	72—77	

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THE PROPOSED HOME OFFICE REGULATIONS

(Special Report. Strictly Copyright)

THE inquiry into the proposed Home Office Regulations respecting the use of electricity in factories and workshops was resumed before Mr. Swinburne on Monday at Caxton Hall, Westminster. As has been previously reported in our columns, objections have been raised to the whole principle of the Regulations, and also to numerous points of detail. During the previous sittings much time was devoted to the argument that electrical undertakers under statutory powers should be exempt from the Regulations, and the proposed rules as to the dimensions of switchboard galleries and passages and as to the compulsory use of no-voltage releases for alternating-current motors were hotly opposed. On the resumption of the inquiry on Monday some arguments were heard with regard to the exemption of docks, and then Mr. A. P. Trotter, Electrical Adviser to the Board of Trade, gave evidence.

MONDAY, MARCH 16th.—FIFTH DAY.

Mr. Vesey Knox, K.C., on behalf of the Mersey Docks and Harbour Board, referred to exemption (*b*), viz.: —"Nothing in regulations 7, 8, 9, 10, and 28 shall apply in electrical stations to any circuit, conductor, or cable used for conveying electrical energy for public supply or traction, under statutory powers or for railway purposes." His clients wished respectfully to point out that there was no reason why the words "or for railway purposes" should not be made applicable to the railway works in connection with docks, especially in the case of a statutory dock undertaking, such as that of the Mersey Docks and Harbour Board. There was no real difference between a railway shunting yard on dock premises and upon purely railway premises; nor was there any difference with regard to cranes, &c. As a matter of law, dock premises did not come within the Factory Acts, unless part of them were used for making goods or something of that sort, and he would like to bring to the Commissioners' notice regulations dated August 24th, 1906, and made under Section 149 of the Factory Act of 1901, relating to the use of locomotives and wagons on lines and sidings used in connection with premises coming within the Factory Acts. In these regulations dock premises were expressly excluded, and he thought that if the same exclusion could not be made in these regulations, at any rate the dock premises should be given the same advantages as railways.

Mr. Swinburne asked if the exemption referred to only included rolling-stock, or did it include other things?

Mr. Vesey Knox thought it was quite clear that the exemption included cranes, capstans, &c., as the words "or for railway purposes" had been added apparently to have a wider meaning than "traction under statutory powers," which would have covered purely traction purposes.

Mr. Downing, on behalf of the Barry Railway Co., suggested the addition of the words, "railway or dock purposes" at the end of the exemption. His company owned a large number of docks, and he concurred in everything Mr. Vesey Knox had said.

Mr. Vesey Knox thought his suggestion might, at any rate, be confined to statutory dock undertakings.

Mr. Gray, on behalf of the Home Office, promised to consider the suggestion.

Mr. A. P. Trotter, Electrical Adviser to the Board of Trade, gave evidence as to overlapping between the present Board of Trade regulations and the proposed regulations of the Home Office. He said he was authorised by the Board of Trade to suggest one or two amendments to the existing regulations with the object of avoiding overlapping.

A new definition would be added to the Board of Trade regulations to read as follows:—"In these regulations the expression 'principal regulations' means regulations for securing the safety of the public made by the Board of Trade in. . . ."

At the end of regulation A1 of the Board of Trade regulations the following provision to be added:—

"Provided that these regulations shall not apply to the supply of energy to any factory, workshop, or mine."

Another paragraph would be added to regulation A1 as follows:—

"An extra high pressure supply shall not be given to any consumer's premises other than a factory, workshop, mine, or electric traction works. Where the consumer's premises are an electric traction works, a supply shall only be given with the consent of the Board of Trade, and shall be subject to such regulations as the Board of Trade may prescribe."

Mr. Trotter continuing, said that at present the Board of Trade had to give consent to each individual case of extra high pressure supply, but in future in factories this would no longer be necessary, because the Home Office regulations would have to be complied with. These alterations would, he thought, obviate any overlapping between the two sets of rules.

A number of questions were put on behalf of the objectors. Mr. Vesey Knox pointed out that insulation was dealt with in regulation 6 of the Board of Trade and regulation 2 of the Home Office.

Mr. Trotter did not think there would be any overlapping here. He said there was a certain point at which the jurisdiction of the Home Office and the Board of Trade met, and this point was defined as the consumers' terminals, which were defined in the principal Act.

Mr. Vesey Knox pointed out that it was proposed to apply the Home Office regulations to stations and sub-stations, so that there must be friction between the Home Office and the Board of Trade regulations.

Mr. Trotter said he had regarded the question mainly from the point of view of factories. He confessed that it might be necessary to exclude from the Board of Trade regulations generating stations and sub-stations if they were to become subject to the Home Office rules.

Mr. Vesey Knox: To what, then, would your Board of Trade regulations apply?—They would apply mainly to the distributing mains in the streets, and to the safety of the public in respect of them.

In reply to further questions, Mr. Trotter said he did not think there would need to be any modifications of the Board of Trade regulations with regard to sub-stations, because hitherto the Board of Trade had only dealt with this from the point of view of ventilation and drainage. The plans generally sent to him for sub-stations would not contain any details of switches. He generally told people that the sub-station must be constructed according to the Home Office regulations.

Mr. Vesey Knox: But the Home Office regulations deal with ventilation and drainage also?—These are very important for the employees.

Continuing, in answer to further questions, Mr. Trotter said that it was quite possible that if the Board of Trade found the Home Office regulations insufficient, or *vice-versâ*, the owners of the sub-station might have to do something more, because the two departments were looking after the interests of different sections of the community. He did not think this was necessarily overlapping, because if the owner of the sub-station complied with the strictest regulations he would satisfy both departments. Similarly, on the question of penalties, although Mr. Trotter understood that there would be two supplemental penal provisions, he did not think they would come into conflict.

Some further questions were put by Mr. Vesey Knox and other representatives of objectors, which Mr. Trotter thought took him away from the question of overlapping, and he gave no answer.

Mr. Guttridge, on behalf of the London County Council, asked if it was proposed to make fresh regulations for tramway sub-stations supplying energy for lighting the tramcars. Mr. Trotter said no. In reply to further questions, that such sub-stations would have to comply with two sets of regulations, Mr. Trotter replied that the Board of Trade at present had no regulations for switchboard details.

Mr. Guttridge drew attention to the extra-high pressure regulations of the Board of Trade, which gave the officials of the Board authority to enter and inspect premises. He thought that this would give the Board of Trade officials power to make regulations as to the details of switchboards. Mr. Trotter said that though these regulations might give this power it was never acted upon, as the Board only took into account the safety of the public.

Mr. Morse suggested that the Board of Trade Regulations, in referring to the safety of the public, sufficiently covered the employees.

Mr. Trotter said he could not give a definition of the word "public," but it had not been regarded by the Board of Trade from the point of view of employees hitherto. Mr. Trotter further said that it was not the intention to hand over to the Home Office the authorisation of extra-high pressure supply, and if the amendments which he had suggested permitted of this then some alteration must be made.

Mr. Morse then drew Mr. Trotter's attention to the fact that some years ago an inquiry was held in London at which the dimensions of transformer boxes under the streets were restricted to certain limits. These limits had been approved by the Board of Trade, and in the case of the County of London Electric Supply Co., there had been 160 such boxes constructed. These boxes would not comply with the new regulations, and he wished to know what position the undertakers would be in.

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seeing that although they did not comply with the regulations they were forbidden to alter them.

Mr. SWINBURNE intimated that he did not think Mr. Trotter could answer this question.

Mr. TROTTER suggested that perhaps in the cases spoken of by Mr. Morse, the Board of Trade had some regard for the safety of the employees, but experience had shown the precautions taken to be insufficient. He had a large number of newspaper cuttings which showed that sub-stations were a very fruitful source of accident.

Mr. GRAY, on behalf of the Home Office, then called further evidence on Rule 12, dealing with no-voltage releases for alternating-current motors.

Mr. E. GARSIDE, Managing Director of Engineering Instruments, Ltd., said that his firm had been making these instruments for some time, and also as a combination of starting switch and stator main switch for alternating-current motors. The smallest sized motor for which they had standardised this apparatus was 50 h.p. The difference in price between a plain hand switch and a switch with no-voltage release for a 50-h.p. 500-volt motor was £5. Hitherto they had mostly been put in coal mines, but a few had been put in factories. His firm only made a completely enclosed switch. For less than 50 h.p., although he had never made a release of this description, he estimated, from his experience with the larger sizes, that the difference in price between a plain switch and one with no-voltage release was £2. His firm had supplied this apparatus for motors from 50 h.p. to 200 h.p., and during the three years they had been supplied he had received repeat orders.

In cross-examination by Mr. Vesey Knox, witness stated that the price for a plain hand switch for a 50-h.p. motor, of the type manufactured by his firm, was about £3, and with the no-voltage release attachment it would be from £8 to £9. These prices were the average selling prices of his firm for the past two years.

Mr. VESEY KNOX said that this price for a plain knife switch was about 200 per cent. more than the Newcastle Co. was in the habit of paying for a perfectly reliable article.

Mr. GARSIDE said that, of course, switches could be obtained at all prices.

In reply to further questions, he said that about 44 of these switches had been supplied during the past three years, 26 of which were for three-phase motors. Most of them had been supplied to electrical contractors and manufacturers, and a good many of them to Messrs. Ernest Scott & Mountain, of Newcastle-on-Tyne. He could not give the names of any collieries in that district, because the collieries were not his clients.

Mr. VESEY KNOX then put a question to witness as to the output of his firm, to which Mr. Gray, on behalf of the Home Office, objected as irrelevant.

Mr. VESEY KNOX said that he regarded this evidence as an attempt to push what he might call an unpractical article with the assistance of the Home Office, and he only wished to show that the firm represented by the witness was not really a large manufacturing firm at all; but he would not press the question.

Questioned by Mr. A. B. Caine on behalf of the London Electric Lighting Companies, Mr. GARSIDE said that he had supplied several to the Union Electric Co. in London, but he could not give the name of any place where one could be seen working. They were supplied to the contractors, and he did not know for what purpose they had been used.

Mr. GRAY, on the question of no-voltage releases, said that having carefully considered Mr. Merz's evidence that probably 95 per cent. of the installations at present existing were safe, without this, it was not fair to make regulations for only 5 per cent., and to make the other 95 per cent. comply with them. The Home Office were willing to alter the second part of Regulation 12 to read as follows:—

"Where necessary to prevent danger, to prevent the automatic restarting of a motor, every electrical motor or group of electrical motors shall be protected by a release which will automatically break the circuit if the current is interrupted, such a release being suitably placed and arranged having regard to the danger to be prevented."

At this point a suggestion was made by the objectors that a conference should be held between the experts on both sides with a view to clearing out of the way many minor points on which all the objectors were agreed. After some discussion, it was decided to appoint a committee of objectors to meet the Home Office experts and advisers, and the afternoon was devoted to a private conference between these. Messrs. Frank Bailey and C. P. Sparks represented the London Electric Lighting Companies and the British Electrical Federation, Mr. C. H. Merz represented the Newcastle Power Companies, the Mersey Docks and Harbour Board, &c., Mr. Cozens-Hardy and Mr. Sillar represented a large number of small public generating stations, in addition to a number of factories and consumers generally, Messrs. W. W. Lackie, H. Talbot, and H. Faraday Proctor represented the municipalities owning generating stations, and Mr. T. Roles represented the Bradford Corporation, the Leeds Chamber of Commerce, and the Yorkshire Electric Power Co. On behalf of the Home Office there were present Mr. J. Hunter Gray and Mr. Raymond Asquith, Mr. B. Arthur Whitelegge, C.B., M.D., H.M. Chief Inspector of Factories, Mr. G. Scott Ram, H.M. Electrical Inspector of Factories, Mr. W. H. Patchell and Mr. J. F. C. Snell.

TUESDAY, MARCH 17TH.—SIXTH DAY.

Mr. GRAY, on behalf of the Home Office, announced that the result of the conference on the previous afternoon was that those concerned had agreed upon certain modifications to the first 11 regulations. We give below the regulations, as amended:—

Regulation 1.—All apparatus and conductors shall be sufficient in size and power for the work they *are* called upon to do, and so constructed, installed, protected, worked, and maintained as to prevent danger *so far as is reasonably practicable.*

The original regulation read "for the work they may be called upon to do," and did not contain the last six words.

Regulation 2.—All cables shall either be covered with insulating material, and further efficiently protected where necessary, or shall be so placed and safeguarded as to prevent danger *so far as is reasonably practicable.*

The last six words have been added.

Regulation 3.—Every switch, circuit-breaker, and isolating link shall be:—(*a*) So constructed, placed, or protected as to prevent danger. (*b*) So constructed and adjusted as accurately to make and to maintain good contact. (*c*) Provided with an efficient handle or other means of working, insulated from the system, and so arranged that the hand cannot *inadvertently* touch live metal. (*d*) So constructed or arranged that it cannot accidentally fall or move into contact when left out of contact.

The word inadvertently has been added.

Regulation 4.—Every switch *intended to be used for breaking a circuit* and *every* circuit-breaker shall be so constructed that it cannot be inadvertently left in partial contact. Every switch *intended to be used for breaking a circuit* and *every* circuit-breaker shall be so constructed that an arc cannot accidentally be maintained.

The italicised words have been added.

Regulation 5.—Every fuse and automatic circuit-breaker used instead thereof shall be so constructed and arranged as effectively to interrupt the current before it so exceeds the working rate as to involve danger. It shall be of such construction or be so guarded or placed as to prevent danger from overheating, or from arcing or the scattering of hot metal or other substance when it comes into operation. Every fuse shall be either of such construction or so protected by a switch that the fusible metal may be readily renewed without danger.

The alteration is merely a verbal one.

Regulation 6.—Every electrical joint and connection shall be of proper construction as regards conductivity, insulation, mechanical strength, and protection.

This regulation is as before.

Regulation 7.—Efficient means, suitably located, shall be provided for cutting off all pressure from every *part of a system as may be necessary to prevent danger.*

The italicised words replace the word "circuit" in the original regulation.

Regulation 8.—It was agreed that, subject to discussion on Regulation 13, this regulation should be altered to read as follows:—

"Efficient means suitably located shall be provided for protecting from excess of current every part of a system as may be necessary to prevent danger."

The regulation is entirely re-written. Originally it specified that every circuit arranged to carry more than 750 watts should be separately protected.

Regulation 9.—Where a conductor of a system is connected to earth, no single pole switch other than a link for testing purposes or a switch for use in controlling a generator, shall be placed in such conductor or any branch thereof.

Originally the regulation read:—"Where one point of a system is connected to earth, no single-pole switch other than a link for testing purposes shall be placed in any cable connected thereto."

Regulation 10.—Where one of the main conductors of a system is bare and uninsulated, such as a bare return of a concentric system, no switch, fuse, or circuit-breaker shall be placed in that conductor, or in any conductor connected thereto, and the said conductor shall be earthed.

There is practically no alteration in this.

Regulation 11.—Every motor, converter, and transformer shall be protected by *efficient means* suitably placed, and so connected that all pressure may thereby be cut off therefrom and from any apparatus in connection therewith, *provided, however, that where one point of the system is connected to earth, there shall be no obligation to disconnect on that side of the system which is connected to earth.*

"Efficient means" replaces the words "switch and switches" in the original regulation, and the last thirty-one words have been added.

The proceedings were adjourned at an early hour to allow of a further conference between the parties in respect of the remaining regulations.

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WEDNESDAY, MARCH 18TH.—SEVENTH DAY.

Mr. SWINBURNE said he understood the Committee of Objectors and the Advisers to the Home Office had not concluded their consideration of the regulations.

Mr. GRAY handed in a report of the proceedings of the private conference as far as it had gone yesterday, and we give the further amended regulations below. At the same time he corrected part of Mr. W. H. Patchell's evidence concerning no-voltage releases. Mr. Patchell had stated that he had used these for both 440 volts and 2,000 volts. Upon inquiry it was found that these had not been actually used for 2,000 volts, although the apparatus was ready.

Regulation 12.—Every electrical motor shall be controlled by an efficient switch or switches for starting and stopping, so placed as to be easily worked by the person in charge of the motor. To prevent danger through the automatic re-starting of a motor every electrical motor *or group of electrical motors* shall be protected by a release which will automatically break the circuit if the current is interrupted, *such release being suitably placed with regard to the danger to be prevented. Provided that no release shall be required for any motor which has an attendant constantly at the controller of such motor while at work.* In every place in which machinery is being driven by any electric motor, there shall be means at hand for either switching off the motor or stopping the machinery.

The words in italics have been added. The last ten words replace the words "for quickly stopping the motor" in the regulation as originally drafted. This is one of the regulations about which there has been much discussion, in view of the contention that no-voltage releases for A.C. motor switches are unnecessary, and that very few are in use.

Regulation 13.—Every flexible wire for portable apparatus shall be connected in a system either by efficient permanent joints or connections, or by a properly constructed connector. Adequate precautions shall be taken against shock due to leakage or other cause in all places where the person handling the portable apparatus is not insulated from earth. In such places and in any place where the pressure exceeds low pressure, the portable apparatus and its flexible wire shall be controlled by sufficient means suitably located, and capable of cutting off the pressure.

The original regulation specified the use of a switch to control every piece of portable apparatus and its flexible, and that in the case of pressures exceeding low pressure the switches should be double-pole. It is seen that the necessity of a switch in the case of low pressure is dispensed with.

Regulation 14.—The general arrangement of switchboards shall, so far as reasonably practicable, be such that: (*a*) All parts which may have to be adjusted or handled are readily accessible. (*b*) The course of every conductor may, *where necessary*, be readily traced. (*c*) Conductors connected to different systems are kept *well* apart and can *when necessary* be readily distinguished. (*d*) All bare conductors are so placed or protected as to prevent danger from accidental short circuit.

The words in italics have been added.

Regulation 15.—Every switchboard having bare conductors normally so exposed that they may be touched, shall be located in an area or areas set apart for the purposes thereof *or where necessary* suitably fenced or enclosed. No person except an authorised person, or a person acting under his immediate supervision, shall *for the purpose of carrying out his duties* have access to any part of such area.

The words in italics have been added.

Regulation 16.—All apparatus appertaining to a switchboard and requiring handling shall, so far as practicable, be so placed or arranged as to be operated from the working platform of the switchboard, and all measuring instruments and indicators connected therewith shall, so far as practicable, be so placed as to be observed from the working platform. If such apparatus be worked or observed from any other place, adequate precautions shall be taken to prevent danger.

No alterations have been made.

Regulations 17 *and* 18.—The consideration of these regulations was postponed. They relate to the design and dimensions of switchboard galleries and passage-ways, and it will be remembered that they are strongly opposed, especially by the owners of existing electricity works.

Regulation 19.—All *parts* of generators, motors, transformers, or other similar apparatus, at high pressure or extra high pressure, and within reach from any position in which any person employed may require to be, shall be, *so far as reasonably practicable*, so protected as to prevent danger.

The word "parts" replaces the words "all fixed coils, conductors, or terminals" in the original regulation, and the words "similar," and "so far as reasonably practicable" have been added.

Regulation 20.—Where a high pressure or extra high pressure supply is transformed for use at a lower pressure, suitable provision shall be made to guard against danger by reason of the lower pressure system becoming accidentally charged above its normal pressure by leakage or contact from the higher pressure system.

The only alteration in this regulation is an important verbal one.

In order to give an opportunity for the Committee of Objectors and the Advisers to the Home Office to complete their consideration of the regulations, the inquiry was adjourned until Tuesday, March 24th.

LOCAL NOTES

BARNES: *Electricity Charges.*—In a report, the Electrical Engineer recommends that 10 per cent. for lighting be allowed to power consumers. In regard to a suggestion made that the charges for private lighting be reduced by 1d. per unit, the engineer states that if such a reduction was made, there would be £1,542 less income, and he suggested that if a reduction was deemed essential, that it should be only ½d. The surplus gross revenue for 1907-8 was £6,837, and deductions from this left a net amount of £4,191. The amount necessary to meet current expenditure was £1,200, leaving £3,000 to be carried to a reserve fund, the establishment of which he strongly recommended. In the result the Council decided not to make any reduction in the charges, but approved the establishment of a reserve fund, and referred the question of the amount of such fund to the Finance Committee.

BATH: *The Electric Light Works.*—At the last meeting of the Corporation the report of the Electric Lighting Committee stated that, in connection with the application of the Bath Rural District Council for an extension of their Electric Lighting Provisional Order for two years, and a transfer of the powers to Mr. Schenk, representing the Somerset Electric Power Co., objection had been lodged with the Board of Trade. Dealing with the proposal to purchase the Corporation's electricity works by Mr. Schenk, the Chairman of the Electricity Committee stated that it would be impossible to complete the arrangements entered into for the transfer to the undertaking by the date mentioned in the agreement, namely, March 31st. Difficulties had arisen which had necessitated a further interview between Mr. Schenk and the sub-committee, and an alternative proposal had been made, which, if it could be carried out, the committee were of an opinion would be equally advantageous to the Corporation. It had been agreed, however, that the sum of £2,500, which had been deposited by Mr. Schenk, would remain the property of the Corporation.

BIRMINGHAM: *The Tividale Tramcar Accident.*—Col. Yorke held an inquiry at the Oldbury Council House on Thursday into the recent accident upon the system of the Birmingham and Midland Tramways, Ltd., when a car overturned when crossing the points at Tividale (ELECTRICAL ENGINEERING, MARCH 5th, p. 367). During the course of the evidence the inspector stated that he was unable to attribute the cause of the accident to the condition of the permanent way. No technical evidence was called.

BRIGHTON: *Shoreham Harbour and the Electricity Works.*—The Shoreham Harbour Trustees at its last meeting discussed the question of the protective measures which it considered the Corporation should take to protect the foreshore of the harbour, in consequence of the operations of the Corporation in connection with the electricity works. It was pointed out that the Corporation had weakened that part of the beach by taking shingle for the foundation of the Southwick works, with the result that part of the beach had given way, and the sea had come over the crown. The Harbour Master expressed the opinion that very much more substantial work should be done than up to the present, and suggested the use of groynes.

CITY OF LONDON: *Tramways.*—At the meeting of the Court of Common Council on Thursday, the following letter from the Clerk of the London County Council was read:—"The Council understands that the City Corporation has under contemplation the rebuilding of Southwark Bridge. The Council feels that this work, if undertaken by the Corporation, would afford a very favourable opportunity for taking the tramways across the bridge from the present terminus in Southwark Bridge Road to a point a little north of the river. By this means important additional travelling facilities would be provided—particularly for those wishing to reach parts of the City which would be thus served. The Southwark Bridge tramways are already largely used by persons travelling to and fro from South London to their places of work in the City, and the present position of the tramway terminus south of the river is a source of very real inconvenience to those passengers. In view of these facts, the Council hopes that the Corporation will be so good as to take into consideration the question of the extension of the tramways as proposed, simultaneously with the reconstruction of the bridge, if decided upon. The Highways Committee of the Council have the matter before them, and they would be glad of an opportunity of attending before the Corporation, or one of its committees, on the subject by depu-

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tation, and explaining the Council's views thereon more fully. It would be a great convenience if you would kindly inform me at an early date whether the Corporation will grant an interview to the committee to discuss the question." The letter was referred to the Bridge House Committee, who were empowered to confer with the Highways Committee of the London County Council.

DUNDEE: *The Stannergate Power Station.*—Mr. H. Richardson, the Electrical Engineer, reports that the extra high tension mains from the Dudhope Crescent Road station to the central area of the city, have been completed, whilst those from the new station at Stannergate will be laid shortly.

DUNFERMLINE: *Electric Lighting.*—In consequence of the refusal of Sir Alexander Kennedy to act as Consulting Engineer to the Town Council, owing to his advice to dispose of the Provisional Order to the Fife Electric Power Company not being acted upon, the Electric Lighting Committee recommends that Mr. O. F. Francis, Electrical Engineer to the Kirkcaldy Burgh Council, be appointed to act. A motion disapproving of this recommendation, and urging that a vote of the ratepayers be taken to decide the question as to whether the Council shall erect a generating station or transfer its Provisional Order, was ultimately carried.

EALING: *Tramways.*—Councillor Armriding, the originator of the proposed scheme of municipal tramways, has stated that he has come to the conclusion that the trams would be neither profitable nor practicable.

EDINBURGH: *Edinburgh Exhibition.*—It is stated that a proposal will be made to the Corporation for laying a double line of electric tramway between the terminus of the present cable line at Murrayfield and the Edinburgh Exhibition. The proposal is being made by the owners of the patent of the Cope shallow-conduit system, who express their willingness to lay down the line free of cost, to work it during the Exhibition, and, if desired, remove it at the close. The Edinburgh Tramways Co. has been negotiated with, and are prepared to arrange for through booking.

HANDSWORTH: *Purchase of Tramways.*—The Urban District Council has served notice upon the City of Birmingham Tramways Co., requiring the company to sell to the Council the tramways in Handsworth. A sub-committee of the Urban District Council recommend that arbitration be resorted to for settling the price to be paid for the undertaking, and that the Board of Trade be asked to appoint a referee.

JOHANNESBURG: *The Gas Driven Generating Station.*—It seems, says the *British and South African Export Gazette*, that an effort to remedy rather than reject the giant producer-gas power plant at Johannesburg has been hindered by premature publicity. The Council had under consideration a scheme by which Messrs. W. and J. Beardmore, the guarantors, were to be allowed to form two companies, one for lighting and one for power, and the former, with a capital of £250,000, was to take over the plant on payment of £175,000, of which £125,000 would be in debentures. This company was to guarantee to commence the restoration of the plant within six months, to bring it to within 25 per cent. of the contract stipulation within two years, and to supply the Municipality with 10,000,000 units per annum, while also reserving the right to supply current to the mines. The power company was to have a capital of £200,000, would guarantee the £125,000 debentures, and would erect and equip a power station. The whole scheme was to be without prejudice to the Municipality's claim on the contractors and guarantors. The details of the scheme were being kept strictly private, when the *Transvaal Leader* astonished the Council and public alike by printing a lengthy account of it, which the Special Committee alleged to have been divulged by one of themselves, and forthwith resigned by way of protest. A new committee has now been appointed, and the scheme, if it be adhered to, needs a great deal of elucidation, and will no doubt, be the subject of thorough discussion by the authorities and the ratepayers before it is adopted.

KIRKINTILLOCH: *Tramways.*—The question of approaching the Glasgow Corporation for an extension of the tramway system into Kirkintilloch, was raised at a recent meeting, and the Clerk to the Council was instructed to write to the Tramways Committee of the Glasgow Corporation on the subject.

LANCASHIRE: *New Tramway Project.*—Messrs. Vaudrey, Oppenheim, and Mellor, solicitors for the promoters of the proposed new tramway between Preston, Chorley, Adlington, and Horwich, coupling up there with the Bolton system, are negotiating with the Bolton Corporation for a supply of current in bulk at the Horwich end of their system.

LEEDS: *Tramwaymen's Hours.*—A deputation of the Amalgamated Society of Tramway and Vehicle Workers has waited upon the Consultative Committee of the Corporation to discuss the men's demand for a reduction of six hours per week in the hours of labour, without any reduction in pay. The Tramways Committee, as a compromise, recently offered a merit badge for seven years' service and afterwards, carrying with it an advance of 1s. per week. The men's Union state that in eleven towns chosen by Mr. Hamilton, the Manager, for the purpose of comparison, the average rate of pay is 6·24d. per hour, as against 6d. per hour in Leeds. The matter has been referred back to the Tramways Committee.

LIVERPOOL: *Tramwaymen's Pensions.*—The City Council has adopted a scheme for providing pensions for the tramway employees. Each employee will contribute 2d. per week, and the Corporation will contribute a similar amount.

LONDON: *London County Council: G.B. Surface Contact System.*—A successful trial trip has been made over the line between Aldgate and Bow Bridge, which has been constructed upon the G.B. surface contact system. It is not expected that the full service of cars will be available for about a month.

New Chairman of the Highways Committee.—The Highways Committee of the London County Council have elected Mr. Whitaker Thompson (Vice-Chairman of the Council) as Chairman of the Highways Committee for the coming year. Mr. A. Shirley Benn has been elected Vice-Chairman, and will also represent the Highways Committee on the General Purposes Committee.

Tramways.—On the report of the Law and Parliamentary Committee, Sir John Benn asked whether the committee were aware that in consequence of the arrangement arrived at between Paddington Borough Council and the Metropolitan Electric Tramways, Ltd., unless prompt action was taken the whole cost of the improvements, consequent on the extension of the L.C.C. tramway to Edgware Road, would fall on the County of London, and that by this arrangement Paddington would escape that proportion which other boroughs had paid in like cases. Mr. Cassel, Chairman of the Committee, explained that there was an arrangement between the promoters of the Bill and the County Council, by which at any time up to the end of committee stage in the Second House the Bill should be withdrawn unless the Council approved of certain points. Difficult negotiations were still in progress, and the results would be laid before the Council as soon as possible. Reference to this matter is also made in the "Local Note" under Paddington, below. The Highways Committee reported that the Board of Trade has approved the adoption of the overhead system on the tramways from Hammersmith Broadway to Uxbridge Road.

Camberwell: Underground Telegraph Wires.—The Borough Council has granted the Postmaster-General's request for consent to the placing of underground telegraph lines along 24 thoroughfares in Peckham, subject to the roadways and footways being made good at the expense of the Post Office authorities.

Fulham: Reserve Fund.—The Borough Council having received a report that at the present time there is a sum of, approximately, £2,016 standing to the credit of the Electric Light Machinery Maintenance and Reserve Fund, with reference to which the Finance Committee has been in consultation with the Electricity and Lighting Committee, has decided that the fund be placed to a separate account on deposit at the bank, such reserve account to be duly credited each quarter with the amount of interest it earns.

Greenwich: Tramways.—The L.C.C. is to be asked to construct a double line of tramway from the present terminus to Church Lane, Charlton, or to Charlton Lane. It is proposed by a joint committee of Greenwich Council that that authority contribute one-third of the cost of the road widenings.

Hackney: Electricity Accounts.—The report of the Finance and Electric Lighting Committee for the year ended March 31st, 1907, the fifth complete year of working, show that at that date the equivalent of 151,222 8 c.p. lamps were connected to the mains, including 372 motors, with an aggregate of 1,670 h.p. The total number of units sold was 3,504,336, and the average price received 2·02d. per unit. For public lighting the average price received per unit was 1·31d.; for private lighting 3·11d.; for power 1·07d.; and for destructor power 1d. The total number of units generated was 3,953,453, the difference being accounted for by works lighting and power, 190,665, battery 96,300, and distribution 162,152. The works costs amounted to 0·50d. per unit, and the total cost of generation, distribution, and management was 0·73d. per unit, a reduction of 0·11d. per unit on the result for the previous year. With these costs, Hackney, for the fifth year in succession, secures the record for the lowest costs of generation and distribution of electricity in the metropolitan area. The report gives the following comparisons of total works and management costs per unit sold:—Hackney, number of units sold, 3,504,336; total works and management costs per unit sold, 0·73d. Poplar: Number of units sold, 4,208,302; total works and management costs per unit sold, 0·92d. Stepney: Number of units sold, 4,751,182; total works and management costs per unit sold, 0·98d. Bermondsey: Number of units sold, 1,906,489; total works and management costs per unit sold, 0·99d. Hammersmith: Number of units sold, 4,220,736; total works and management costs per unit sold, 1·07d. Fulham: Number of units sold, 2,214,747; total works and management costs per unit sold, 1·26d. St. Pancras: Number of units sold, 7,276,214; total works and management costs per unit sold, 1·37d. Battersea: Number of units sold, 2,159,873; total works and management costs per unit sold, 1·45d. Shoreditch: Number of units sold, 4,218,574; total works and management costs per unit sold, 1·44d. Islington: Number of units sold, 3,829,650; total works and management costs per unit sold, 1·63d. Hampstead: Number of units sold, 4,303,765; total works and management costs per unit sold, 1·77d. Southwark: Number of units sold, 1,003,855; total

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works and management costs per unit sold, 1·81d. The financial results of the year's working shows that the total revenue was £31,417 6s. 10d., and working expenditure (including expenses in connection with public lamps), £12,124 10s. 7d. The gross profit for the year, plus interest, was £19,630 19s. Principal and interest absorbed £16,744 18s. 1d., and the balance of £2,886 0s. 11d. has been transferred to the reserve fund. The capital expenditure of the undertaking is £292,078 9s. 3d. The reserve fund now stands at £12,946 4s. 1d.

Marylebone: Expenditure on Electricity Works.—At Tuesday's London County Council meeting, the Finance Committee reported that they had received an application from the St. Marylebone Borough Council for the advance of £9,172 for the undermentioned purposes in connection with the Borough Council's electric lighting undertaking:—(i.) Mains (£5,033); (ii.) Machinery, viz., additional bonus on efficiency of four turbo-dynamos (£1,529), circulating water pump and motor (£845), sub-station switchboards, &c. (£1,480); and (iii.) Telephone equipment (£287). The loan was sanctioned, repayable as follows:—Mains, &c., 30 years; machinery, 20 years; and telephone equipment, 10 years. In addition to this application, the Borough Council has applied for a sum of £44,002, in connection with its electric lighting undertaking, which, added to the sums already sanctioned, will bring the total amount of loans in respect of the undertaking up to £2,043,000. When the last application from the Borough Council for a loan in connection with the undertaking was under consideration, the Finance Committee informed them that, in view of the very large sum which had been expended upon the undertaking, they would feel great difficulty in recommending sanction to any further loans, and that only loans for such additional expenditure as was absolutely necessary would be considered. They have therefore reminded the Borough Council of this communication, and have been told in reply that the present applications relate chiefly to expenditure in connection with the change of pressure and system of supply, and to the balance of the cost of erecting the generating station. With regard to the change of pressure, the Borough Council points out that it was impossible in the early stages to estimate closely the probable cost, and that the work had to be carried through in a very limited time, and involved larger expenditure than was thought would probably have been the case, owing to the stringent regulations laid down by the Board of Trade and the Council. The Borough Council adds that the applications cover the expenditure to date, and that it is not contemplated that any additional outlay on generating plant will be necessary in the normal development of the undertaking for some years to come. The Finance Committee are, however, deferring their report upon the application for the larger amount.

Paddington: Tramways.—The Borough Council has agreed not to oppose the Metropolitan Electric Tramways Company's Bill for an extension of their tramways along the Harrow Road from Lock Bridge to Edgware Road, the company having agreed to carry out, at its own expense, all the necessary street widenings, and to contribute £4,500 towards some street improvements now in the course of progress.

Shoreditch: Expenditure on New Connections.—At Tuesday's meeting of the London County Council, the loan of £7,150 was sanctioned for expenditure from October, 1905, to June, 1907. This has been necessitated by the demands of consumers. 285 additional premises have been connected during the period, whilst mains have been laid over a route length of about 8½ miles. The items and periods of loan are as follows:—Mains, £4,365, 30 years; Meters, £706, 10 years; and house services, £2,079, 12 years. The Finance Committee of the London County Council have, however, informed the Borough Council that it is not desirable that applications of this character should be so long deferred.

Westminster: Underground Telephone Wires.—The Works Committee recommend that a protest be made against the London County Council exercising jurisdiction in connection with the laying of underground telephone wires by the National Telephone Co. in any street in the City, except as may be necessary for the protection of property vested in them, or imposing upon the company any conditions with reference to matters which are within the jurisdiction of the City Council as road authority. It is proposed to forward a communication to the L.C.C. accordingly, and copies to the Postmaster-General, the National Telephone Co., the Corporation of London, and the Metropolitan Borough Councils, with a request to the last-mentioned to address a similar communication to the County Council in the event of their concurring with the views of the City Council. The Works Committee point out that the power given to the County Council by the Telegraph Act, 1892, which, however, only applies to the works of a licensee under the Telegraph Acts, *e.g.*, the National Telephone Co. does not override the power of the road authority, *i.e.*, in London, the respective City, and Borough Councils, but is supplemental to it.

MANCHESTER: *Tramcar Cleaners' Hours.*—The Municipal Employees' Association at Manchester has made an application for an advance of wages for the cleaners and brakesmen. Mr. J. M. McElroy, the General Manager, has replied that the Committee, having carefully considered the application, is unable to comply. The work of cleaning and examining the cars is now done at night, and in order to meet the wishes of the men expressed by a deputation recently, instructions have been given for arranging the work so that each man shall have one night per week off.

OXFORD: *Tramway Position.*—It is stated that an agreement has been arrived at between the Oxford Tramways Co., which owns the existing horse tramways, and the National Electric Construction Co., which has Parliamentary powers to acquire these and to reconstruct them upon the surface-contact system, whereby the present arbitration proceedings shall be abandoned and a new company formed. This new company will receive the Parliamentary concession, and also the plant and property of the existing company. The arrangements, of course, have to receive the sanction of the shareholders of the existing company, and also of the Corporation, as the arbitration proceedings are nominally between these two.

PENZANCE: *Electric Lighting.*—It has been decided to allow the Penzance Electric Lighting Co. until October 31st to give them an opportunity to satisfy the Council that they are in a position to proceed with their Electric Lighting Order. This decision has been come to in consequence of a request by the promoters of the company that the Council shall take no action at present to secure the revocation of the Order of 1904.

PERTH: *Electricity Charges.*—The Town Council has notified the North British Railway Co. and the Highland Railway Co. of their intention to increase the charge for electricity to 2¾d. per unit. The two companies in question have accepted this increase on the distinct understanding that the Council will reconsider the matter when fixing the rates for next year with a view to having them reduced.

SCUNTHORPE: *Provisional Order Revocation.*—The Electric Lighting Order granted to the Urban District Council in 1903 has been revoked by the Board of Trade.

SWINDON: *Tramway Accident Rate.*—The current year's rate at Swindon includes one penny in the pound as a final payment of the rate of 2s. 7d., which was levied in consequence of the heavy claims arising out of the accident on the tramway system two years ago.

YARMOUTH: *Street Lighting.*—Fifty-four incandescent gas lamps are to be converted to electric lighting.

YEOVIL: *Electric Lighting Order.*—The Board of Trade has been informed that the Council does not consider it advisable to take any further steps in regard to putting into force the electric Lighting Order granted in 1903.

YORK: *Tramways.*—A communication has been sent to the Corporation by the Yorkshire Architectural and York Archæological Society protesting against the threatened encroachment of the City ramparts in connection with the electric tramways recently sanctioned by the Light Railway Commissioners. The communication states that the defensive earthwork surrounding the City of York is one of the very few in England that has not been entirely obliterated, and the preservation of it is highly desirable.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ARGENTINE.—The workshops of Tafa Viejo, on the Central Northern Railway (National) are to be electrically equipped, and tenders will shortly be invited.

AYR.—Mr. R. Marshall, the Borough Electrical Engineer, recommends the installation of a 500 kw. alternator and other additions. Application is to be made for sanction to borrow £30,000 to meet extensions during the next eight years.

BECKENHAM.—It is proposed to install a battery at the generating station.

BRAY.—The Urban District Council invites tenders for electrical stores during the year ending April 1st, 1909, including cable, carbons, switches, incandescent lamps, &c. Tenders to the Clerk by April 7th.

BRISTOL.—The Electricity Committee invite tenders for a twelve months' supply of arc lamp carbons, and joint and junction boxes. (See an advertisement this week.)

BURSLEM.—At the last meeting of the Council, the Electric Lighting Committee reported that Mr. H. R. Hooper, the Local Government Board inspector, had recently visited the works at Burslem, and had remarked to the Engineer that having regard to the probability of the scheme for the federation of the Potteries being carried through, it was inadvisable to carry out any extensions at Burslem except those absolutely necessary to meet immediate requirements. The committee, however, adhere to their resolution to apply to the Local Government Board for sanction to borrow £12,000 for the electrical undertaking. This recommendation has been confirmed by the Council.

CHESHIRE LINES COMMITTEE.—Tenders are invited for

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the purchase of a second-hand boiler, steam engine, &c. Full particulars from the Engineer at Central Station, Liverpool, and tenders by April 7th. (See an advertisement this week.)

CHESTER.—The installation of a refuse destructor at the electricity works has been decided upon.

DEWSBURY.—The Electricity Committee invite tenders for surface condenser and cooling tower. Full particulars from the electricity works (fee £1 1s., returnable), and tenders to the Chairman of the Electricity Committee by March 30th.

DUBLIN.—The North Dublin Union Guardians are considering the lighting of the union with electricity.

EDINBURGH.—Tenders are invited for the supply of the following material for the Electricity Supply Department for the year from May 16th, 1908:—1. Bitumen. 2. Arc lamp carbons. 3. Arc lamp globes. 4. Cast-iron pipes and pavement boxes. 5. House service fuse-boxes. 6. Electricity meters. Particulars from the Engineer's office, Dewar Place, Edinburgh (fee, 10s. for each specification, returnable), and tenders to the Town Clerk by March 30th. (See an advertisement this week.)

FROME.—Mr. H. R. Hooper held a Local Government Board inquiry last week into an application by the Urban District Council for sanction to borrow £11,100 for the purpose of the electric lighting undertaking. The inquiry was adjourned until March 31st.

HALIFAX.—The Tramways Committee recommend that motors and material be purchased at an estimated cost of £6,000. This includes £4,000 for fifty 35 h.p. motors to replace existing 25 h.p. motors, and £1,100 for controllers for same.

HUDDERSFIELD.—Tenders are invited for the supply of single-phase alternating-current meters during the ensuing twelve months. Tenders to the Town Clerk by March 25th.

BLACKBURN.—Tenders are invited for the new Y.M.C.A. Hall in Limbrick, Blackburn, which will be lighted by electricity. The architect is Mr. T. J. Parkinson, of Richmond Terrace, Blackburn.

LEEDS.—The Electric Lighting Department invite tenders for the supply of steam coal and various supplies, including rubber-covered cables, main boxes, jointing and insulating material, electric lamp fittings, and sundries. Particulars from the Manager, and tenders to the Town Clerk by March 31st.

LIVERPOOL.—The Tramways, Electric Power and Lighting Committee recommend that application be made to the Local Government Board to borrow £3,000 for the erection of additional buildings at the Northend sub-station.

LONDON: *Bermondsey.*—The Electrical Engineer has submitted estimates for extensions as follows:—750 kw. generating set, £5,810; marine boiler, 14,000 lb. evaporation, £1,900; condenser, 25,000 lb., £3,460; total, £11,170. In a report made, the Electricity Committee recommend that the work should be put in hand with the least possible delay, so that the proposed extended plant may be ready to meet the increased demand which may confidently be looked for in the coming winter.

Hampstead.—A new sub-station is to be erected at an estimated cost of £380.

Marylebone.—Sanction has been granted for a loan of £9,172 in connection with the Borough Council's electricity undertaking, and application has been made with regard to an additional £44,002. Further particulars will be found in our "Local Notes" pages.

Shoreditch.—Haggerston Baths are to be re-wired at an estimated cost of £75 15s. 6d. In the working-class dwellings, 106 prepayment electricity meters are to be installed, at an estimated cost of £225. A commutator grinder is to be obtained for the generating station, at an estimated cost of £65.

ROTHERHAM.—The Engineer, Mr. E. Cross, recommends an application to the Local Government Board for a loan of £3,500 for the addition of a turbo-alternator with condensing plant, switchboard, &c., to the electricity works. This recommendation has been confirmed by the Corporation.

WOLVERHAMPTON.—Double-deck tramcars are to be purchased at an estimated cost of £2,000.

TENDERS RECEIVED AND ACCEPTED

AUSTRALIA: *Victoria.*—The tender of Mr. R. B. Hungerford, 163 Pitt Street, Sydney, has been accepted by the Victorian Postmaster-General's Department for the supply and delivery, at Melbourne, of five sections of a telephone switchboard for incoming junction lines for the Central Telephone Exchange, Melbourne, at £2,989.

In connection with the erection of a central telephone exchange in Latrobe Street, Melbourne, the tender of Messrs. Swanson Bros., at £18,499, has been accepted.

BARNES.—The Urban District Council has accepted the tender of Babcock & Willcox, Ltd., at £855, for a locomotive crane.

BRIGHTON.—Tenders have been received for carbon filament incandescent lamps for street lighting, and the Engineer reports that the best all-round lamp for life and efficiency is that submitted by the Sun Electrical Co., who quote 6¾d. per lamp, and the second best that of the British Thomson-Houston Co., who quote 6d. per lamp, a reduction of 1d. and 1¾d. respectively on the amount paid under the present contract. The Engineer points out, however, that these reductions in price have been made at the expense of the efficiency of the lamps, for whereas the running contract is for lamps consuming 3½ watts per candle, the present offers are on the basis of 4½ watts. This would mean an additional £468 per annum in the cost for electricity. Under the circumstances, he strongly recommends the Council to reject the whole of the tenders received, and to adopt the new 16 c.p. "Tantalum" lamp which has just been put upon the market. By this means the candle-power at present given, he estimates, could be exactly doubled for the same consumption of current at a net increased cost of £138 per annum. If this suggestion is adopted, the Engineer states that the cost of the present street lighting, with double the candle-power, could be effected for £2 18s. per post per annum, compared with £3 0s. 6d. for incandescent gas. The report was adopted at the last meeting of the Corporation.

DARTFORD.—Since the termination of the contract with the A.B.P. Accumulator Co., the Electrical Power Storage Co. has been entrusted with carrying out the renewal of the cells of the lighting battery at about 40 per annum, the cost being £86 per annum. At this rate the renewal of the battery will be completed in five years' time, but the Electricity Committee regard this method as disadvantageous, and recommends that a contract be entered into with the Electrical Power Storage Co., to renew the whole of the cells at once at £392, the payment to be spread over five years.

DERBY.—The tender of the British Thomson-Houston Co. for a Tirrill regulator at £82 10s. has been accepted. The following tenders have also been received:—Cast iron piping, Messrs. Cinkins & Knighton, £133 8s.; steel piping, Messrs. Aiton & Co., £115. The tender of Mr. W. Walkidine for the construction of car sheds at Nottingham Road at £4.998 16s. has been accepted. Ten tenders were received, the accepted one being the lowest. The proposed shed will accommodate 20 cars.

GREYSTONES (IRELAND).—The Rathdown Rural District Council has requested the Wicklow County Council to give the necessary permission to Messrs. Coates & Sons for carrying out the proposed scheme for lighting Greystones by electricity.

LONDON: *London County Council.*—The tender of Messrs. John Smith (Keighley), Ltd., has been accepted for the supply of a 10-ton overhead travelling crane for the Hammersmith temporary tramways sub-station at a price of £159 10s. Other tenders received were from Carrick & Ritchie (£201) and Thos. Larmuth & Co. (£210). The following tenders have been received for points and crossings for the junctions required upon the reconstruction of the Brixton Road tramways on the overhead trolley system:—Lorain Steel Co. (U.S.A.), £833 10s.; Hadfield Steel Foundry Co., £808 12s. 6d.; Edgar Allen & Co., £888 10s. The Chief Engineer's estimate was £810. The Lorain Steel Co.'s tender was on the basis that the Council should supply to the company, free of charge, wrought rails for use in manufacturing the crossings required, instead of these rails being made of cast-steel in the usual manner. On making allowance for this the Lorain Co.'s tender would no longer be the lowest, and therefore the Hadfield Steel Foundry Co.'s tender has been accepted.

The Asylums Committee has accepted the following tenders for the annual supply of electric lighting sundries:—British Thomson-Houston Co., Ltd., £110 14s. 7d.; General Electric Co., Ltd., £2; Baxter and Caunter, £22 16s. 8d., £43 17s. 8d., £44 18s., and £11 13s.; Pryke and Palmer, £18 10s. 10d. and £21 8s. 11d.; H. S. Timpson, £66 0s. 7d.; India-rubber Gutta-percha and Telegraph Works Co., Ltd., £3 13s.

Bermondsey.—The Borough Council has accepted the tender of the Brush Electrical Engineering Co. at £23 7s., for spare parts for a 500-kw. set.

Camberwell.—The Borough Council has accepted the following tenders for annual supplies:—Electric lamps, plain. Britannia Electric Lamp Works (1905), Ltd., 100 volts, 8 and 16 c.p., 5s. per dozen; 32 c.p., 5s. 6d.; 200 volts, 8 and 16 c.p., 5s. 6d. per dozen; 32 c.p., 6s. per dozen; frosted, 100 volts, 8 and 16 c.p., 5s. 6d. per dozen; 32 c.p., 6s.; 200 volts, 8 and 16 c.p., 6s.; 32 c.p., 6s. 6d. "Osram" electric lamps, 100 volts. Geipel and Lange, 30 c.p., 36s.; 50 c.p., 38s. 3d. Maintenance of private telephones and electric bells, Private Wire and Telephone Installation Co., Ltd., Town Hall, £4 4s. per annum; Grove Vale depôt, £3 3s.

Hammersmith.—The Borough Council have accepted the following tenders for annual supplies:—Arc lamp globes and lamp shades, H. G. Mayer and Co., £20 17s., less 2½ per cent. discount; electrical accessories, Veritys, Ltd., £16 11s. 2d., less 2½ per cent.; electrical insulating goods, for whole of items. General Electric Co., £15 16s. 11d., less 2½ per cent.; for Para

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rubber strip, tape, and solution only, Siemens Bros. & Co., £12 19s., less 2½ per cent.

St. Pancras.—The Borough Council has accepted the tender of Messrs. Brentnall and Cleland to supply 500 tons of best hand-picked "Desford" steam coal at 15s. 8d. per ton, delivered to either electricity station, subject to a condition that this supply be discontinued so soon as Messrs. Barber-Walker's collieries re-open after the strike, and the Council can be supplied therefrom under their contract.

LOWESTOFT.—The tender of Messrs. W. T. Henley's Telegraph Works Co., Ltd., for house cut-outs at 4s. per pair, and 10s. 6d., 6s., and 6s. 9d. per set has been accepted. An offer by the Underfeed Stoker Co., Ltd., to supply mechanical stokers to two of the boilers of the power-house, at £350, the Corporation finding the motor, has also been accepted. Payment is to be spread over two years by eight quarterly payments.

SHEFFIELD.—The following firms have been successful in obtaining the contracts for the supply of electrical and engineering goods for the twelve months ending March 25th, 1909, to the Corporation Cleansing Department and Telegraph Works:—Messrs. Dewhurst's Engineering Co., the India-Rubber and Gutta-Percha Co., Taskers' Engineering Co., Messrs. Taskers Sons & Co., Mr. J. Robinson, Messrs. T. A. Ashton, Ltd., Messrs. S. Peace & Son, Messrs. Chas. Mackintosh & Co., the Sheffield Corporation Electrical Supply Department, and Mr. W. Bakewell.

WEST HAM.—The Education Committee has placed an order with the Borough Electrical Engineer for the supply of "Osram" lamps at the following rates:—30-c.p. lamps, 4s.; 50-c.p. lamps, 4s. 3d.

WOLVERHAMPTON.—The Empire Roller Bearings Co. have received an order for fitting further cars for the Corporation with roller-bearing axleboxes.

YARMOUTH.—The tender of Messrs. Bessey & Palmer for 500 tons of coal at 15s. 11d. per ton, for the Electricity Department, has been accepted.

APPOINTMENTS AND PERSONAL NOTES

By a clerical error the name of Mr. H. F. Forbes Mackay, late of the Great Western Railway Electrical Department, who has been appointed electrical engineer to the Municipality of Sydney, was given on pages 419 and 416 as H. F. Forbes.

The Stepney Borough Council has increased the salary of Mr. W. C. P. Tapper, the Electrical Engineer and Manager, from £650 per annum to a maximum of £750 per annum, the re-adjustment taking effect from July 24th last, on which date instructions were given him to proceed with the preparation of the Blyth's Wharf scheme. The salary of Mr. A. J. Squire, the chief clerk in the electricity department, has been increased from £200 to £210 per year, with further annual increments of £10 until a maximum of £250 per year is reached.

Mr. J. R. Woodruffe Gardam, late manager and engineer to the Empire Electric Light Co., Sydney, Australia, has been appointed representative of Messrs. Noyes Bros., at Perth, West Australia.

Mr. F. Hope Jones, M.I.E.E., has been awarded the bronze medal of the Royal Humane Society for his attempts to rescue a skater who had fallen through the ice at the Welsh Harp last January. Mr. Hope Jones dived no less than five times, but failed to effect a rescue.

At the Halifax Corporation tramway shed on Friday, Mr. F. Spencer, the retiring tramway manager, was presented with a Doulton dinner service, consisting of 73 pieces, by the tramway staff.

MISCELLANEOUS CITY NOTES

ELECTRICAL DEVELOPMENT CO., ONTARIO.—It is stated that negotiations are complete for transferring the control of this company to the Toronto Railway Co. The proposal is that the Toronto Railway Co. will guarantee bonds which will pay off the floating debt of the Electrical Development Co., and provide working capital. Ordinary stock of the Electrical Development Co. will be transferred to the Toronto Railway Co., sufficient to ensure it the control.

GENERAL ELECTRIC CO.—A notice in Tuesday's *London Gazette*, summoning the shareholders of the General Electric Co., Ltd., to a meeting to receive the report of the liquidator as to the winding up of the company, need not cause any alarm to the friends and clients of the G.E.C. It relates merely to the old parent company, which was a private limited company, registered in 1889. In 1900 the company was reconstructed as a public company, under the title of the "General Electric Co. (1900), Ltd.," £500,000 being paid to the old company as purchase money. Four years ago the word "1900" was again dropped from the name of the company. The notice in question represents the final step in the liquidation of the old company, commenced at the end of 1900. The present General Electric Co. is as flourishing as ever.

LANARKSHIRE TRAMWAYS CO.—An extraordinary general meeting was held on Wednesday to sanction additional capital required for the construction of the remaining extensions authorised by the Order of 1903.

LONDON STREET TRAMWAYS.—The report for the year 1907 shows a net profit of £4,129. The directors recommend a dividend of 2s. 6d. per share, which will absorb £3,875, leaving £254 to be carried forward.

NEWCASTLE ELECTRIC SUPPLY CO.—Subscriptions have been invited during the week for an issue of £50,000 preference shares and £50,000 ordinary shares of £5 each. Lloyd's Bank, in conjunction with others, have purchased the whole issue at a premium, and offer it for sale at £5 for each preference share, and £6 for each ordinary share. The prospectus states that during the last ten years the horse-power connected to the company's system has increased from 2,200 to 92,764, whilst at the present time a further 27,000 h.p. is awaiting connection. During January and February this year, the number of units sold shows an increase of 24 per cent. over those of the corresponding period of 1907. The prospectus further states that the original system laid down in 1890 has been entirely replaced by a modern high-tension system out of monies set aside for reserve and depreciation. As stated in our last issue, the new capital will be utilised in equipping an extra power station at Dunston-on-Tyne, and in redeeming the third mortgage debentures.

ROSARIO ELECTRIC CO.—A dividend of 3s. per share, less tax, has been declared upon the ordinary shares.

SOUTH LONDON ELECTRIC SUPPLY CORPORATION.—In the Chancery Division, on Saturday, a petition was heard for the reduction of the capital of this company from £65,000 in £5 shares to £65,000 in £4 shares. This decision has been rendered necessary in consequence of the results of the legal proceedings between the Lambeth Borough Council and the company regarding the refuse destructor, which has been dismantled. The application was granted.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO.—The register of debenture stockholders will be closed from 18th to 31st instant, for preparation of warrants for interest at the rate of 4½ per cent. per annum for the half-year to April 1st, 1908.

TELEPHONE COMPANY OF EGYPT.—Subscriptions have been invited for 20,000 4½ per cent. debenture stock, ranking *pari passu* with the stock now quoted on the Stock Exchange. The present issue is offered at par, and carries a full half-year's interest on July 1st.

WESTERN TELEGRAPH CO.—A second quarterly interim dividend of three shillings per share has been declared free of income tax for the year ending June 30th, 1908, being at the rate of six per cent. per annum. The transfer books of this company will be closed from March 18th to March 24th, both days inclusive, and the dividend will be payable on March 25th.

Electrical Bills in Parliament, 1908.—The annual report of the Board of Trade upon all the Bills and Provisional Orders for the current Parliamentary Session relating to railways, tramways, electricity, &c., has been issued. There are 19 tramway Bills, involving the construction of 31 miles of new line, the aggregate capital proposed being £525,000 in shares and £749,760 by loans. There are 27 electric lighting Provisional Orders, involving a capital of £259,180, and three tramway Provisional Orders involving a capital of £14,002, nine Bills relating to the supply of electrical energy, the proposed capital of which amounts to £7,600,000. Some particulars are given in the return of all the electrical Bills before Parliament, a full digest of which will be found in ELECTRICAL ENGINEERING, Vol. II., p. 1007.

Telegraph Traffic. During the past week a few more interruptions to the telegraph service have to be recorded. The El Arich route between Peyreuth and Lattagui ceased working from March 11th to 13th. On the 15th instant the cable between Tangier and Cadiz was again restored to working order, while two days later we received information of the interruption of the cable belonging to the Compagnie Française des Cables Télégraphiques, between Cayenne (French Guiana) and Salinas (Brazil). The land line to Ahvaz, in Persia, has at last been restored. Information has also reached us to the effect that telegrams to the Island of Guadeloupe must be forwarded by mail from contiguous islands. We have already notified that the Martinique-Guadeloupe cable is down, and the above information indicates that the cables between Dominica and Guadeloupe, and between Antigua and Guadeloupe, belonging to the West India and Panama Telegraph Co., must also be interrupted. As Guadeloupe is the handing-over centre in the West Indies for the West India and Panama and the French West India telegraph systems, some inconvenience will ensue, as the cable between Mole St. Nicolas and Guantanamo is also down. There being no other known interruption in the West Indies, it is probable that the cable ship *Henry Holmes* is already engaged in the repair of these cables. Communication with Alderney, Channel Islands, has also given out. The Central and South American Telegraph Co. have now stationed the cable steamer, *Relay* (Captain Alex Taylor), 1,200 gross tonnage, in the Atlantic, where she has arrived from Callao, Peru, her former station, to take the place of the cable steamer *Mexican*. Their new boat, the *Guardian*, will now be stationed at Callao. The gross tonnage of the cable ship *Mexican* being only 402, there is no doubt she is now considered too small a vessel to undertake repairs on the New York-Guantanamo-Colon cable.

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MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night, was £59 10s. to £60 per ton (last week £59 to £59 10s.).

ARTISTIC FITTINGS.—We are informed that, owing to expiration of lease, Messrs. Strode & Co. are offering for sale a surplus stock of fittings and accessories below cost price at their City showrooms, 67 St. Paul's Churchyard, E.C.

CALENDAR.—A wall calendar (from March, 1908, to March, 1909), upon which is a series of portraits of the principal heads of departments, has been issued by the General Electric Co. It should be of considerable use to all the company's customers.

SIMPLIFIED UNDERGROUND CONDUCTOR CO.—We are informed that the Howard Asphalt Troughing Co., Ltd., have purchased outright the whole of the patents formerly belonging to the Simplified Underground Conductor Co., Ltd. (in liquidation), of 180 Crown Street, Liverpool.

GREAT CENTRAL RAILWAY.—We have received from the Great Central Railway Co. an illustrated booklet, entitled "Strolls in Beechy, Bucks," containing illustrated descriptions of walks in the county of Buckinghamshire. Copies, post free 2½d., may be obtained from Publicity Department, Great Central Railway, 216 Marylebone Road, N.W., or the publisher, Walter Hill, 67-69 Southampton Row, W.C.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—A meeting of the Electric Power Development Co., Ltd., will be held at 21 Ironmonger Lane, London, E.C., on April 14th, at 12 noon, to receive the liquidator's account of the winding-up.

A supplementary dividend of 2½d. in the £ will be paid on March 25th at the Official Receiver's Offices, 24 Bond Street, Leeds, in the bankruptcy of Albert Dickinson, electrical engineer, Dixon Lane Road, Wortley, Leeds.

The trustee has been released in the bankruptcy of G. & J. S. Robson, trading as Robson, Robson & Co., electrical engineers, at Empire Buildings, Newgate Street, Newcastle-on-Tyne.

DISSOLUTIONS OF PARTNERSHIPS.—H. Cecil Hodges and Harry Snowdon, carrying on business as electrical engineers and manufacturers at Balfour House, Finsbury Pavement, London, have dissolved partnership. Debts due to and owing by the firm will be received and paid by H. Snowdon, at Snowdon's Wharf, Millwall, London, E.

George Arthur Knapton and Robert Ironside Bagnall, trading as electrical engineers as Knapton, Bagnall & Co., at 95 Lansdowne Road, Old Charlton, Kent, have dissolved partnership. G. A. Knapton continues as G. A. Knapton & Co.

The partnership between A. H. Sowerbutts and F. Walker, electrical engineers, 17 High Road, Kilburn, under the title of Sowerbutts & Rogers, has been dissolved.

Notice is given of the retirement of Mr. E. S. Hindley, from Messrs. E. S. Hindley & Sons, engineers and manufacturers of machinery, 11 Queen Victoria Street, London, and at Bourton, Dorset. The business will be carried on as usual by the remaining partners.

ROBERTSON'S SOCIAL AND ATHLETIC CLUB.—A plain and fancy dress dance was held at the electric lamp works, Brook Green, Hammersmith, on Saturday. There was an attendance of about 350.

COMPANIES' MEETINGS AND REPORTS

BRITISH INSULATED & HELSBY CABLES.—The report for the year ended December 31st, 1907, shows that the profit amounts to £135,619, to which has to be added the balance brought forward from last year, £36,713, making a total of £172,332. Deducting directors' and debenture trustees' fees, interest on debenture stock, depreciation, &c., dividend on preference shares to December 31st, 1907, interim dividend on ordinary shares to June 30th, 1907, &c., £113,997, leaves £58,335. The directors recommend a further dividend of 4 per cent. on the ordinary shares, making a total of 8 per cent. for the year ended December 31st, 1907, together with a bonus of 2 per cent., which will absorb £50,000, carrying forward £28,335. The volume of trade during the past year, especially in heavy cable work, has not been so great, owing to the high price of copper in the earlier part of the year, and to the financial stringency later on, and the profits have thereby been adversely affected. It is, however, satisfactory to be able to say that the volume of business done so far this year and orders in hand at present compare very favourably with the corresponding period of last year. A sum of £10,000 has been transferred to reserve account, and a further £5,000 to debenture stock redemption account, in addition to £22,000 depreciation of buildings, plant, and machinery. The meeting is on Monday.

DEVONPORT AND DISTRICT TRAMWAYS.—The half-yearly meeting was held in London on Wednesday last week, Mr. W. G. Bond presiding. The accounts show an available balance of £2,157, and it is proposed to transfer £1,000 to permanent way renewals fund, £1,000 to capital redemption fund, and to carry forward the remainder. There has been a decrease in the receipts of £346, and an increase in the expenditure of £175, making a net reduction for the half-year of £521, compared with the previous half-year. Permanent way repairs and maintenance are largely the cause of the increased expenditure. This, said the Chairman, was a cause of expense over which the company had no control, and their efforts at opening up new sources of revenue and to stimulate existing sources had not met with any great success. A parcel service had been inaugurated, and the issue of workmen's tickets had been instituted, but the latter had been withdrawn. The directors were of an opinion that it would be very good business both for the company and for the Plymouth Corporation if they ran over each other's lines, but so far they had been unable to induce the Corporation to agree. In view of the present position, the directors had placed the situation of the company frankly before the Devonport Corporation, from whom they rent nearly 50 per cent. of the lines they work upon very onerous terms. In fact, said the Chairman, it was practically these onerous terms which had stood between the ordinary shareholders and moderate dividends. In most prosperous days, they had never paid more than 4 per cent., but since they had been working the Devonport extension no dividends had been paid at all. The letter which had been addressed to the Corporation suggested that the Corporation should re-arrange the terms so far as interest and sinking fund paid by the company were concerned, and also reduce the price charged for electrical energy from 3d. to 1·4d. to 3d. to 1·2d., the lower price to be reduced every subsequent year by one-tenth of a penny until ·8d. was reached. The Corporation is also asked not to oppose the running of Devonport cars into Plymouth, nor *vice versâ*. Failing the acceptance of these terms, the directors intimate their willingness to negotiate for the sale of the company's undertaking to the Corporation.

CHELSEA ELECTRICITY SUPPLY.—At the annual meeting held on Wednesday last week, Sir I. Courtney presiding, the report and accounts given in our issue for February 27th were adopted. In referring to the increase in the expenditure of £2,158, the Chairman stated that this chiefly related to coal, which accounted for £1,304, whilst increased rates accounted for a further £695. The total now paid in rates, he said, was £5,843, or more than 45 per cent. of the amount distributed in dividends, and equal to two-fifths of a penny per unit sold. The gross receipts had increased by £1,285, and they had been able to pay the same dividend as last year, in addition to placing a substantial amount to depreciation and writing off amounts in respect of two items. The works costs per unit sold were almost the same as last year. Very little capital expenditure had been incurred during the year, extensions having been made to the distributing mains only where necessary to furnish a supply to new consumers. Referring to the use of metallic filament lamps, the Chairman expressed the same views as those of other chairmen of electric lighting companies, namely, that the supply industry would benefit from their adoption eventually. At a subsequent special meeting, the promotion of the London Electricity Supply (Joint Committee) Bill was confirmed.

CITY OF LONDON ELECTRIC LIGHTING.—The report for the year ended December 31st, 1907, states that the total capital expenditure up to that date was £2,181,038. The capital expenditure during the year was £87,069, and £176,436 has been written off at various times, including £38,958 during 1907, so that the net addition to capital account for the year was £39,710, and the net total as at December 31st is £2,051,960. The total reserves now stand at £300,601. The total revenue for the year, including £1,719 for interest on investments and discounts, was £280,861, from which must be deducted the following items:—Expenses of generation and distribution, £66,561; repairs and maintenance of buildings, machinery plant, mains, and other works, £10,265, and rent, rates, taxes, management expenses, and special charges, £45,285, leaving £158,750, to which must be added the balance brought forward from 1906, £20,621; making a total available revenue of £179,371. Of this sum the following amounts have been distributed or provided for:—Interest on loan from bankers, consumers' deposits, &c., £4,378; interest on first and second debenture stock for year ended December 31st, 1907, £31,825; interest transferred to debenture stock premium redemption fund, £1,511; staff superannuation fund, £336; Parliamentary expenses, £1,093; stores: values written down, £301; experimental street arc lighting, £1,115; provision for doubtful debts, £1,600; amount applied in reduction of certain items of the capital account, £8,400; transfer to reserve account, £45,000; transfer for leasehold redemption, £500; leaving £85,513 for dividends on preference and ordinary shares, and for "carry forward" to 1908. The directors now recommend that the following dividends for the year ended December 31st, 1907, be declared, subject to the deduction of income tax, to members registered in the books of the company at the closing of the transfer books on March 4th, 1908. Preference shares Nos. 1 to 40,000.—12s. per share, being a distribution for the year at the full rate of 6 per cent. Of this sum 6s. per share was paid on account on July 17th last, leaving a balance of 6s.

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per share for present distribution. Ordinary shares Nos. 40,001 to 110,595.—12s. per share, being a distribution at the rate of 6 per cent. for the year. Of this sum 5s. per share was paid on account on July 17th last, leaving a balance of 7s. per share for present distribution. The dividends to be distributed as above amount to £34,873, which, with the dividends already distributed, brings the total dividends for the year up to £65,039, leaving £20,474 to be carried forward to 1908. The report gives some comparative tables setting out the position of the company at the ends of various years. The gross revenue has increased by £18,092 over that in 1906, and there has been a corresponding increase of £12,775 in the net revenue. The average price per unit obtained for private supply was 2·63d., as against 2·64d. in 1906, and consumers show an increase of 226, and the connections the equivalent of 110,160 8-c.p. lamps, or 3,672 kw. On February 19th, 1908, there were 1,041,293 8-c.p. lamps (equivalent to 34,710 kilowatts) applied for, out of which 1,022,695 were connected, and the customers numbered 12,581. The total units generated during the year were 26,393,590, of which 23,684,575 were sold, 744,810 were used on works, and 1,964,205 were expended in distribution, &c. The maximum supply demanded was 17,908, so that the load factor works out at 15·1 per cent. The total units sold during 1907 show an increase of 2,020,472 over the quantity sold during 1906. Power and heating supplies continue to show a steady increase, the total units sold during the year for power purposes being 5,169,640, and for heating, 914,415. These are together equal to 27·19 per cent. of the total units sold for private supply. In July last the Corporation of London acceded to the company's request to be allowed, in certain thoroughfares of the City, to alter some of the standards and replace the arc lamps previously in use, by arc lamps of a modern type. These new lamps have been in satisfactory operation during the past winter, and the directors hope that the demonstration will have the effect of proving the superiority of electricity for street lighting. The expenditure incurred by the company up to December 31st, 1907, amounting to £1,114 11s. 3d. has been charged against revenue. The directors have thought it advisable to take an interest in a small limited liability company formed by a certain number of the London electric supply companies for the purpose of promoting a Joint Bill in the present Session of Parliament. The expenses incurred in connection with Parliamentary matters during the year 1907, amounting to £1,033, have been also charged against revenue. The meeting was held yesterday.

COUNTY OF LONDON ELECTRIC SUPPLY.—The report for the year ended December 31st, 1907, states that the capital expended during the past year on account of the company's London districts amounted to £57,670, and the sum of £19,679 has been deducted in respect of machinery displaced. The net total expenditure in respect of those districts up to December 31st last amounted to £1,571,777. The total revenue for the year was £109,089, out of which £39,908 was absorbed by interest on debentures, £11,400 was paid as dividend on preference shares, £7,600 as interim dividend, at the rate of 4 per cent., and £23,000 was carried to reserve for depreciation, repairs, renewals, &c., leaving £27,181 for further distribution. The directors now recommend :—(*a*) That payment of the interim dividend on 40,000 six per cent. preference shares for the half-year ended June 30th, 1907, less income tax, be confirmed. (*b*) That payment of the interim dividend on 40,000 ordinary shares, at the rate of four per cent. per annum, for the half-year ended June 30th, 1907, less income tax, be confirmed. The Directors also recommend :—(*c*) That a further dividend on 40,000 six per cent. fully-paid preference shares for the half-year ended December 31st, 1907, less income tax, be declared; and (*d*) That a further dividend on 40,000 ordinary shares for the half-year ended December 31st, 1907, at the rate of six per cent. per annum, less income tax, be declared, and that the said dividends be paid to all proprietors registered on March 6th, 1908. The above-mentioned payments (*c*) and (*d*) will absorb £22,800, and leave a balance of £4,381 4s. 9d. to be carried forward. The profits derived from the company's London stations for 1907 amounted to £118,200 17s. 7d., against £105,300 3s. 8d. for 1906. The total applications received at December 31st last amounted to the equivalent of 1,001,171 50-watt lamps (30,035 kilowatts), being an increase of 106,040 lamps (3,181 kilowatts) for the year. Included in these figures are motors aggregating 14,851 h.p., being an increase of 2,166 h.p. for 1907. The total units sold were 13,970,179, as against 10,755,424 for the previous year, being an increase of 29·9 per cent. The funds required to meet the capital expenditure incidental to the increasing business of the company have been provided by an issue of six per cent. preference shares at par to the shareholders. The Bournemouth and Poole Electricity Supply Company, Ltd., continues to show satisfactory progress. The directors have recommended a final dividend on the ordinary shares of that company at the rate of 9 per cent. for the six months ended December 31st last, making 7 per cent. for the year. The business of the Coatbridge & Airdrie Electric Supply Company, Ltd., formerly the Scottish House-to-House Electricity Company, Ltd., shows substantial improvement. During the year additional applications for the equivalent of 28,999 30-watt lamps (870 kilowatts) have been received, including 907 h.p. in motors. The Bulk Supply Bill, promoted in 1907 by the London Electric Supply Companies, and referred to in the last report, was withdrawn. A limited liability company has been formed by eight of the London Supply Companies, and a Bill is being promoted by that company in the present session of Parliament. The directors have deemed it well to secure an interest in that company, and an extraordinary general meeting of the shareholders has been convened for the purpose of considering and, if thought fit, approving, the proposed Bill. A supply is now available in Purley and Sanderstead under the company's Croydon Rural Provisional Order. The Royal assent has been obtained to the Provisional Order promoted by the company in the last session of Parliament for the district of the Maldens and Coombe Urban District Council, which adjoins the company's existing areas of supply.

At the meeting on Monday the report and accounts were adopted. Mr. J. P. Braithwaite, the Chairman, who presided, said that, taking the company's capital expenditure during the past seven years, there had been a steady decrease going on, and the company's engineer estimated that this would still further decrease in the future. He had been asked by the shareholders whether the capital expenditure was profitable. In 1903 a capital expenditure of £133,772 gave an increased profit of 8·7 per cent.; in 1904 a capital expenditure of £83,504 gave an increased profit of 23 per cent.; in 1905 a capital expenditure of £82,380 gave an increased profit of 11·7 per cent.; and in 1906 a capital expenditure of £67,813 resulted in an apparently increased profit of 4·3 per cent.; but in this case the bulk of the capital expenditure was made towards the end of the year, and was really not effective until the following year. In 1907 a capital expenditure of £57,670 gave an increased profit of 22·3 per cent. Taking, therefore, the five years altogether, a total capital expenditure of £425,139 gave an increased profit of £56,504, or 13·2 per cent. He thought this would satisfy the shareholders that the directors did not spend capital rashly or recklessly. With regard to the revenue account for 1907, the receipts showed an increase of 12½ per cent., or £19,561, whilst the increase in the works costs amounted to £5,628. There had been increases in one or two other directions over which the directors had no control, such as rates and quinquennial valuation, whilst income tax and wages had increased somewhat. Taking the London stations alone, which were the backbone of their business, the revenue showed an increase of £20,438, or 14 per cent. The five 1,500 kw. Curtis turbines were working exceedingly well, and the lamp connections for the year were an absolute record. The efficiency of distribution showed an improvement of 3 per cent. for last year, and was now 75·9 per cent., an improvement due to the increased sale for power purposes. On December 31st last they had just over one million lamps applied for, but the progress for 1908 was even better. The applications up to date were equivalent to 23,520 thirty watt lamps, against 16,139 last year, an increase of 46 per cent. The average price per unit had gone down from 4·58d. in 1902 to 2·83d. in 1907. The fact that the increase of business had synchronised with the decrease in price, and that still they were making larger profits was very great testimony to the soundness and efficiency of their staff. The Chairman concluded with a reference to the London power question, and said he was not without hope that the President of the Board of Trade would call a conference of all parties concerned, for he was quite sure that if they could once get round a table on a business footing, the matter would soon be settled to their mutual satisfaction.

At an extraordinary general meeting held subsequently, the London Electric Supply (Joint Committee) Bill was approved.

DIRECT SPANISH TELEGRAPH.—The report and accounts for the year ended December 31st, 1907, show, after providing for interest on and redemption of debentures, and crediting the reserve fund with the sum of £3,905, an available balance of £2,793, which enables the directors to recommend the declaration of the dividend of 10 per cent. on the preference shares, and a dividend of 4 per cent., free of income-tax, on the ordinary shares, for the year 1907, amounting to £5,586. Half of this amount was distributed on October 1st, 1907, as an interim dividend in respect of the half-year ended June 30th, 1907. The traffic receipts shown an increase of £302, and the ordinary working expenses a decrease of £142, as compared with the year 1906. During the year 1907 the Bilbao cable has been twice interrupted. On the first occasion the break occurred at about 25 knots from Falmouth, and the necessary repairs were effected by the Eastern Telegraph Company's cable steamer *Britannia*, after an interruption to communication lasting four days. The second break took place at about 19 knots from Arrigunaga, the cable being repaired by the cable steamer *John Pender* after an interruption of nine days. The cost of these repairs, amounting to £3,294, has been charged to revenue. Sir John Denison-Pender, K.C.M.G., is the director retiring by rotation, and offers himself for re-election. The meeting is to-day.

W. T. GLOVER.—The accounts for the year 1907 show a credit balance of £31,995 in addition to £11,044 brought forward from last accounts. After paying debenture interest, interest on second mortgage preferred stock, and transferring the sum of £7,500 to first mortgage debenture redemption fund, a dividend

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is recommended for the past 3½ years on the preference shares, thus clearing off all arrears, and the sum of £5,576 is carried forward.

At the meeting on Monday, the report and accounts were adopted.

MANSFIELD & DISTRICT TRAMWAYS.—At the ordinary general meeting at Mansfield last week, the report and accounts given in our last issue were adopted. The Chairman pointed out that the gross receipts had exceeded by several hundred pounds the estimates in the original prospectus, and the expenses had been only slightly higher. The directors had under consideration the construction of an additional short length of tramway, but the shareholders could rest assured that the directors would not sanction any additional capital expenditure unless they were perfectly certain that it would materially add to the company's revenue.

NORTHAMPTON ELECTRIC LIGHT.—At the annual meeting on Thursday, the report and accounts given in our issue for February 27th were adopted. The chairman pointed out that owing to the adoption of metallic filament lamps, there had been a great shrinkage in consumers' bills, although the number of consumers had increased from 975 to 1,083.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY.—The report for the year ended December 31st last, states that the revenue for the year amounted to £59,373, and the expenditure to £36,252, leaving a balance of £23,120. After deducting £4,000, placed to the credit of the depreciation and renewals fund, there remains £19,120 to be carried to the net revenue account. This balance of £19,120, together with sundry receipts and the amount brought forward from the previous year, make up the sum of £20,505. After providing for debenture and loan interest and other charges shown in the account, there is a balance of £12,672. The directors recommend a dividend at the rate of 4 per cent. per annum, and that £386 be carried forward. The name of the depreciation and reserve fund formed out of the profits for the year ended December 31st, 1906, has been changed to "Depreciation and Renewals Fund," to meet the requirements of the Board of Trade. The capital expenditure during the year amounted to £33,415, and has now reached a total of £433,820. During the year £3 per share was called up on 25,740 shares, making these shares fully paid, and a further 10,000 shares of £10 each have been issued, upon which £5 per share has been paid. The paid up share capital at December 31st, 1907, was £350,020. £126,500 5 per cent. mortgage debentures were sold in July, 1907, being part of a total authorised amount not to exceed one-third of the share capital for the time being actually issued upon which one-half has been paid up. At December 31st last £78,100 had been received in respect of such sales. The total number of units sold during the year amounted to 11,183,316, which, compared with the previous year's figure of 7,999,367, is an increase of 3,183,949 units (approximately 40 per cent.). An agreement having been entered into with the Corporation of the City of St. Albans for the incineration of the city's refuse, the erection of a generating station and refuse destructor is proceeding at St. Albans for this purpose, and also to enable the company to give a supply of electrical energy in bulk under the St. Albans Electric Lighting Order, 1898. The company has joined the British Electrical Federation, which has been formed by various electric traction and lighting companies for the purpose of co-operation and joint action in matters of common interest. The company's investment in the North Metropolitan Electrical Power Distribution Company, Ltd., has during the year been increased to £47,070, upon which a dividend of 2 per cent. will be received, calculated from the date of payment. The meeting is on March 24th.

OXFORD ELECTRIC.—The seventeenth ordinary general meeting was held at Oxford, March 6th. The Chairman, Sir Henry Mance, presided, and the report and accounts given in our issue for February 27th were adopted. The accounts showed, he said, that the capital had been increased by the issue of 2,500 preference shares of £5 each during 1907. The shares were rapidly taken up; in fact, they were subscribed for three times over. The directors do not see the necessity for issuing further capital at present. They had put down a 500-kw. alternator and high-tension switch-boards, and all the switch-boards which were erected 16 years ago had been carefully overhauled and remodelled, in order to comply with the regulations of the Home Office. The chief engineer had been carefully experimenting with appliances to ascertain if a cheaper kind of coal could be used, and although they were not yet in a position to speak decisively, they believed that the results obtained will be satisfactory. The older boilers, some of which have been working 15 years, have been thoroughly overhauled. Considerable expense had been incurred to lay feeder cables to the north of Oxford, in order to regulate the pressure in that part of the city. Arrangements have been made with the promoters of the Oxford Tramways Co. for a supply of electrical energy.

SHEFFIELD GAS.—At the ordinary general meeting last week, Mr. W. Mappin, vice-chairman, who presided, made some remarks in which he compared gas with electricity. He stated that at the last meeting of the Corporation a statement was made that the lighting of the Glossop Road Baths by electricity was costing £120 per annum, whereas formerly the cost of lighting by gas was only £40 per annum. It did not seem right that the ratepayers' money should be wasted in this manner, and as one of the chief ratepayers in the town, the Gas Company felt they had a grievance. Referring to one or two places elsewhere, he stated that in Islington 20 miles of road were lighted by electricity at a cost of £5,245, whereas 100 miles were lighted by gas at a cost of £4,077. If the 20 miles now lighted electrically were changed to gas, the cost would be £1,049. In Camberwell, he said, the street lighting cost £90 per mile per annum for gas, and £170 per mile per annum for electricity. The Borough Surveyor for Deptford had pointed out that the cost of one arc lamp would be £15 per annum, against five incandescent lamps for the same amount, and gas in London was more than double the price it was in Sheffield. He concluded by stating that he mentioned these matters in order that the Corporation might reflect before increasing the lighting rate of the city unnecessarily.

VICKERS, SONS & MAXIM.—The directors' report for the year 1907 recommends a dividend at the same rate as last year, after providing the usual liberal deductions for depreciation, &c., and writing the sum of £150,000 off "goodwill and patent rights," reducing this item in the balance-sheet to £100,000. The meeting is on the 20th inst.

NEW COMPANIES

BRITISH FLEXLUME SIGN CO.—Registered on February 27th, with a capital of £20,000 in £1 shares (6,600 8 per cent. non-cumulative preference), to acquire certain patents relating to improvements in illuminated signs and sign letters, to adopt an agreement with R. R. Wiley, J. C. Plimpton, and S. R. Kirkness, and to carry on the business of manufacturers of and dealers in illuminated and other signs and sign letters, glass, aluminium, lead, iron, steel, brass, and other metals, electricians, gasfitters, sanitary, electrical and mechanical engineers, &c. No initial public issue.

ELLWOOD & SLEDMERE.—Registered on February 25th, with a capital of £10,000 in £1 shares, to acquire the business carried on at 53 Mortimer Street, London, and elsewhere as Ellwood & Sledmere, to carry on business as designers, manufacturers of and dealers in cabinet works, household furniture, leather goods, hardware, jewellery, plated goods, ironmongery, turnery, and other household and electric fittings and utensils, house decorators, electrical engineers, and contractors, &c., agents in the United Kingdom, India, the British and other Colonies, and elsewhere. No initial public issue.

HIRST MAGNETO CO.—This company was registered on February 21st, with a capital of £2,000 in £1 shares, to carry on the business of manufacturers of and dealers in motor cars and self-propelled and other vehicles and machines of all kinds, electrical, mechanical, and general engineers, founders, fitters, &c. The subscribers are:—M. Grunebaum, J. F. Toohig, W. C. Page, T. Burrett, A. Pollock, A. W. Harris, A. Hirst. No initial public issue. The number of directors is not to be less than two nor more than four; the first are J. F. Toohig (permanent) and A. Hirst. No qualification necessary. Remuneration (except managing director), £80 per annum, divided.

NEW LOWCA ENGINEERING CO.—This company was registered on February 12th, with a capital of £25,000 in £1 shares, to adopt an agreement with J. Burns, C. Walton, H. Bentley, and J. N. Bentley, to acquire the business of the Lowca Engineering Co., Ltd., and to carry on the business of electrical, mechanical, civil, and general engineers, engine builders, and fitters, boiler and machinery makers, steel converters, founders, &c. The subscribers are J. Burns, J. Fearon, J. R. Bleasdale, J. Chatt, T. Fisher, C. C. F. Walton, H. Bentley. No initial public issue. The number of directors is not to be less than two nor more than five. The first are H. Bentley, C. Walton, and J. Burns. Qualification £500. Remuneration £200 per annum, divided. Registered office, Lowca, near Whitehaven, Cumberland.

PRADEAU MOTORS.—Registered on February 27th, with a capital of £1,000 in £1 shares, to adopt an agreement and to carry on the business indicated by the title and that of electrical and mechanical engineers, saddlers, rubber and tyre manufacturers, smiths, &c. No initial public issue. Registered office, Finsbury House, Blomfield Street, E.C.

TRACTION BATTERIES.—Registered on February 25th, with a capital of £1,000 in £1 shares, to buy, sell, import, export, manufacture, repair, let on hire and deal in batteries, galvanic cells, motors and electrical or other machinery, motor and other vehicles, &c. Among the subscribers are A. F. Sims (solicitor), F. H. March, A. N. D. Smith and A. Laban, chartered accountants. No initial public issue. Registered office, 6 Victoria Avenue, Bishopsgate, E.C.

NEW PUBLICATIONS

"An Introduction to the Study of Electrical Engineering." By Henry H. Norris. First Edition. (London: Chapman & Hall.) 10s. 6d.

"Experimental Electrical Engineering and Manual for Electrical Testing." By V. Karapetoff. First Edition. (London: Chapman & Hall.) 25s. 6d.

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SUMMARY

A report has been issued by the Parliamentary Committee of the London County Council dealing with the three Bills relating to electric supply which are before Parliament this session, namely, the London and District Electricity Supply Bill, the London Electric Supply Bill, and the London (Westminster & Kensington) Electric Supply Co. Bill. Deputations have been heard from the promoters of the first two Bills, and representations have been made by the Borough Councils of London in regard to the three schemes. The Committee state that they see no reason why the Council should depart from the view which it has hitherto held, that the most satisfactory solution of the question is to be found in a principal generating station in a favourable situation. It is recognised that there may be advantages in the London Electric Supply Bill if this measure could be so limited as not to be inconsistent with or unduly hamper a large scheme; and if linking-up powers in any form are granted to the companies, similar powers should be granted to local authorities. With regard to the London and District Electric Power Bill, the report states that provision should be made in the Bill for, say, £1,000,000 of the capital to be raised within twelve months, and for the works to be substantially commenced in two years. Provisions in this Bill with regard to purchase and limitation of dividends are considered unsatisfactory, and the Committee agree with the suggestion made by Mr. Lloyd George that a conference between all parties concerned should be arranged. (Page 463.)

The Motor-Car Exhibition now being held at the Agricultural Hall contains only a small proportion of electric cars and accessories of electrical interest. (Page 464.)

The discussion on the advisability of standardising fuses is continued in our correspondence columns by Mr. A. H. Dykes, who thinks there is no general demand for such standardisation, and Mr. F. Broadbent, who goes into the variations in the requirements of fuses for different classes of work, and points out that before the fuses themselves can be standardised, a standard set of conditions to be complied with must be formulated. As we go to press we have received a letter from the Union Electric Co., calling attention to the fact that they have standardised a series of no-voltage releases for polyphase motor switches; and a long letter from Mr. H. Laws Webb answering Mr. Bennett's letter in our last issue. (Page 464.)

The report of Messrs. W. B. Peat & F. W. Pixley upon the accounts of the London County Council Tramway Department, which they have investigated

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from a "commercial" point of view, has now been issued. Exception is taken to the amount which has been laid aside to provide for the obsolescence of the horse tramway system, and the opinion is expressed that the amounts which have, from time to time, been applied to the relief of rates, should have been reserved on this account. The approximate loss under this head which they regard as still to be provided for exceeds £1,000,000. The amounts credited to renewals and reserve fund are also criticised, and the opinion is expressed that an insufficient amount is being allowed under this head. Amongst other matters, the question of the allocation of expenditure on street improvements is dealt with. The report was discussed at the meeting of the Council on Tuesday. (Page 465.)

A comparison between the installation rules of the Society of German Electrical Engineers (Verband Deutscher Elektrotechniker) and those of the Institution of Electrical Engineers was contained in a Paper read by Mr. W. P. Steinthal last Thursday before the Leeds Local Section of the Institution of Electrical Engineers. The differences discussed included those in the specifications of insulation, and the different conditions under which pure rubber-covered wires are used were commented on. The multiplicity of rules in this country was deplored in the discussion, and it was remarked that the German rules were consistently enforced. (Page 467.)

A form of arc lamp pillar for centrally-hung arc lamps, with a long hinged bracket-arm which can be lowered for trimming, is in use near Paris. (Page 468.)

The Poulsen wireless telegraphy station, situated at Lyngby, near Copenhagen, was enlarged last summer, and the height of the aërial was increased. This station is in communication with Newcastle, Berlin, and St. Petersburg. The generating plant consists of a petrol engine coupled to a 10 kw. dynamo, which supplies a single arc-gap. To supply the inert gas, with which the arc is surrounded, a few drops of alcohol are introduced into the arc-chamber every second. This renders the use of a complicated hydrogen generator unnecessary. (Page 469.)

The annual report of the National Physical Laboratory has been issued, and consists of a full account of the work done in all departments. The work proposed for this year includes the installation in the photometric department of a new set of electrical sub-standards for working with metallic filament lamps, and of an arrangement for determining the mean candle-power without rotating the lamp itself. Experiments in the determination of oscillation frequencies in wave telegraphy are also to be made. (Page 469.)

A considerable degree of success has attended the first year's working of the accumulator-driven motor-coaches recently put into service by the Prussian State Railways for local traffic. The total costs are given as 7·5d. per car-mile, including depreciation and interest on capital. Several more cars of a similar nature are on order. (Page 470.)

The switchboard which forms a part of the new extensions at the Wolverhampton Electricity Works is of the high-tension type, with all the actual high-tension apparatus in concrete cells, separated from the board itself by a passage-way. The operating panels are vertical, and carry also the excitation bars. Special arrangements are adopted for protecting the windings of the converting plant from abnormal rises of pressure. (Page 471.)

In a Paper read on Monday before the Society of Road Traction Engineers, Messrs. P. Trot Smith and W. A. Stevens alluded to the lack of financial success which has attended the use of the gear-driven petrol omnibus, and described a vehicle with electrical transmission gear, by the adoption of which they hope that the operating expenses will be very materially reduced. (Page 475.)

In an interesting Paper in the *Proceedings* of the Bristol Naturalists' Society on the effect of electricity upon plants, Mr. J. H. Priestley gives a historical review of the earlier experiments, and follows this with a detailed and quantitative account of the large scale trials made by Mr. J. E. Newman, resulting in a clear demonstration of the beneficial action of the electric discharge. Some further experiments by the author are also described. (Page 477.)

Tests have been made on one of the large single-phase turbo-alternators in the Electricity Works at Frankfort. Very low steam consumption figures were obtained. (Page 480.)

In the Paper by Dr. W. E. Sumpner and Mr. J. W. Record, read before last Thursday's meeting of the Institution of Electrical Engineers, the latest forms of iron-cored alternating-current instruments developed by these authors were described. One of these is a combined wattmeter and voltmeter, in which a swinging coil supplied by a current from a special transformer moves in the field of a shunt-wound alternating electromagnet with a laminated core, and another is a phase meter with a fixed iron core and light unrestrained moving coil. The mathematical theory of these instruments has been fully worked out, and is embodied in a previous Paper by Dr. Sumpner. Considerable admiration for the new instrument was expressed in the discussion, especially by Mr. S. Evershed, although a few disadvantages as compared with the dynamometer type of wattmeter were pointed out by Mr. K. Edgecumbe. Prof. E. Wilson compared Dr. Sumpner's method with other systems of power measurement on a mathematical basis; and Dr. Drysdale neatly demonstrated how the new instrument might be looked upon more as a special case of the induction wattmeter than as a real moving coil apparatus. One or two other speakers addressed the meeting, but owing to the excessive length of the remarks of some of the first speakers, several gentleman had to communicate their remarks subsequently. (Page 481.)

Professor F. Haber has carried out a careful series of experiments in order to ascertain whether porcelain heated until it becomes a conductor obeys Faraday's laws. As the result of his experiments, he finds that this is the case. It would appear that aluminium silicate, which is the main constituent of porcelain, acts very similarly to cryolyte in the electrolysis of aluminium. In the case of aluminium, the alumina is ionised in the cryolyte. In the case of porcelain the various metallic oxides are ionised in the aluminium silicate. Under "Electrochemistry and Electrometallurgy" we also draw attention to the formation of lead peroxide electrodes upon carbon, to the production of oxygen and hydrogen, to a modification of the thermit process, and to the use of aluminium vessels with acid solutions. (Page 487.)

At the Royal Institution on Saturday last, Prof. J. J. Thomson delivered the third lecture on "Electric Discharges through Gases," and showed how it was possible to freeze out the conducting portion of a gas, as at ordinary pressures the conducting particles were heavier than the molecules of the gas itself. A report of the lecture is given under "Electrical Science," together with an abstract of a Paper on the scattering of beta-rays by matter. In the Papers abstracted in the Continental Section, Rossi describes an improved magneto-elastic detector; Rüdenberg investigates the working of wireless receivers; Branly describes four methods of increasing the sensitiveness of electrolytic detectors; and Ries discusses the photo-electric sensitiveness of selenium. (Page 487.)

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A patent specification by J. H. Webb, describing an improved method of signalling by continuously-generated electric oscillations, was published on Thursday last. Two specifications by B. G. Lamme, relating to methods of obtaining regenerative action with single-phase commutator traction motors of the series type, were also published. One by F. P. Driver describes a method of cementing filaments to the leading-in wires of incandescent lamps; and another by E. Heitmann and F. W. Young relates to magnetic wedges for armature slots of alternators and induction motors. (Page 489.)

The conference between the committee of objectors to the proposed Home Office regulations and the advisers to the Home Office, was continued on Thursday and Friday last week, with the result that an agreement was arrived at with regard to the remaining regulations from No. 20 onwards, the previous ones having already been agreed upon. The inquiry before Mr. Swinburne was resumed on Tuesday. Mr. W. H. Patchell gave the results of some interesting experiments of the effect of voltage and current upon a number of experimenters, including himself. These results are set out in the shape of two curves in our report of the proceedings this week. Mr. C. P. Sparks, on behalf of the London Electric Lighting Companies, followed Mr. Patchell on the question of the limit of voltage in the regulations; so far as alternating current was concerned, he said that there might very well be no limit at all, as no commercial alternating current system was in use at a lower pressure than 65 volts. With regard to the pressure of 130 volts for continuous current, he pointed out that there are, in London, cases in which direct current supply is being given below 130 volts in competition with alternating current, and whereas the alternating current supply will come under the regulations, the direct current supply would not. Lord Robert Cecil addressed the Commissioner on behalf of the London Electric Lighting Companies, and in effect stated that, whilst an agreement had been come to with regard to the details of the regulations, the electrical industry generally felt that it would be much better off without any regulations at all. On the question of whether existing work should come within the regulations or not, Lord Robert Cecil urged that a similar regulation to No. 55 of the Coal Mines Regulations should be added. This gives an appeal to an independent arbitration from the decision of an inspector as to whether the existing work complies with the regulations or not. Mr. Vesey Knox addressed the Commissioner on behalf of the various power companies in the North-East of England, and also for the Mersey Docks and Harbour Board, and suggested that the scope of the regulations should be limited as much as possible, and to this end they should not be made applicable to factories and workshops. He could recall no case of such an important industry as the electrical industry being called a dangerous trade, and he could conceive no other result than that the regulations would have the effect of seriously retarding progress if they were allowed to go forward in their present form. The inquiry concludes to-day, and a full report of the final proceedings will appear in our next issue. (Page 491.)

Mr. J. Christie reports that the repairs to the Shoreham Harbour and Southwick Electricity Works are now complete, and in his opinion everything is now quite safe. The proposal to construct an electric tramway in connection with the Edinburgh Exhibition has been rejected by the Corporation. There is still a great deal of discussion as to the tramway track in Hanwell. The letter received from the United Tramways Co., defending the condition of the track, has been characterised by the District Council as a gross misstatement of the facts. Arrangements have been concluded between the Oxford tramways and the National Electric Tramways Co., whereby the shareholders of the existing company will get a return of 72 per cent. of their capital, 60 per cent. of which will be paid in cash. Complaints have been made as to the danger arising from live studs from the Mexborough, Rawmarsh, and Swinton tramway system, and a conference is to be held on the subject. The extensions of the West Ham tramways to Iron Bridge, Canning Town, are to be proceeded with. (Pages 493–495.)

At the meeting last week of the City of London Electric Lighting Co., the chairman stated that the net revenue showed an increase of £12,775, in spite of the fact that the sales to the London County Council tramways in 1906, which amounted to over £5,000, did not appear in the accounts for 1907. Notwithstanding the higher cost of coal, the works costs had been reduced by 0·2d. per unit. Over six million units had been sold during the year for power purposes. At the annual meeting of the North Metropolitan Electric Power Supply Co., the chairman called attention to the large increase of business during the year, including the bulk supply, which was now being given to the Hendon Electric Supply Co. The slight increase in expenses was mainly due to the higher price of coal. Applications have been invited during the week for £600,000 4½ per cent. debenture stock by the Charing Cross, West End and City Electricity Supply Co. (Pages 496–498.)

The result of the long inquiry, presided over by Mr. James Swinburne, F.R.S., relating to the proposed new Home Office Regulations, which concludes to-day, has been that a number of alterations suggested by the many objectors to the form in which the rules were originally drafted have been considered, and considerable modifications have been introduced into the majority of the proposed regulations. The wise course of delegating to a committee of the objectors the task of drawing up the revised form of the regulations, given in another column, to which they would agree, has considerably shortened the work of the inquiry itself. In saying that the objectors agree to this final form, it must be borne in mind that they still hold to the opinion that regulations of the nature proposed are unnecessary; but if they are compelled to accept them, they regard the revised details as being of a more suitable character than those first proposed. It is right to point out that the Home Office has gone a long way to meet the objectors in the case of most of the regulations to which serious opposition was offered, except as regards the question of the limits of voltage below which the regulations are not to apply. In respect to these limits as they now stand, the somewhat anomalous fact was brought out by one of the speakers on Tuesday that in a case where a 110-volt continuous-current system was established at a place where it was in competition with an alternating-current system working at about the same voltage, the latter would be handicapped by being obliged to conform with restrictions from which the former would be free. The difficulties which present themselves when any attempt is made to standardise the dangers of electrical circuits were well brought out by Mr. Patchell, who in his evidence described a series of experiments on the effects of certain voltages upon different persons and under different circumstances. The curves which we reproduce show clearly how very wide is the variation in the effect of the same voltages upon different people, and how impossible it is to define a sharp limit to the

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range of voltage which is dangerous. In considering the alterations which have been made, attention may be called to the modification in the much-discussed Regulation 17, by which the dimensions specified for switchboard passage-ways will not apply to existing installations, and also to the concession as to the minimum width of passage-ways in the case of high-tension switchgear. Considerable stress was laid on Tuesday and Wednesday upon the necessity for an appeal to a technical arbitrator from the decision of a factory inspector under the new regulations, although there appeared to be some difference of opinion as to the exact form such appeal should take. We look forward with interest to the final decision of the Home Office when they have considered the results of the inquiry, which the Commissioner will lay before them.

THE report of Messrs. W. B. PEAT and F. W. PIXLEY upon the accounts of the Tramway Department of the London County Council, which we reprint at some length in another column, has been awaited with a good deal of interest, as representing the views of independent professional accountants upon matters about which there has been considerable controversy. Previous discussions on the tramway question have always been so strongly flavoured with party bias that it is a relief to read the clear and dispassionate, although perhaps strongly worded, criticisms contained in the report. It is the business of the auditor to be on the safe side with his figures, and we are not surprised at the expression of opinion that the provision made for the obsolescence of the horse-tramway system has been on too small a scale, and that the money which has been, so to speak, returned to the ratepayers in the form of relief of rates ought properly to have been employed in writing off unsecured or insufficiently secured capital. The estimation of the amount to be written off in this matter is not a simple matter of arithmetic, but there are factors which vary according to the point from which they are viewed. It is urged by those who defend the accounts as they stand that, in addition to the "scrap value" of the track and cars, the capital sunk is still represented by a real asset in the form of the right of running tramways along certain streets and receiving the profits resulting from the traffic. The question is a large one, and will probably eventually resolve itself into a compromise. The matter of arrangements for a renewal reserve fund has been discussed and reported upon in connection with other undertakings times without number, and here again the auditors apparently desire to be on the safe side. They are evidently frightened by the table of increasing cost of repairs per mile, which they have included in their report, but we think it should be pointed out that this is only natural in a young undertaking, in which all the plant has not yet completed its first cycle of wear and repair. Another point considered is the knotty question of the allocation of the cost of street improvements among the various books at Spring Gardens, but the conclusions arrived at are not as sharply defined as the opinions expressed in the rest of the report. The general trend of this rather pessimistic report, whether its figures are too high or too low, is to show that the L.C.C. tramway system is not yet so free of the burdens of the colossal capital expenditure which called it into being as has been represented. In troubles of this nature it is not, however, alone among London traffic organisations which are still in the early days of their altered conditions. But as it is in the happy position of having to pay no dividends to its shareholders, there need be no undue haste in allotting profits to the relief of rates so long as the stale items on the capital account remain to be written off, or so long as there can be the least anxiety as to the sufficiency of the renewals reserve fund.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, MARCH 26TH.

Royal Institution.

3 p.m. Afternoon Lecture II., by Dr. R. T. Glazebrook, F.R.S., on "Standardisation in Various Aspects: (2) Electrical Engineering."

Royal Society.

4.30 p.m. Meeting at Burlington House. Among the Papers to be read is one by T. Mather, F.R.S., and F. E. Smith, on "Note on the Values of the Board of Trade Standards of Current and Electromotive Force."

FRIDAY, MARCH 27TH.

Physical Society.

5 p.m. Meeting at the Northampton Institute, Clerkenwell. Dr. C. V. Drysdale will read notes on the following subjects:—(1) On the Plug Permeameter, (2) On the Use of Shunts and Transformers with Alternate-current Measuring Instruments, (3) Wattmeters, (4) Experimental Demonstration of Alternate-current Wave Propagation in a Helix.

Electro Harmonic Society.

8 p.m. Last Smoking Concert of the Season at the Great Hall, Cannon Street, London, E.C.

Royal Institution.

9 p.m. Evening Discourse by the Hon. R. J. Strutt, F.R.S., on "Radio-active Change in the Earth."

SATURDAY, MARCH 28TH.

Royal Institution.

3 p.m. Afternoon Lecture IV. on "Electric Discharges through Gases," by Prof. J. J. Thomson, F.R.S.

Institution of Electrical Engineers: Students' Section.

10 a.m. Visit to the Thames Ironworks.

TUESDAY, MARCH 31ST.

Institution of Electrical Engineers: Manchester Local Section.

7.30 p.m. Meeting in the University. Paper to be read:—"Electrolytic Corrosion," by Prof. W. H. H. Gee.

Finsbury Technical College Old Students' Association.

8 p.m. Smoking Concert at Anderton's Hotel, Fleet Street, London.

THURSDAY, APRIL 2ND.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at 25 Great George Street, Westminster, S.W. Paper to be read:—"High-speed Electrical Machinery," by G. Stoney and A. H. Law.

Civil and Mechanical Engineers' Society.

8 p.m. Meeting at Caxton Hall, Westminster, S.W. Paper to be read:—"Efficiency of Boiler-heating Surface," by C. H. Wingfield.

Telegraph Traffic.—The French Co.'s cable between Martinique and Guadeloupe has been restored to working conditions, but Guadeloupe cannot as yet be reached by the cables of the West India and Panama Co. The *viâ* Fao route was not working on the 18th, there being some derangement between Bagdad and Bassorah, which was remedied on the 19th inst. Connection has also been re-established with Alderney and the Channel Islands by the repair of the cable between Guernsey and Alderney.

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LONDON ELECTRIC POWER BILLS

THE Parliamentary Committee of the London County Council has reported with regard to the three Bills dealing with electric supply before Parliament this session, viz., the London and District Electricity Supply Bill, the London Electric Supply Bill, and the London (Westminster and Kensington) Electric Supply Companies Bill. A *resumé* of the contents of these Bills was given in ELECTRICAL ENGINEERING, Vol. II., p. 1007, and we summarise the Committee's conclusions below.

Deputations from the promoters both of the London and District Electricity Supply Bill and the London Electric Supply Bill, have been received by the Parliamentary Committee, who have also heard representatives from the Borough Councils, both those having their own electrical undertakings and those having purchasing rights over the undertakings of companies within their areas. The scheme proposed by the London and District Electricity Supply Bill for a principal generating station on the river below bridges is in accordance with the Council's scheme of last session and the views accepted by Parliament, both when the Administrative Company's Bill was being considered in 1905, and in the report of the Select Committee on the Council's Bill of 1906. The promoters of the London Electric Supply Bill, on the other hand, urge that there is not now, and will not for some considerable time be, any necessity for a new principal generating station, and that if they are allowed to link up their existing stations they will be able to satisfy all demands as cheaply as could be done from a principal station. They lay stress on the point that the demand for electric energy for power purposes is not so great as has been supposed. This is a question upon which it is difficult for the Council to obtain the data necessary to arrive at a final conclusion. After advice by the officers and full consideration, the conclusion has been come to that, on the materials and facts at present available, there is no reason why the Council should depart from the view which it has hitherto held, that the most satisfactory solution is to be found in a principal generating station in a favourable situation. At the same time it is felt that every year's delay has increased the difficulties in the way of a new comprehensive bulk supply scheme, and that the most careful consideration should be given to any new facts which the promoters may be able to lay before Parliament. The Committee also recognise that there may be advantages to be obtained under the London Electric Supply Bill if it can be so limited as not to be inconsistent with or unduly hamper a large scheme, and the same remark applies to the London (Westminster and Kensington) Bill. It must necessarily take a considerable amount of time until the new undertaking is in operation, and in the meantime, according to the contention of the promoters, it will help to cheapen electric supply if existing undertakers are allowed to make the most of their plant and stations by linking up their systems. If linking up powers in any form are granted to the companies, similar linking up powers should also be granted to the local authorities if they are willing to take them in a Bill to be introduced next Session. The representation proposed to be given to the Council on the joint committee is not considered desirable, as it is not a sound policy for the Council to have representatives on the boards of management of private commercial undertakings. The London Electric Supply Bill also affords an opportunity for consolidating and making effective the purchase rights of local authorities over the undertakings of the existing companies, which at present are in many cases valueless, because the local authorities cannot purchase complete systems, but only such mains or stations as are within their areas. It is pointed out, however, that in some instances local authorities have at present purchasing powers before 1931, so that one effect of consolidation would be to postpone the date of purchase in those cases. Moreover, if the central authority had to purchase all the undertakings at one and the same time a larger sum might be required than could conveniently be raised in cash, so that it might have to be provided that the purchase consideration might be satisfied in stock.

The provisions for purchasing the undertakings of the joint committee and the existing companies are also regarded as unsatisfactory.

Dealing with the provisions of the London and District Bill, it is pointed out that in the first place it is essential that Parliament should be satisfied as to the financial ability of the promoters, and there should be a provision that the powers are to lapse, unless a considerable proportion of the capital, say, £1,000,000, is raised within twelve months, and unless the works have been substantially commenced within two years. No objection can be taken to the maximum prices, inasmuch as these are, as pointed out above, similar to those in the Council's own Bill, but the power of asking for periodical revision of prices should also be given to the Council. The purchase clause in the Bill is regarded as quite unsatisfactory. Under it the purchasing authority might have to pay large sums in respect of wholly obsolete and valueless plant, and the terms of purchase at the end of 42 years should, as in the case of the Administrative Company's Bill of 1905, be those provided by the Electric Lighting Act, 1888. There should also be a power to purchase in 1931, but in the event of purchase at the earlier date better terms would undoubtedly have to be conceded. The Committee also consider the provisions as to limitation of dividends unsatisfactory, and think that there should be substituted for it a sliding scale of prices and dividends subject to revision by the Board of Trade.

With regard to the position of existing electrical undertakings, the Council is interested in this matter, inasmuch as upwards of £5,000,000 have been borrowed on the security of the rates for the purposes of such undertakings. The promoters of the London and District Electricity Supply Bill have stated that their object was to assist and not to compete with the existing undertakings and to that they should be strictly held. No doubt the main consideration is to obtain a cheap supply of electricity for London, but it is essential in the public interest that existing authorised undertakers who have taken the risk of establishing these undertakings should receive fair treatment. The Select Committee which reported on the Bill of 1906 also took this view. Objections are raised both to the clause in the present Bill and also to the "Kitson clause," which was in the Council's Bill of last session. The Committee hope that the County Council will be able to assist in Committee in settling a clause which will be acceptable and fair to all parties. There are cases when it would appear to be clearly in the interests both of the ratepayers in the particular borough having an electric undertaking and the consumers of electric current that a supply should be taken from outside, *e.g.*, when the generating costs exceed the price at which energy could be purchased. Again, in most cases it would be more advantageous to take current from the new station rather than incur expenditure in increasing small existing stations.

The House of Lords passed a resolution in favour of referring these Bills to a Joint Committee of both Houses, but the House of Commons did not agree with the resolution, so that the Bills will come before Committees in each House in the usual way. In moving the House of Commons to disagree with the resolution of the House of Lords, Mr. Lloyd George said that there ought to be a conference between the parties to see whether agreement could not be come to. It is thought that the Council should co-operate in endeavouring to bring about a general agreement. The Committee therefore recommend—(*a*) That the Council do continue its opposition to the London and District Electricity Supply Bill on the lines indicated in the above report, with a view to obtaining such amendments and the insertion of such provisions as the Parliamentary Committee may think necessary or desirable in the interests of the public or the Council. (*b*) That the Council do continue its opposition to the London Electric Supply Bill and to the London (Westminster and Kensington) Electric Supply Companies Bill on the lines indicated in the above report, with a view to obtaining such amendments and the insertion of such provisions as the Parliamentary Committee may think necessary or desirable in the interests of the public or the Council.

Electrical Engineers Volunteers.—The Clyde division of the Electrical Engineers Volunteers held a supper and smoking concert at Greenock on Monday last week. The present strength of the division is four officers and 70 men.

A Steep Grade Electric Cable Railway.—The recently constructed electric cable mountain railway in the Southern Tyrol, near Bozen, known as the Virgl railway, is described in the *Street Railway Journal* as having the steepest gradient of any railway of its class. Formerly the Mendel Railway and the Mount Vesuvius cable line held first and second places respectively with maximum grades of 64 per cent. and 63 per cent., but the new line has a grade of fully 70 per cent. at its upper end, and in general averages 66 per cent. in a run 288 metres (about 945 ft.) long horizontally, and 195 metres (about 640 ft.) vertically. The road construction, however, is considerably lighter than the Mendel Railway, because the cars are smaller and the braking stress on the track less. The experiments in automatic vacuum braking made on the 70 per cent. grade showed that loaded cars freed from the cable could be stopped without shock within a length of 1·2 metres. The cable machinery is located in the upper station, and is driven by a 55-h.p., 550-volt, three-phase motor, operated by current transmitted at 3,450 volts from a power plant in the valley. The station machinery is operated at a speed to permit the cars to make the trip in five minutes. Hand and automatic brakes are in the station for the control of this machinery. Automatic braking occurs whenever the speed of the machinery rises 15 to 20 per cent., when a car goes beyond the upper stopping point, when there are interruptions in the power supply, and in other contingencies. In every application of this automatic brake the power circuit to the motor is broken. The electrical equipment was supplied by the A.E.G. Co., of Vienna.

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MOTOR-CAR EXHIBITION AT THE AGRICULTURAL HALL

IT is more than ever to be regretted this year that a means of harmonising the conflicting interests which result in the continuance of more than one group of automobile shows in the year in London has not been arrived at. Owing to this multiplicity of exhibitions, the Agricultural Hall Show opened last Saturday, coming as it does not very long after the magnificent show of private cars held at Olympia by the Society of Motor Manufacturers and Traders, and practically clashing with the exhibition of commercial vehicles promoted by the same Society, cannot possibly claim to be representative of any class of the automobile industry, and we were surprised to see a considerable amount of the space filled up by second-hand cars.

The lack of exhibits of either importance or novelty was also intensified during the first days of the Show by the lamentable unpreparedness of the majority of the stands. A glance round the Hall reveals only one stand devoted to electric cars, and an entire absence of the petrol-electric vehicles which have formed a marked feature of more than one recent exhibition; nor in the section devoted to accessories is any great novelty shown.

The Electric Vehicle Company, 1 Earl Street, S.W., show, in the ample space allotted to them, five or six electrically-propelled vehicles, all of which are, we believe, of American design. These range from a 2-ton van to a what is perhaps a novelty in this country, in the shape of an electric carrier tricycle. In this latter a small motor, ingeniously suspended in a framework, which also acts as a radius-rod, drives the single rear wheel through a bevel gear. The batteries are contained in a part of the usual carrier box between the front wheels. A small phaeton and a landaulette are also shown.

The gallery, as on previous occasions, is partly devoted to accessories. Amongst the electrical exhibits may be mentioned a collection of Siemens-Obach dry cells for ignition purposes, shown by Messrs. Siemens Brothers & Co., of 12 Queen Anne's Gate, S.W., and some new patterns of coil on the stand of the Prested Miners' Gas Indicating Electric Lamp Co., Ltd., of Elthorne Road, Holloway. The latest Prested coil is on the single trembler system, although a low-tension commutator is retained, and separate coils are employed for each cylinder. By this means as good synchronisation can be obtained as with a high-tension distributor without its disadvantages, and there is less strain on the coils than when a single coil does duty for all the cylinders. In one form of the coil a pair of tremblers are provided, with a change-over switch, and these, with their actuating magnets, can be placed, if found convenient, in a separate box from the coils themselves. The same firm also show an ignition accumulator of their own manufacture, with an improved form of plate.

Among other exhibits in the gallery is Hay's electrically-heated vulcaniser for tyre repairs, shown by Maison Talbot, of 1 Long Acre, W.C. This apparatus is much more compact than the ordinary spirit-heated vulcaniser, and we understand that the requisite vulcanising temperature, which is about 280° F., can be obtained in 10 minutes from an ordinary 4-volt, two-cell ignition accumulator, and it is said that overheating is impossible.

Various electrical appliances for motor-cars are also shown in the gallery by Messrs. W. & R. Jacobs, of 39c King William Street. These comprise a British-made accumulator, known as the "Electary," which is fitted with a special form of incorrodible terminal coils, switches, voltmeter, &c., and a special series of head, side and tail lamps for motor-cars and cycles, in which 4-volt or 8-volt Osram lamps are used. A few electrical accessories are also shown in the arcade near the entrance. On the stand of Messrs. J. C. Lyell & Co., of 55 Victoria Street, S.W., may be seen, among other exhibits, a special change-over switch, which allows of the employment of magneto or coil ignition at will, with only one plug per cylinder, and some examples of the M.S. low voltage metallic filament lamp for carriage lighting. The lamps, having an efficiency of about 1·2 watts per candle-power, consume less than half the current of an ordinary small carbon filament lamp, and give about twice the light. Another advantage of metallic filament lamps for use with batteries is that the diminution of light as the voltage of the battery falls off is much less than with carbon filament lamps. A new pattern of electric hand-drilling machine is also shown.

Messrs. Geipel & Co., of 92 St. Thomas Street, S.E., also exhibit in this section a number of instruments, including the well-known "Vulcan" electrical speed indicator, which consists of a small magneto-generator and a voltmeter, and other indicating instruments of the hot-wire type.

CORRESPONDENCE

THE STANDARDISATION OF FUSES.

To the Editor of Electrical Engineering.

Sir,—I have read with interest the note in your issue of the 12th inst., on the suggested intention of the Engineering Committee to deal with the question of electrical fuses. What is it intended to standardise—the type, the size, the fusing current, or the material? Unless one particular pattern be selected, it is obvious the other variables cannot be standardised, as the length depends entirely on the design. The ratio between the working current and the fusing current, again, depends entirely on the type, as what is a practicable ratio with one type of fuse is quite different with another. The number of different fuses on the market is legion, and, speaking generally, they mostly do the work required of them by practical men.

The Committee has done good work, and much remains for it to do, but I cannot help thinking that it is a mistake to spend time and money in dealing with articles for the standardisation of which there is no general demand, and, indeed, no felt want.

A. H. Dykes.

1 Victoria Street, London, S.W.
March 18th, 1908.

To the Editor of Electrical Engineering.

Sir,—Whilst, as I pointed out in my Institution Paper on Wiring Rules in 1901, too much standardisation tends to retard progress, yet a certain amount is a necessary evil for commercial considerations. Before we can standardise fuses we ought to formulate a standard set of conditions to be complied with. These would tend to bring about some kind of uniformity in distribution-box design, for, as Mr. Russell points out, the standardisation of fuse-box design is perhaps more urgent than the question of the standardisation of the fuses themselves. What I should like to see is the adoption of a standard length of fuse, so that fuses of various carrying capacities could be used alongside each other in the same box, a practice which is, of course, diametrically opposed to the idea of non-interchangeability of fuses, standard minimum spacing distances between fuses, minimum standard clearances between live metal and case, and some uniformity in the method of leading the wires into and out of distributing boxes.

As to the standardisation and interchangeability of fuses, this is, if not impracticable, at any rate most undesirable. This point does not, perhaps, affect lighting fuse-boxes to the same extent as motor fuse-boxes. In the case of lighting, the ultimate carrying capacity of any branch circuit can be settled once for all when the installation is first laid down. But in the case of motors, which in well-arranged installations are individually fed from a separate pair of fuses in a distribution fuse-box, there is no such guarantee. It is often necessary to increase the size of the motor, and consequently the carrying capacity of the fuses. Again, motors of various sizes are fed from one fuse-box, involving fuses of widely different carrying capacities. It is essential, therefore, that the fuse-gaps—that is, the centres between the fuse-clips—should be of the same dimensions for a wide range of fuse sizes.

The spacing also is an important matter. It is not at all uncommon for several adjacent motor fuses to blow, due to arcing over from one to another. This applies, of course, to the open type of fuse. Wher cartridge-type fuses are used, it is desirable that the fuse-boxes should be ventilated. The amount of heat given off, say, by a dozen pairs of cartridge fuses in motor circuits is often sufficient to injure the insulation of the leading-in wires if the boxes are fairly airtight.

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The essential requirements for the fuses themselves are that they should be capable of being easily replaced or attended to without any risk of shock or burn to the attendant; that there should be no possibility of connections becoming slack; that in motor circuits they should have a considerable time element—that is, they should be able to take very large overloads for sufficient time to permit of a motor being started up quickly; in the circuits of induction motors the fuses should stand four or five times their normal current for about half a minute to permit of starting up, but the motor should be protected against continuous overload.

The main fuses on an installation should carry an overload for a longer period than the branch fuses. Many cases have come under my experience in which main fuses capable of carrying 200 amperes or so have blown, due to the switching on of a motor without the starting resistance being in circuit, when the motor fuse itself had not blown. This is due to the use of enclosed-type copper fuses in the motor circuits and open-type lead fuses in the main circuits. If there were some uniformity of practice as regards nature of fuse metal and type of fuses, *i.e.*, open or enclosed, this kind of thing would be to some extent overcome.

It is not uncommon to find motor fuses, particularly in printing offices, large enough to carry three or four times the full load current of the motor. This is necessary in order to permit of the motors being started up quickly. If the fuses had sufficient time lag this would not be necessary. As to the overload current which a fuse should stand, I do not think any hard and fast rule can be made. In motor circuits it depends to some extent on the type and rating of the motor. Some I should not care to overload more than about 20 per cent., whilst others will stand 100 per cent.

There is no need for a large margin in the fuses protecting lighting circuits, as the conditions are very different to motor circuits. But the fuses, particularly the main fuses, should have a considerable time element to permit of an instantaneous "short," due, say, to a bad lamp, whilst the continuous overload permitted should not exceed, say, 50 per cent.

Yours faithfully,

Frank Broadbent.

4 Queen Street Place, E.C.

L.C.C. TRAMWAYS ACCOUNTS

THE report giving the result of an investigation into the accounts of the London County Council Tramway Department, which has been conducted by Mr. W. B. Peat (President of the Institute of Chartered Accountants) and Mr. F. W. Pixley (a past President of the Institute), has now been issued. The investigation covers the period from 1892–3, when the Council commenced expenditure in connection with tramways, down to March 31st, 1907, the date of the last published accounts.

The report first deals with the horse-traction system. All the tramway undertakings acquired have been on the horse-traction system, with the exception of a small section worked on the cable system. In May, 1903, the Clapham to Tooting section was opened on the electric system, and this system of traction has been gradually superseding the horse-system. Owing to the supersession of horse-traction the original system of traction becomes obsolete as electrification proceeds.

The total net expenditure under this head up to March 31st, 1907, was £2,380,736, 13s. 1d. This debt is being repaid over the following periods:—60 years, £1.819,831 12s. 11d.; 25 years, £463.117 12s. 8d.; and 8 years, £97,788 7s. 6d. The debt outstanding at March 31st, 1907, was £2,010,902 7s. 4d.

The Council includes in its capital account up to March 31st, 1907, the outlay on both the horse-traction and the electric-traction tramways, the latter including the expenditure on street improvements, &c., namely:—Horse traction, £2,380,736 13s. 1d., and electric traction, £4.356,000 12s. 4d.

This principle in our opinion, continues the report, is not sound, because there are practically no existing assets to represent the horse-system of traction so far as it has been displaced. It is suggested that a certain residue of value exists in some of the displaced horse-traction assets, but, in our opinion, this value cannot alter the fact that there is a large loss not provided for on the displacement of the horse-traction system.

The original track cost £1,017,942 9s. 11d., to which must be added £23.826 3s. for payments to the tramway companies in respect of their expenditure on street improvements (included in purchase prices), and £13,827 6s. 11d. for additions by the Council. Deducting £27,944 8s. 8d. for proceeds of sales of old material, a balance of £1.027,651 11s. 2d. is left, which represents the track of the horse tramways displaced by the electric system. It is suggested to us that there is a residue of value in the track of the horse-tramway system in excess of the scrap value of the old materials, but no figure has been placed upon this residue—subject thereto, and to a proportionate amount of the sinking fund instalments which have been paid out of revenue, the above balance is a loss for which no provision has been made in the accounts of the tramways. Practically the whole of the debt in respect of the above expenditure is being repaid over a period of 60 years.

Parliamentary, law, and other costs, amounting to £77,533 8s. 11d. were incurred by the tramway companies, and it is reasonable to conclude that these expenses have now no value and subject to a proportionate amount of the sinking fund instalments which have been paid out of revenue the above amount represents a loss, for which no provision has been made in the accounts of the tramways. The goodwill relates to the horse tramways acquired by the Council, and was estimated by the valuer to the Council in apportioning the purchase prices of the various undertakings at £166.937 7s. 6d. The debt in respect thereof is being repaid in instalments at the end of 8, 25, and 60 years, and includes an item of £97,787 7s. 6d. paid to the North Metropolitan Tramways Co., as the consideration for cancelling the unexpired term of their lease from the Council, viz., 4 years. It is advisable that this £166,937 7s. 6d. should be written off out of revenue over a shorter period than is provided by the payment of the sinking fund instalments.

The net capital outlay on property and buildings is given as £773,318 8s. 11d.

Some of these buildings have been converted by the Council to other uses in connection with the electric system, and the leases in some cases have been disposed of or determined. Where the buildings have been made available for other purposes the expenditure has been rightly charged to the capital of the electric undertaking, but the capital displaced by demolition or reconstruction has not been written off, and remains part of the cost of the horse-tramway system. It is, in the circumstances, impossible to indicate what loss (if any) will arise in connection with the property and buildings.

The total cost of rolling stock was £126,232 0s. 7d., the realisations have been £3.657 5s. 2d., and the stock remaining is valued at £2.166, leaving an estimated loss of £120.408 15s. 5d., for which no provision has been made in the accounts of the tramways, subject to a proportionate amount of the sinking fund instalments, which have been paid out of revenue. The debt in respect of rolling stock is being repaid over a period of 25 years.

The estimated loss on machinery and plant, after deducting proceeds of sales and plant purchased in 1906 (mainly from the North Metropolitan Tramways Co.) at cost, was £55,060 5s. 4d., subject to a proportionate amount of the sinking fund instalments which have been paid out of revenue. Practically the whole debt is being repaid over 25 years.

The estimated loss on harness and equipment was £5.980 10s. 1d., subject to a proportionate amount of the sinking fund instalments, which have been paid out of revenue. The debt is being repaid over 25 years.

With the exception of the cost of temporary generating stations and other expenditure of a special and temporary nature, in all amounting to £43.885 4s. 4d., paid for out of revenue, the combined total net cost of the horse-traction system and the electric-traction system appears as an asset in the capital account. As already mentioned, the Council, apart from the repayment instalments of the debt charged against revenue, have made no provision for the loss on any of the foregoing items of permanent way, rolling stock, &c. While we recognise, continues the report, that the Council had no means of writing off at once the loss on the displaced assets of the horse system, we consider that such loss should be provided for out of revenue more rapidly than by the charging of the annual instalments in repayment of the debt. Until these losses are provided for there can be no profits applicable for relief of the rates.

Summarising the position as regards the loss on the displacement of the horse-traction system, we are of opinion that, even assuming that the freehold and leasehold properties and buildings are of sufficient value to represent the amount at which they stand in the accounts, and after allowing for any

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residue of value which may remain in some of the other assets, the loss for which the Council will have to make provision, must approximate £1,500,000. Subject to the proportionate amount of the sinking fund instalments, in redemption of the debt, which have been paid out of revenue, and which, on the whole of the horse-traction debt, amounted on March 31st, 1907, to £369,854 5s. 9d., the approximate loss still to be provided for must exceed £1,000,000.

£293,592 2s. 11d. has been applied in relief of rates since 1897. This sum has been applied out of the earnings of the horse-traction system. We consider that these amounts should have been reserved towards the loss referred to above. Until the revenue of the tramways has been charged with (1) the losses on displaced assets of the horse system, (2) a full provision for renewals on the system now in force, (3) the charges in respect of the outstanding debt, and (4) a proportionate amount of the full Central Office charges, we are of opinion that no sum will be available for relief of rates. In the balance-sheet the loss referred to should appear as loss on conversion of the horse system to electric traction.

Passing on to electric traction, the total net expenditure to March 31st, 1907, not including the amount charged for street improvements, &c., is given as £4,076,184 16s. 10d. Of the the whole debt in respect of this £3,128,942 19s. 11d. is being repaid over 25 years and the remainder over 60 years. The debt outstanding on March 31st, 1907, was £3,853,376 8s. 5d. To the extent that the Works Department has been employed as contractors, actual cost only has been charged to capital, and no allowance made for profit to that department. This is quite in accord with our views of a proper basis of the capital charge.

The amount at the credit of renewals reserve fund on March 31st, 1907, was £141,855 1s. 3d., made up as follows :— Balance of amount set aside out of the horse-system profits to March 31st, 1903, £29,051 4s. 9d.; amount set aside out of electric-system profits from April 1st, 1903, £105,000; and interest and dividend accumulations, £7,803 16s. 6d. What provision should be made out of revenue for renewals of the electric undertaking is a very difficult question to decide when the life of the assets forming part of such undertaking has not yet been ascertained by experience. It is impossible for us to fix a rate. The Council has been advised by its officers that at least one penny per car-mile run should be provided for the renewals reserve fund, this being in addition to any general repairs of the undertaking and the renewal of the machinery, plant, and buildings of the generating stations. A charge for renewals is, in our opinion, essentially an element in the cost of the year's trading, and should not be determined or affected by the result of such trading. It should form a charge in the revenue account of each year before the balance of net revenue is arrived at. It should not be treated as an appropriation of any balance of revenue available. As an example of the erroneous method of dealing with this charge we refer to the accounts for the year ending March 31st, 1907. The surplus revenue is shown as £9,673 15s., but if one penny per car-mile had been charged for renewals, the tramway undertaking would have shown a deficiency of £58,107 5s. It is to be noted that the result for 1906-7 was exceptional, and consequent on the working of the remaining horse systems at a loss before charging interest on and repayment of debt. We are of opinion that revenue should be charged with the cost necessary to maintain the undertaking as a going concern, which can only be done by providing an adequate reserve for future renewals; otherwise, long before the termination of the loan periods, the undertaking will become an instrument incapable of making profit, because of the excessive repairs and renewals which will be necessary, and the absence of an adequate renewals fund out of which the cost of the renewals could be met. As having an important bearing on this point, the following table is given of the increase in ordinary repairs, &c., during the four years of the working of the electric system, as shown in the following statement :—

Year.	Total car mileage of the electric system.	Total net repairs, &c., of the electric system. £ s. d.	= Per car mile run. Pence.
1903-4 ...	4,469,576	15,060 8 6	0·808
1904-5 ...	10,931,396	40,988 10 0	0·899
1905-6 ...	12,164,292	57,842 15 10	1·141
1906-7 ...	16,267,579	89,429 7 8	1·319

It will be observed that 1906-7 shows an increase of ½d. per car-mile run over 1903-4. The inference to be drawn is that the increase in repairs inevitably points to the need for early renewal.

In our opinion it is essential that the whole of the renewals fund should be specifically invested so as to be available when required. We find that out of the Council's renewal fund of £141,855 1s. 3d. on March 31st, 1907, only £83,008 16s. 2d. had been so invested, the balance of £58,846 5s. 1d. having been used for the general purposes of the tramway undertaking. The renewals provision necessary to keep the undertaking as a going concern have, in our opinion, no relation to the statutory sinking fund.

With reference to the allocation of expenditure on street improvements, the authors of the report are of opinion that the proportion of the cost of the street improvements and widenings, which should be charged to the tramways, should bear a direct relation to the benefit derived or to be derived by the tramways. (*a*) When the improvements were undertaken wholly to accommodate the tramways and were not otherwise necessary. (*b*) When improvements were undertaken along a route concurrently with the construction of a tramway. (*c*) When the improvements were undertaken with the object of accommodating general traffic, and also providing a sufficient width of thoroughfare for a contemplated construction of tramways. (*d*) When the tramways, although constructed, derive in common with the general traffic benefit from the improvement.

With regard to (*d*), it may be urged that the tramways should not be charged with any improvement made subsequent to their construction, on the ground that an incorporated company owning a tramway system under a charter for a term of years could not be called upon to pay any portion of such expense. This may be true, but the incorporated company may run an inefficient service of trams, if it prefers to do so, rather than bear any share of the expense, whilst on the other hand the Council being responsible for providing facilities for both the general and the tramway traffic, the expenditure thereon should be apportioned according to benefits received. They are further of opinion that in assessing the benefit apportionable to tramways, the Council should be guided by the advice of experts who would take into account all the circumstances of each particular case. Some specific examples of street improvements are then considered.

In connection with the expenditure on *improvements undertaken or proposed in connection with tramway schemes*, the total expenditure up to March 31st, 1907, was £752,128 11s. 8d.; of this, £190,999 6s. 1d. has been charged to tramways, and £173,690 7s. 1d. has been contributed by local authorities, the remainder, viz., £387,438 18s. 6d., being charged to improvement account. A substantial, but as yet unascertained, proportion of this last figure, in the opinion of the authors of the report, should be charged to tramways capital account. The expenditure on *improvements for the purposes of general traffic* amounted at March 31st, 1907, to £1,007,103 11s. 2d., the local authorities concerned contributed £142,982 1s. 1d., the balance, £864,121 10s. 1d., being charged to improvement account. In their opinion a considerable, but as yet unascertained, proportion of this latter figure should also be charged to tramways capital account.

In considering the basis of the valuation of the tramway undertakings by the valuer to the Council, dated January 16th, 1907, the basis adopted by the valuer, viz., "of applying a multiplier to an ascertained net income," is stated to be a fair and usual basis for arriving at the value of the goodwill of an undertaking, the property and other assets being as a rule taken over at the valuation of an expert, but assuming that such a basis is a fair one to apply to the tramway undertaking as a whole, the number of years used as the multiplier should be arrived at after due consideration is given to the permanence and profitable character of the undertaking, and the provision made for depreciation and renewals, before arriving at the net income to which the multiplier is to be applied.

The valuer has fixed 25 years as his multiplier, but in so doing it is thought that he has not given sufficient consideration to the possibility of supersession by some other system of traction and competition by other means of conveyance.

The report continues: The valuer, in arriving at his figure of net income, for the southern system, has not in our opinion made sufficient allowance for renewals and nothing at all for contingencies such as accidents or for possible loss by the substitution of other means of traction.

If the net income had been properly ascertained, we consider that 25 times the amount of the annual net income yielding a purchaser only 4 per cent. is too high a valuation for an undertaking subject to all the risks of a tramway enterprise and the liability to make good the roads in the event of its discontinuance. In our opinion, without questioning the principle, we think that both the multiplier and the net income are too great.

The balance sheet as published is presented in a very clear and concise form, and we have no suggestion to make for its alteration, except the following :—(1) That the total capital expenditure on the horse traction system should be shown distinct from that on the electric traction system; (2) instead of showing the debt repaid out of revenue as "excess of assets and capital outlay over liabilities" it should appear as depreciation reserve account—total debt repaid to date, charged against revenue as depreciation of the assets of the undertaking. We recommend that the revenue accounts should be presented in a summarised form, with schedules giving details. The details of the power expenses do not appear in the revenue account, but in a schedule, and we think on the whole it would be preferable if the other charges against revenue account, such as traffic expenses, repairs, and general expenses, were dealt with in the same way, and then the revenue account would give a view of the net results attained by showing the gross totals of leading items of expense and revenue and the schedules would supply necessary details for those desiring to examine them.

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COMPARING GERMAN AND ENGLISH WIRING RULES

MR. W. P. STEINTHAL read a Paper before the Leeds Local Section of the Institution of Electrical Engineers last Thursday, in which he compared the rules for electric installation work drawn up by the Society of German Electrical Engineers (Verband Deutscher Elektrotechniker), with those of the Institution of Electrical Engineers.

While the Institution rules "are intended neither to take the place of a detailed specification nor to instruct untrained persons," the author thinks that if an installation is erected to the regulations of the German society, no further specification could in any circumstances be required. Although the general tendencies of the two sets are similar, there are notable differences.

Current Density.—From 9 amperes to 20 amperes the current density in conductors permissible in Germany is three times or more, from 20 amperes to 200 amperes twice or more, from 200 amperes to 240 amperes one and a half times or more, and for 500 amperes 1·3 times that of the I.E.E. rules, and the author has been unable to find any limit given to the permissible drop of pressure.

[This at once renders valueless the author's opinion that the German rules can take the place of a detailed specification.—Ed. E.E.]

Insulation.—The author thinks it may be assumed that pure rubber-covered wires have been "entirely discarded" in this country except for flexibles. In Germany they are used to some extent for surface work up to 110 volts. The use of this rubber-covered wire, he says, is what is referred to in this country as "Continental wiring with flexibles," but the conductors are not flexibles in our meaning of the word, and are merely pure rubber-insulated wires as against vulcanised rubber wires. For installations up to 125 volts where the work is done on the surface the use of this rubber-covered wire, fixed on porcelain bobbins, is very common. This method of installation is cheap, and, if properly carried out, neat and perfectly sound from an electrical point of view.

The radial thickness of insulation required is appreciably smaller in the case of the German rules. This is shown in Table I.

Table I.: Radial Thickness of Insulation.

Cross-section. Sq. mm.	Mils V.D.E.	Mils I.E.E.
1·0	31	40
1·5	31	41
2·5	39	44
4·0	39	47
6·0	39	47
10·0	47	52
16·0	47	62
25·0	55	71
35·0	55	76
50·0	62	80
70·0	62	87
95·0	70	94
120·0	70	101
150·0	78	107
240·0	94	125
500·0	125	141

Flexibles.—The very exhaustive Paper read by Professor Schwartz last year to this Institution deals very fully with the subject of flexibles, and in Appendix C of that Paper will be found the German rules as they stood in 1905. The 1908 rules contain no appreciable modification. One German rule in particular relates to the supporting of a fitting by means of an additional wire, which carries no current, in addition to the actual conductor carrying the current. [The author of the present Paper omits to explain that the addition is only required in the case of counterweight pendants, and that even then an additional "cord," made up with the wire, may be used instead of a third wire.—Ed. E.E.]

Insulation Resistance.—The German requirements are put in a rather different form from that to which we are accustomed in this country. They do not base their tests according to numbers of points, but they require that the leakage current should not exceed 1 milliampere between any two fuses, and further, that a distributing board should have an insulation resistance of 1,000 ohms multiplied by the pressure of supply. In measuring the leakage current, it is specified that the minimum pressure for the testing current should be 100 volts.

The author next calls particular attention to the following points in the German rules:

The cross-section of conductors employed for making earth connections must be proportioned with due regard to the strength of the possible earth current. The smallest cross-section in electric power-rooms is to be 0·248 sq. in. (16 sq. mm.), and 0·0062 sq. in. (4 sq. mm.) elsewhere; generally for copper conductors, 0·00155 sq. in. (1 sq. mm.) for every 10 amperes may be reckoned.

Cells in battery rooms must be so arranged that the attendant cannot simultaneously touch two points between which the difference of potential exceeds 250 volts.

The nominal working current and pressure should be marked on switches. The author expresses strong approval of this rule, and also of the following: Plugs for the connection of movable conductors must be so constructed that they do not fit sockets made for a higher current strength. The normal current capacity and pressure should be marked on the socket and on the plug.

Under the heading of fuses, the author notes that the Edison screw type of fuse plug is used almost universally in Germany, where particular value is attached to non-interchangeability.

Switch lamp holders are not permitted for use with hand lamps.

The use of papier-mâché conduit with either a brass or an iron sheath appears to be very common in Germany. This type of conduit is, the author believes, sold in this country under a trade mark "Adnil." From inquiries he has made, this conduit does not appear to offer any advantage as regards price, but he adds that it is possible that there may be a saving in cost of labour with this type of conduit over the steel conduit in general use here.

Another matter to which the author calls attention is that in the German rules a layer of pure rubber between the conductor and vulcanised rubber insulation is not specified.

DISCUSSION.

Mr. R. H. Campion (Dewsbury), in opening the discussion, said he wished the Paper had been read before the last revision of the Institute Rules, as we might have benefited by the comparison. The main point of difference appeared to be the permissible current density in the conductors. The Germans allowed a considerably higher limit, resulting in less expensive work. All the Continental surface wiring which had come under his notice was for about 100 volts. He considered the English practice of painting all the bus-bars of switchboards accessible from the back with red, a better plan than merely marking the polarity on the bars. The rule requiring the marking of all switches with the nominal working current and pressure was worthy of copying, also that specifying that controllers, heating apparatus, &c., should be mounted clear of the walls. The regulations referring to the non-interchangeability of fuses were very instructive. The average Englishman was so anxious to get the current on that he would use anything handy as a fuse, from a hair-pin to a pocket-knife, with consequent risk of overload. This would be impossible with a proper system of standardised cartridge fuses.

Dr. R. Pohl (Bradford) defended the V.D.E. Rules, and considered that in this country we might with advantage permit higher current density in our cables than is the present practice. With metal filament lamps the voltage variation possible is greater than with carbon lamps. The amount might be increased from 2½ per cent. to 3½ per cent. for the same drop in candle-power; also by raising the current density it would be possible to transmit to greater distances. The German rules were enforced in practice, but it is not so with the I.E.E. rules. It is very deplorable there should be so many different sets of rules in this country, and he was strongly of the opinion that only one set should be recognised, and if it were possible, they should also be international. He supported the V.D.E. rule that fuses should not be interchangeable for different current strengths. The climate on the Continent was on the average drier than in this country, but he did not consider that an important consideration, as they had a considerable rainfall and many damp days.

Mr. S. W. Cuttriss (Leeds) said that, although there were many minor points of difference between the two sets of rules, the main points of distinction, so far as installation work is concerned, appear to be the current density, quality, and thickness of dielectric and method of installing the wires. No doubt in this country we erred on the side of low density, but it is a good fault, as it allowed a better margin for overloading, which constantly took place by the addition of more lamps, without due consideration of the capacity of the wires. While not desiring to reflect on the soundness of the V.D.E. rules referring to the insulation of conductors, he was very much in favour of keeping up the quality, even for very low voltages. An insulation test meant little or nothing in con-

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sidering the life of an insulated wire. In this matter we were largely at the mercy of the manufacturers, and could do little else than trust that the higher the grade the more good rubber it contained, consequently the longer the useful life. He remarked that wood-casing appears to be entirely neglected on the continent, judging by the rules, and in this respect we had the advantage. Despite the claims of the Conduit people, wood-casing properly installed in suitable situations could not be beaten as a convenient and reliable protection for the wires. Referring to "Continental Wiring" (unprotected surface work), the revised I.E.E. rules embodied a concession in that respect, and there was little doubt that, since the advent of low voltage metal filament lamps, its adoption would extend, especially for small houses. For installations of 50 volts and under, where the risk of shock and fire is practically nil, he considered that special rules might with advantage be compiled, allowing further concessions in the matter of installation.

Mr. H. Visger (Leeds) said the German rules were generally accepted and enforced, and it would be much more satisfactory if our own rules were treated in a similar manner. At present a contractor does not know where he is with regard to rules and regulations, and in private plants they are often more or less ignored unless there is independent supervision. He was also in favour of the non-interchangeability of fuses, as sometimes under present methods too large a fuse is inserted, and fire resulted. Referring to the question of insulation, generally the grade is specified higher than necessary. The success of an installation very often depended on the way the work is executed rather than on the quality of the wire.

Mr. S. D. Jones (Batley) considered that the Germans should be given credit for knowing what they wanted. There were too many rules in this country, and still more coming. The insulation of battery stands from earth was a good thing, and had only recently been adopted here. He also spoke in favour of increasing the current density and the size of solid wires permissible.

Mr. J. T. Fawcett (Leeds) remarked that although the specified thickness of the dielectric is less than required in this country, he would like to know whether manufacturers adhered to the rule; his impression was they exceeded it. In reference to flexibles, although no mention was made of a pure rubber covering against the wire, he had found such a covering in some German flexibles. The speaker also had a tilt against the multiplicity of rules in this country, and advocated that the I.E.E. rules be made compulsory by law.

Mr. H. Dickinson (Chief Engineer, Leeds Corporation) was inclined to the opinion that in this country the rating of conductors was too low. No doubt in all supply undertakings there are cases where individual mains are overloaded, but personally he had found no trouble, except in reduction of pressure. He thought that a higher rating could be allowed with perfect safety. The thickness of the dielectric ought to be kept up; if it is thin and perishes, cracks occur and let in moisture, but if thick, although perished, the protection is much better. There are many old installations where the rubber has perished, but the insulation test remains good. They could not put customers to the expense of rewiring their installations, but agreed to connect them to the service, except in exceptionally bad cases. The precautions taken are to see that the fusing is particularly well attended to.

Mr. Steinthal in reply said it had been the general practice in Germany in the early days to use "Continental wiring," but now that higher pressures were being adopted, *papier-mâché* tubes were being used. Wood casing was very uncommon in Germany. He agreed with Dr. Pohl that the Germans knew what they were doing with regard to current density. The non-marking of switches with the nominal working current and pressure was principally the fault of the manufacturers, and it would be a desirable practice to enforce. Replying to the question respecting foreign cables, he said most German manufacturers were far too cute to send their thinner cables over here, but what they sent were made specially to pass our requirements. It would be much better in all respects if we were confined to one set of rules, and would be the means of getting rid of a great deal of inferior work.

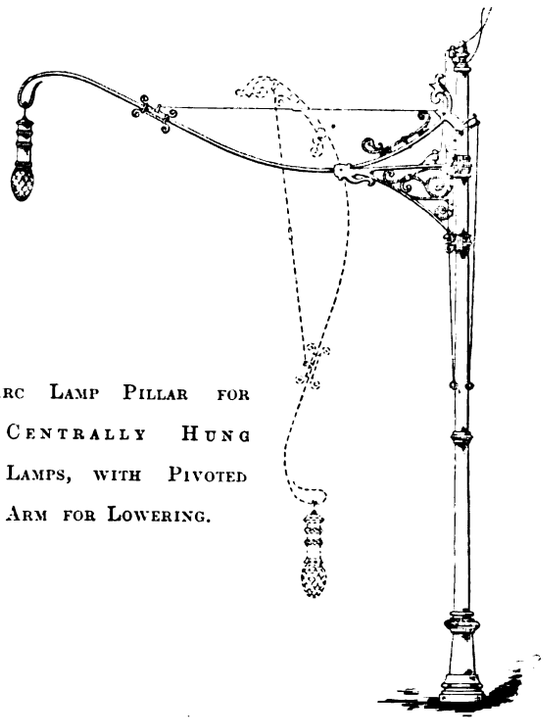
Institution of Electrical Engineers.—The following is the result of the ballot for new members at the meeting on Thursday:—*Associate Members:* R. Blackmore, A. L. Boyle, K. M. Faye-Hansen, J. Hey, D. James, H. C. Ogilvie, B. Smith.

1,650-Mile Electric Railway.—It is stated that the St. Paul, Minneapolis, and Settle Electric Railway Co., recently incorporated with a capital of $50,000,000 to build an electric railway between Twin City and Puget Sound, will shortly commence laying the track for the first section. The line will be 1,650 miles in length, and it is anticipated that the first division to the Red River Valley will be completed in eighteen months. The route adopted will be 200 miles shorter from St. Paul to Settle than either the existing Northern Pacific or the Great Northern Railways. The line will be double track, and the third rail system is to be used throughout.

AN ARC LAMP PILLAR FOR CENTRAL LIGHTING

THE practice of lighting streets by centrally suspended arc lamps has, on the whole, been given more attention on the Continent than in this country, though this arrangement has been adopted in a few isolated cases in England—notably in the case of the experimental lighting of Cannon Street in the City of London. The most usual arrangement is to stretch cross-wires along the street, and in some cases arrangements of pulleys are adopted to lower the lamps for trimming.

A somewhat different arrangement, which has been adopted at Levallois-Perret, near Paris, is described in a recent number of *L'Electricien*, and is shown in the accompanying illustration. As will be seen, the lamp is mounted on a long bracket-arm



Arc Lamp Pillar for Centrally Hung Lamps, with Pivoted Arm for Lowering.

carried by a tubular pole, and pivoted so that the lamp can be lowered. The long, movable arm is pivoted at a point at the end of a short, fixed bracket, and is balanced by a weight suspended from a wire rope, and contained within the tubular pole. There is also a locking arrangement which can be released when the lamp is to be lowered by a rope terminating in a ring which is reached by a hook at the end of a pole. The other rope shown at the left-hand side of the post passes round a pulley, and raises the counterweight when pulled, allowing the arm and lamp to swing down into the position shown dotted in the illustration. This form of post has superseded a somewhat unsatisfactory arrangement of cross-wires and pulleys for drawing to the side and lowering, and has been so successful that about 400 are being put up.

Repairing Electric Light Street Boxes.—In the City of London Court on Friday, the French Asphalt Co., sued the City of London Electric Lighting Co., for £3 8s. for making good the footway round eight electric lighting street boxes in Fleet Street. The French Asphalt Co., it appears, has a contract with the City Corporation for repairing certain streets in the City of London, including Fleet Street. They recently discovered that the pavement around eight electric lighting boxes belonging to the City of London Electric Lighting Co., was in a sunken condition, and under their contract with the City Corporation effected the necessary repairs, and charged the account to the company. As the Electric Lighting Co. was not notified that the work was being done and no price was quoted them, they refused to meet the account. Judge Rentoul, K.C., after hearing evidence, held that as the defendants had not ordered the work they were not liable for the cost. There seemed to be many legal intricacies in the matter which the French Asphalt Co. could not deal with without advice. He suggested that they should take legal advice, and if they decided to go on, the Electric Lighting Co. must be awarded costs.

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THE POULSEN WIRELESS TELEGRAPHY STATION AT LYNGBY

In a former article (see Electrical Engineering, Vol. II., p. 765), describing the Poulsen station at Knockroe, Tralee Bay, Ireland, which is to be used for transatlantic telegraphy, reference was made to the Copenhagen station, which had then been for some time in communication with a station near Newcastle. The former station is situated at Lyngby, not far from Copenhagen, and was originally a small experimental station equipped with a 3·5 kw. 240-volt dynamo and a mast only 120 ft. high. Last summer the station was considerably enlarged, and now contains a 10 kw. 500-volt dynamo driven by a petrol motor capable of developing 20 h.p. The two wooden masts, each 230 ft. high, are 300 ft. apart, and support a stranded copper cable, to which are attached twenty-three copper conductors. These are spread out on either side by means of insulated guide-ropes and brought together again below, forming a roof-shaped aerial. The corresponding electrical "counterpoise" consists of a wire network spread out over the surface of the ground.

The 10 kw. dynamo supplies an oscillation generator composed of a single arc-gap in hydrogen. The electrodes are, as usual, copper and carbon respectively, the copper electrode being water-cooled if more than 5 or 6 kw. is being supplied to the arc. A strong transverse field is provided. The working of the Poulsen transmitter was described in Electrical Engineering, Vol. I., p. 81. The energy generated in the oscillation circuit varies, according to the wave-length employed, from 2 to 5 kw. The receiver in use at this station is the usual Poulsen "ticker," with telephone or relay and Morse printer. The new apparatus for registering the Morse signals photographically is also in use at Lyngby. Messages are received and recorded by this apparatus from the station at Cullercoats, near Newcastle, some 600 miles distant. The latter station has a dynamo of only 4·6 kw. capacity. The messages can be received by telephone and recorded by the above apparatus simultaneously. The ss. *Hellig Olav* has been in communication with the station at Lyngby up to distances of 1,200 miles with a wave-length of 4,000 ft. It will also be remembered that messages were received at Steglitz, near Berlin, from this same ship, when some 2,000 miles distant in mid-Atlantic. It has been found possible to receive two sets of messages simultaneously by means of one aerial with wave-lengths differing in effective length by only 3·5 per cent. Skilled operators can receive separate messages with a difference in wave-length of only 1 per cent., and it is partly to this high selective property that the superiority of the continuous-wave system over the damped-wave spark system is due.

An important improvement in the transmitter has recently been made, in that the complicated apparatus for producing the hydrogen has been replaced by an arrangement by which one or two drops of alcohol are introduced into the arc chamber every second (for a generator producing about one kilowatt in the oscillating circuit). The Lyngby station is in communication with Berlin and St. Petersburg as well as with Newcastle, and experiments are being made in wireless telephony.

THE NATIONAL PHYSICAL LABORATORY

The General Board of the Laboratory met at Bushey House, Teddington, on Friday last, and at the invitation of Lord Rayleigh, chairman of the General Board, several visitors were also present, and a general inspection of the new buildings and appliances was made. The annual report commences with a reference to the death of Lord Kelvin, who was a member of the General Board and a frequent visitor to the Laboratory. The late Sir Benjamin Baker was also a member of the General Board. During the past year research work of electrical interest has been carried out in several departments of the Laboratory, and the following notes on this work are taken from the report.

In the Physics Department several researches on electric measurements have been carried out and the results published in various Papers before societies. The Paper on the Ampère balance, by Prof. Ayrton, Mr. Mather, and Mr. Smith, was read before the Royal Society in June last. Measurements of a very high order of accuracy were obtained, and in consequence the ampere is now probably much more exactly determined than either of the other fundamental electrical units. A further Paper by Mr. Smith, Mr. Mather, and Dr. Lowry deals with the silver voltameter. Voltameters of six different patterns were compared, with the result that provided the electrolyte is a solution of pure nitrate of silver, the mass of silver deposited per coulomb is found to be the same in all, and to amount to 1·11827 milligrammes. The value found by Lord Rayleigh in 1884 was 1·1179. A third Paper by Mr. Smith deals with the Weston cadmium cell. A large number of these cells have been constructed, different methods of preparing the mercurous sulphate being tried. If sufficient care be taken to avoid hydrolysis, these different methods lead to the same result. The E.M.F. of the cell at 17° C. expressed in terms of the ampere as realised by the Ayrton-Jones balance and the international ohm set up in the Laboratory is 1·01830 volts, while comparisons with cells set up in Berlin, Paris, and Washington show differences of only a few microvolts. Some work has been done on the Lorenz apparatus, which the Drapers' Company are to present in memory of the late Professor Viriamu Jones. Mr. Campbell's researches have chiefly been connected with the methods of measuring to a high order of accuracy small capacities and inductances. For this purpose a large standard of mutual inductance, the value of which can be calculated with great accuracy from its dimensions, has been set up. Methods of comparing self-inductances involving the use of a new form of vibration galvanometer and of a variable mutual inductance have been devised. This work has been carried on in preparation for some investigations into methods of measuring oscillation frequencies in wave telegraphy, which the Laboratory has been asked to carry out for the Post Office. Progress in the interesting experiments on the dielectric resistance of insulating materials under high stresses has been stopped by the failure of the 100,000-volt transformer which was built for the Engineering Standards Committee. A number of experiments have been made with a view to setting up an apparatus to give an approximate indication of the loudness of noise. A sensitive indicating arrangement was obtained by connecting a microphone transmitter and battery to the primary of a transformer of very high ratio (*e.g.*, 1 : 500)—an ordinary spark coil being suitable; the secondary circuit was connected to a low-reading electrostatic voltmeter. The experiments brought out clearly the fact that an ordinary "solid-back" transmitter has several strongly marked resonance frequencies (*e.g.*, at about 500 and 1,000 ~ per second) lying quite within the range of ordinary speech.

The total number of instruments and apparatus tested has increased greatly, and this increase extends over practically all divisions of the work. A comparison of tests made during the years 1906 and 1907 shows that in the Physics Department, 254 electrical measurement tests were made in 1907 against 74 in 1906. In 1907, 897 tests included under the heading of Electrotechnics were made, against 696 in 1906. In the Photometry Department 400 tests were made in the year 1907, all of these being incandescent lamp tests; the corresponding number in 1906 was only 214, out of which 205 were incandescent lamps. Among the more interesting inquiries may be mentioned an examination into a large number of old and modern rails for the Great Northern Railway, and the investigation for the Board of Trade into the cause of failure of a thermal storage drum at Greenwich. In the Photometric Division, a large number of lamps have been tested for life in accordance with the specification of the Engineering Standards Committee. The Magnetic Observatory at Eskdalemuir is now practically complete, and a staff has been appointed. The sums paid during the year include £1,476 for the equipment of the new electricity building and £300 for the building and equipment of a transformer house.

During the year a Committee appointed by the Treasury has been sitting to inquire into the work now performed at the National Physical Laboratory, with special reference to the character of the tests undertaken. The report of the Committee has been communicated to the Royal Society by the Secretary of the Treasury, with the intimation that their Lordships accept the recommendations of the Committee, and they trust that the Royal Society will do the same. In reply, the

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President and Council, at the request of the Executive Committee of the Laboratory, have expressed their readiness to use their best endeavours to carry the report into effect. In the future, with the exceptions specified in the report, tests on materials will only be carried out on the receipt of a request addressed to the director, on an official form, supplied by the Laboratory. The conditions under which such tests are undertaken will be printed on the form, together with a statement, to be signed by the applicant, that his application is made subject to these conditions.

The report includes a statement of the proposed work for the year 1908. In the Physics Department the standard condensers will be tested against the new mutual inductance standards, and the latter will be used as a basis for the measurement of self-inductance. The variable mutual inductance standards will be checked against them, and by their means the effect of variation in frequency upon self-inductance will be investigated. The experiments for the determination of high frequencies will be continued. A number of experiments have been already made on the behaviour of insulating materials (such as are used in telephone cables) at different frequencies, as regards their effective resistivity and permittivity (inductive capacity). These will be extended to higher frequencies. The high-frequency alternator will be completed, and a new wire interrupter set up. The marble variable inductance will be completed. The hysteresis research will be continued, and arrangements for determination of total iron losses improved. In the photometric section a new set of electric sub-standards, running at a higher efficiency than those now in use, will be established. These are needed for work with new metallic filament glow lamps. The existing lamps run at about four watts per candle. It is proposed to make two new sets, one to run at about 2·8 and the other at 2 watts per candle. The question of stepping from the redder to the whiter light will need careful investigation. By employing intermediate steps of small colour gradation, it is hoped to produce a set of standards which will accurately represent the equivalent of the candle in a whiter light. It is also intended to construct an arrangement for the measurement of mean candle-power by the rotation of mirrors, instead of by spinning the lamp itself—so that lamps may be tested whose filaments are too delicate to allow of rotation. Special attention is being paid to the installation of a very complete equipment for dealing with large quantities of life tests on lamps under the Engineering Standards Committee specification. The sub-Committee of the Engineering Standards Committee which is dealing with fuses desires experiments carried out on various types of fuses, with the object of determining the safe distance between contacts to be prescribed. It is proposed to test both open and enclosed types, and also to determine the fusing currents of various kinds of wire. Several individuals and institutions unconnected with the Laboratory are also co-operating in the work. It is probable that investigations on the larger fuses will be made by the Laboratory staff at some central station, where the larger capacity of the plant will admit of short circuiting tests being carried out without danger to the machinery and apparatus.

With regard to determination of oscillation frequencies in wave telegraphy, the problem of calibrating the various wave meters used for measuring high frequencies (*e.g.*, up to several million ~ per second) has been taken up at the instance of the Post Office authorities. A standard wave meter is being arranged, consisting of a highly accurate variable air-condenser and a well-stranded coil of small self-inductance. For the measurement of such small inductances the variable mutual inductance is employed, and in this way small self-inductances from one microhenry upwards are measured with ease and accuracy. As the indicating instrument for the wave meter a Duddell thermo-galvanometer has been purchased. For the absolute determination of frequencies by photographing the spark, a rotating mirror has been constructed which can be driven at 100 to 150 revolutions per second. A Poulsen arc lamp, a large air-condenser, and tuning coils are under construction.

The Post Office, the National Telephone Co., and other authorities have been consulted, with a view to evolving, if possible, a standard test for dry cells. This may involve the testing of a large number of cells over a long period of time.

The report also contains a list of papers published by the Laboratory or communicated by members of the staff to scientific societies, and an appendix to the report gives a full description of the new electrotechnical buildings and equipment.

The Aldwych-Embankment Subway.—It is stated that the through tramway service between the north and south of London *viâ* the Aldwych subway and the Embankment will be opened on April 10th. A description of the subway and its equipment was given in Electrical Engineering, March 5th, p. 343. Since that time the work of laying the track has been rapidly pushed forward, and the whole of the special work for the junction with the Embankment lines has been put in position during the last few days.

ACCUMULATOR RAILWAY CARS IN GERMANY

Some particulars of the accumulator motor coaches put into service just a year ago by the Prussian State Railways in the neighbourhood of Mainz, were published in Electrical Engineering, Vol. II., p. 206. The following further particulars of the electrical equipment, charging arrangements, and working results for the first year are taken from an article by K. Fürst in a recent issue of the *Elektrotechnische Zeitschrift*. The cells, of which there are 180 in each car, weigh 111 lb. each; and as they are rated at 200 ampere-hours under normal running conditions, this gives 3·6 watt-hours per lb. weight of cell. The estimated life of the positive plates is some 70,000 car-miles, and of the negative plates some 37,000 car-miles. A record has been kept for some cells, and it is found that after a total run of 10,000 car-miles, the capacity is considerably higher than that guaranteed, and the deposit is only 0·47 inch in depth. The average efficiency of the cells, obtained by taking the ratio of the utilised energy to the energy supplied to all coaches over a month's working, worked out at 76 per cent. The firm which supplied the cells (Akkumulatoren Fabrik-A.G., Berlin) has contracted to keep all the batteries in good condition, and to replace all parts damaged through use under normal conditions, for a charge of 1·55d. per car-mile for a period of five years.

The charging station at Mainz contains one 100 h.p. 160 r.p.m. Diesel oil engine, direct-coupled to a 75 kw. direct-current generator. Normally one car is charged at a time, taking from 110 to 120 amperes, but two cars could be charged at the same time if necessary. There is also a three-phase asynchronous motor, which can be connected to the town three-phase mains, and which is direct-coupled to a 50 kw. direct-current generator. This set was used before the Diesel motor set was installed, and is now only employed as a reserve. The total cost of this charging plant was £2,965.

The cars run on three lengths of track—from Mainz to Gau-Algesheim (13·2 miles), four return journeys per day; from Mainz to Oppenheim (12·7 miles), four return journeys per day; and from Mainz to Rüsselsheim (7·6 miles), six return journeys per day.

The cars are recharged after each journey from Mainz and back in the first two cases, but two journeys to Rüsselsheim are made on one charge. The times taken to recharge at a rate of 110 to 120 amperes are as follows:—After a journey to Oppenheim and back (25·4 miles), about 40 minutes; after one journey to Rüsselsheim and back (13·2 miles), about 25 minutes. There are five cars in all—three working, one in reserve, and one under repair. The average energy consumption is some 30 watt-hours per ton-mile. The average speed about 20 miles per hour, and the average distance between stops 2·5 miles.

The following are the approximate working costs in pence per car-mile:—

Cost of energy supplied to cells	1·36d.
Lubrication, cleaning, and heating	0·27d.
Wages of driver	1·16d.
Wages of conductor	0·89d.
Depreciation of cells (including renewals) ...	1·55d.
Depreciation of motors and equipment ...	0·085d.
Depreciation of car-bodies and bogies	0·36d.
Total	5·675d.

It is proposed to run the cars without conductors, which would reduce the above figure by 16 per cent. In order to obtain the total working costs, the amount of 1·85d. per car-mile must be included for interest on the capital cost of the charging installation and rolling-stock. This makes the total working cost 7·525d. per car-mile. The figure of 1·85d. per car-mile for interest on capital cost is based on the assumption that each car travels 21,000 miles during the year. The figure of 1·36d. per car-mile for the cost of energy is based on a generating cost of 0·875d. per kw.-hour, which is the total cost of generating with the Diesel motor set. If the motor-generator set is used, the cost is about three times as great, as besides the extra losses in the transformation, the charge of the town supply is 1·8d. per kw.-hour. The working results have been so satisfactory that the Prussian State Railways have ordered 57 more of these accumulator cars, which are to be delivered during this year.

Monte Video Tramways.—It is stated that the equipment of the 80 miles of line owned by the United Electric Tramways Co. of Monte Video will be completed by the end of June. According to the *Stock Exchange Gazette*, the lines, when fully electrified, will represent a capitalisation of £20,000 per mile, a figure below that of any other leading tramway company in South America.

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NEW HIGH-TENSION SWITCHBOARD AT WOLVERHAMPTON

As briefly mentioned in the article in our last issue describing the extensions to the generating plant in the Corporation Electricity Works at Wolverhampton, one of the features of the additions to the equipment of the station is the new three-phase high-tension switchboard which has been installed by the Electric Construction Co. The position of the switchgear, alongside the older continuous-current board towards the end of the station, where the new generating sets are placed, although not actually in the new portion of the building, was indicated in the large plan of the station given on page 436 of the article referred to, and a photograph showing the general appearance of the operating panels is here reproduced in Fig. 1.

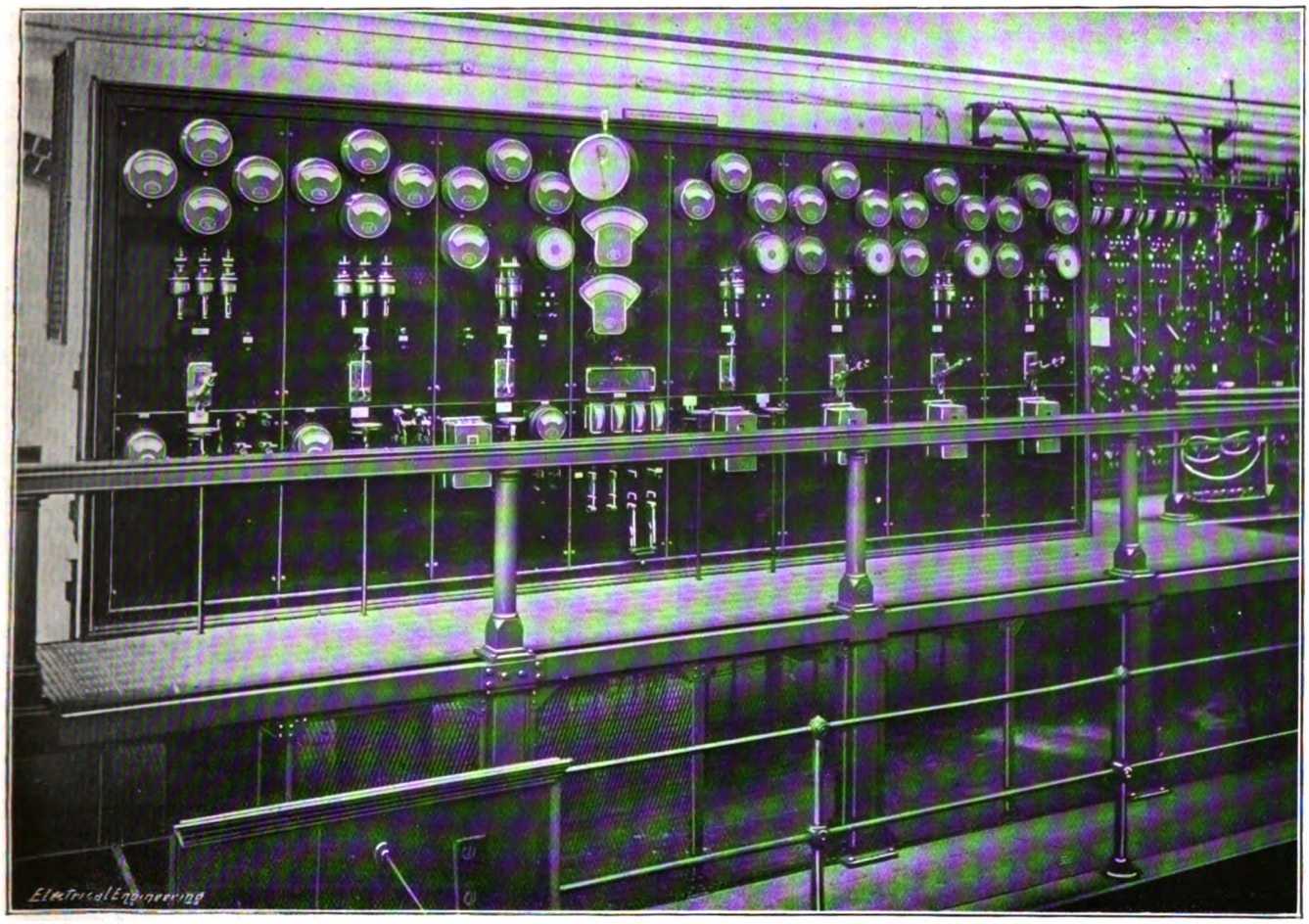


Fig. 1.—Front View of new 6,000-volt Switchboard.

As will be seen, the board is placed on a low gallery with a glass floor, which forms a continuation of the gallery of the continuous-current board. All high-tension apparatus is contained in cells separated by a passage-way behind the board itself. The actual board consists of eight slate panels, comprising two generator panels, a panel devoted to each of the converter sets, three power feeder panels, and a panel upon which are mounted the synchronising instruments, and also some of the switches and instruments belonging to the exciter circuits.

In general, it may be said that the front panels carry all instruments, operating levers, and low-tension switches, while all high-tension apparatus and connections are mounted in reinforced concrete cells placed against the wall behind the board. The cells are closed with expanded metal lock-up doors, and are shown in the side view given in Fig. 2.

The instruments for the high-tension circuits, which are mounted on the operating board, are all worked from the secondary side of transformers fixed in the cells in the usual way, and the whole arrangement is such that in the ordinary working of the board the high-tension connections and apparatus are inaccessible to unauthorised persons. The cells are in two tiers, and each forms an independent unit. The doors are carried on hinges, but so arranged that they can be lifted off when required. The expanded metal is of $1\frac{1}{2}$ in. $\times \frac{1}{8}$ in. $\times \frac{1}{8}$ in. mesh No. 24 metal.

The framing of the operating board consists of 6 in $\times$ 3 in. channel base, and 3 in. $\times$ 3 in. vertical H section joists. A 3 in. $\times$ 3 in. angle is provided for carrying the platform in front of the switchboard, also horizontal angles at the back for carrying the portable platform and the rails for removing the oil switches.

The panels themselves are of paraffined slate $1\frac{1}{2}$ in. thick, of the same height as the original continuous-current board, and a polished teak moulding has been provided top and bottom to match the older panels.

Before describing the equipment of the various panels and cells in detail, attention may be directed to the diagram of connections given in Fig. 3. It will be seen that the 'bus-bars are arranged in a kind of ring, and that isolating switches are provided so that they can be sectionalised to a considerable extent. The 'bus-bars themselves consist of 0·5 sq. in. bare copper throughout the main and return portions. Each phase of the

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'bus-bars is totally enclosed in a separate concrete cell, and the arrangement is such that extensions could readily be made. The isolating switches are, of course, contained in the cells in positions shown in Fig. 4. They are so arranged that the three poles are operated together, as this is found to be more convenient in the case of the 'bus-bars than single-pole switches. It will be noted that the switches in the 'bus-bar circuits isolate the circuits in addition to fulfilling the function of dividing the bars. The isolating switches in the 'bus-bars are equivalent to the carrying capacity of 0.5 sq. in. wrought copper, while those at the cable ends of the feeders are equal to carrying 200 amperes. All these switches are worked from the passage-way behind the board by keys without opening the doors of the cells. As they are all of the same design, only one key is provided for all of them.

The two generator panels for the new 1,000 kw.

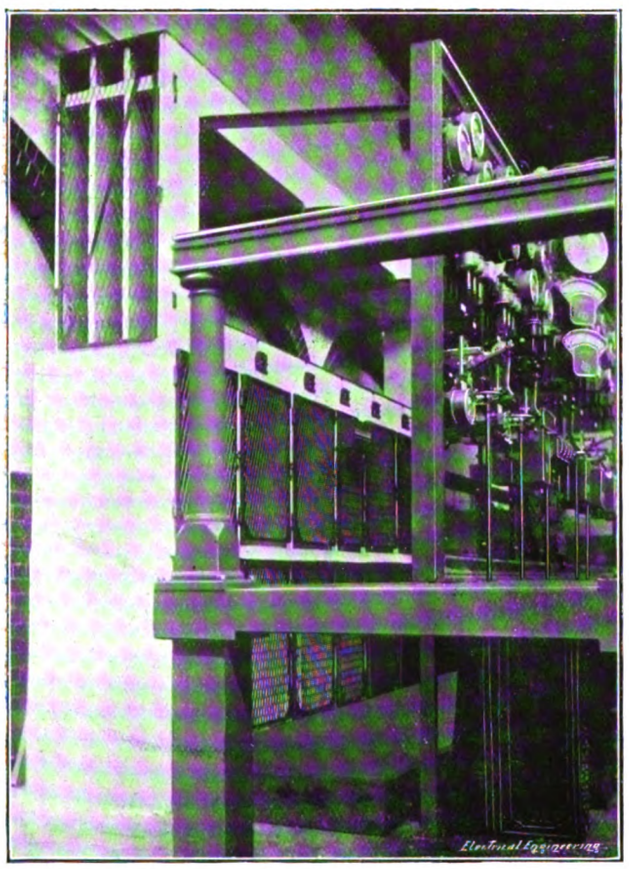


Fig. 2.—Side View of Switchboard, showing E.H.T. Cells.

6,600-volt three-phase alternators are placed at the left-hand side of the board. The levers for operating the main oil switches are arranged in the centres of the panels, and actuate the high-tension gear in the cells behind through a system of rods passing under the floor of the passage-way. The oil switches themselves are of the standard E.C.C. 6,600-volt type, and have all been tested and found capable of breaking 2,000 kw. at 10,000 volts. They are fitted with tripping coils wound for continuous current. The arrangement of the operating lever is such that the switch cannot be held closed under an overload. Should the switch trip automatically the handle on the operating board immediately moves to the "off" position, thereby indicating that the circuit has opened. Each phase has a double break in a separate oil tank. A set of rails for supporting the circuit-breakers when drawn out of the cell is provided. The switches are shown in position in Figs. 4 and 5.

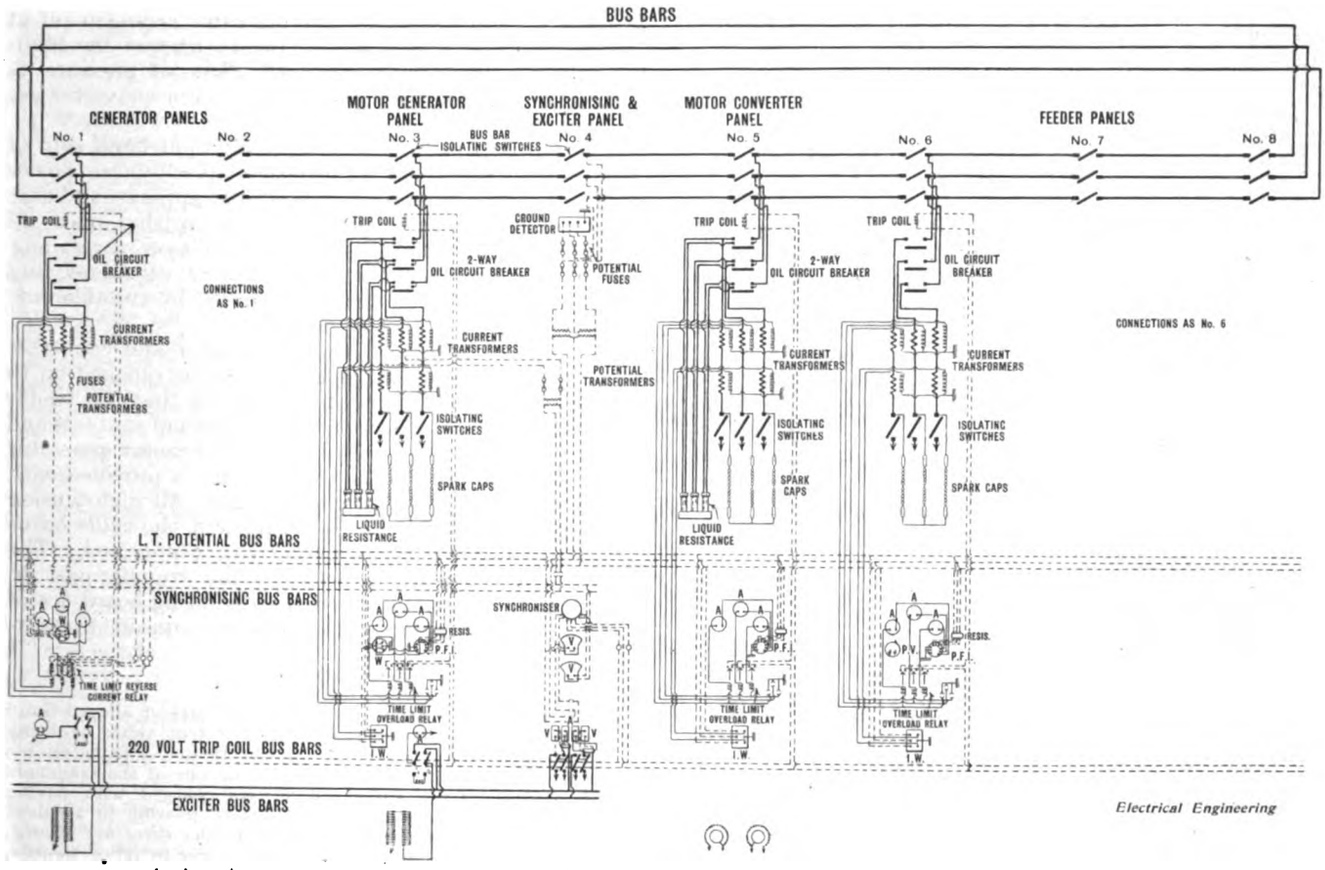
The reverse current time-limit relays are of the British Thomson-Houston Co.'s manufacture, and are mounted on the front of the panels above the switch levers. Overload relays are not used on the generator circuits. As will be seen from Fig. 1, all the main indicating instruments are mounted at the top part of the panels. Those on the generator panels comprise three ammeters and an indicating wattmeter for unbalanced loads. Separate machine voltmeters are not provided, but the high-tension cells corresponding to each machine contain potential transformers, which can be plugged on to the voltmeter on the synchronising panel mentioned hereafter. All the instruments on the board are of Messrs. Everett, Edgcumbe & Co.'s manufacture. The ammeter and wattmeter are of the round pattern, with 8-in. dials. All have cast-iron cases enamelled black, with nickelled facings. As pointed out already, the ammeters are worked by current transformers. These are of E.C.C. standard open type, and are of course placed in the high-tension cells. The potential transformers in the generator circuits are of the single-phase type, and are contained in cast-iron cases filled with suitable oil. The current for the potential circuit of the machine wattmeter is not obtained from these transformers, but is derived from a two-phase transformer in the synchronising cell, which also furnishes all current to the potential circuits of all indicating wattmeters, integrating wattmeters, power-factor indicators, and one side of the synchroniser. The potential transformers are protected by fuses of the glass-tube dust type, held in clip contacts, and a set of ebonite tongs has been provided so that these can be replaced when alive.

The lower part of each generator panel is devoted to the excitation circuits. A pair of 80-volt exciting 'bus-bars run along all the generator panels. These are mounted on porcelain insulators on the uprights of the operating board framework, and are fixed below the platform level. The exciter gear on each generator panel comprises a double-pole field-breaking switch with non-inductive resistance and a round pattern ammeter with a 6-in. dial.

Between the ammeter and field-breaking switch is the small hand-wheel and vertical spindle by which the field-regulating rheostats are worked. The resistances themselves with their multiple-contact switches are placed under the gallery floor.

The next panel, which may be considered to all intents and purposes as a feeder panel, controls the circuits leading to the 500 kw. synchronous motor-generator. The arrangement is generally similar to the generator panels, except for certain additional apparatus. Among the instruments on the upper part of the board a direct-reading power-factor indicator is provided, with an arrangement of plug sockets by which the power factor of any phase can be observed. The oil switch and reverse current relays are also similar, except that two sets of contacts are provided on the oil switch, which come into action successively as the switch is put on. The object of these is to enable the voltage to be put on to the windings of the incoming machine through a set of water resistances before it is applied direct to its terminals, in a similar manner to the arrangement sometimes used for feeder charging. Further protection to the high-tension windings of the motor-generator is provided by a multi-gap static discharger of the British Thomson-Houston Co.'s standard 7,500-volt type. The position of this apparatus in the high-tension cells is seen in Fig. 4. The only other apparatus on this panel which does not correspond exactly to that on the 1,000 kw. generator panels is an integrating watt-hour meter on the lower part of the panel, connected, of course, to the appropriate current and potential transformers. It should be remarked that the synchronous motor-generator is always started up from the continuous-current side by means of the switchgear placed close to the machine itself, so that provision has only to

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A. Ammeter.
V. Voltmeter.
P.V. Pilot Voltmeter.
W. Indicating Wattmeter.
I.W. Integrating Wattmeter.
P.F.I. Power Factor Indicator.

FIG. 3.—DIAGRAM OF CONNECTIONS.

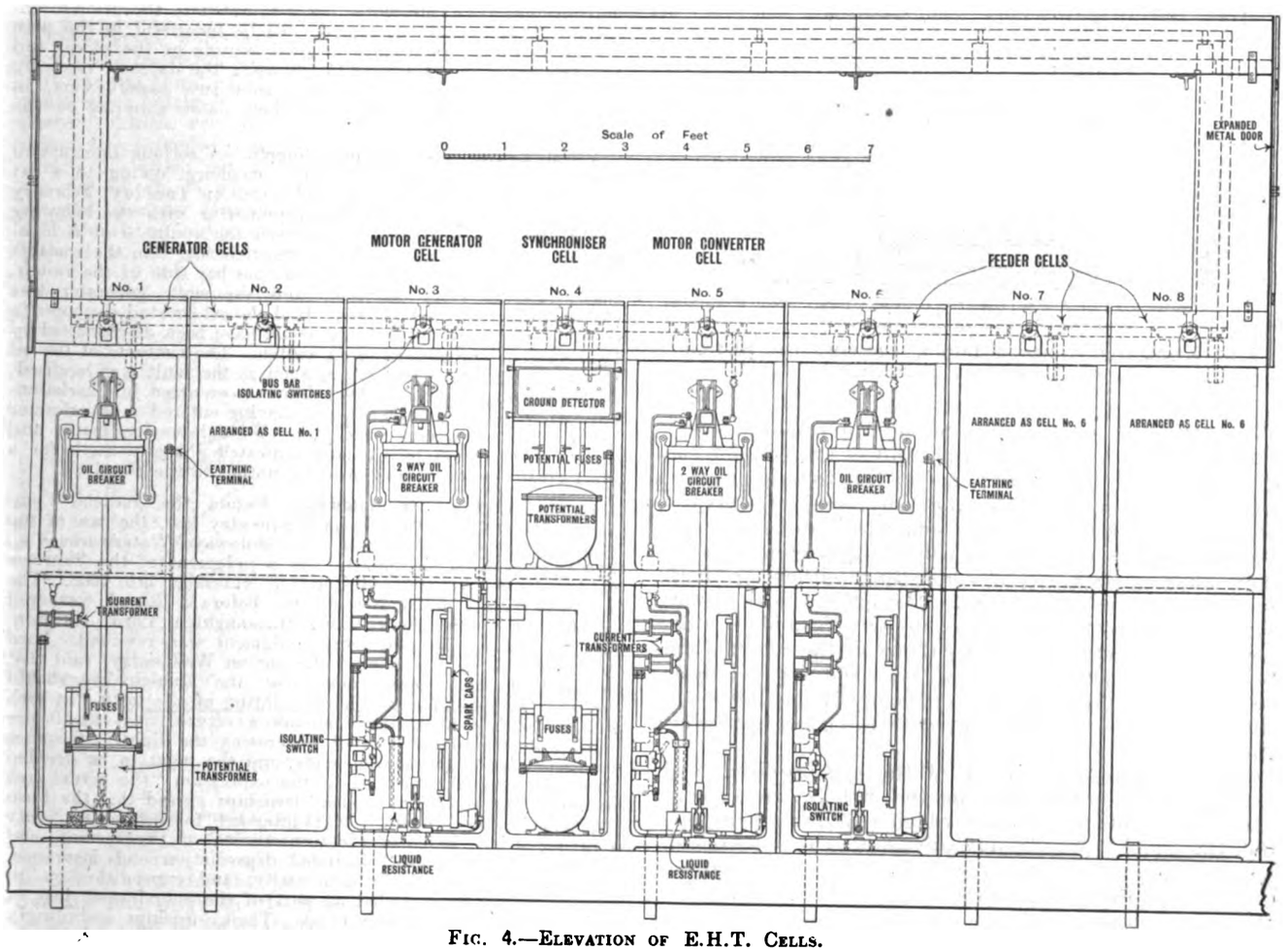


FIG. 4.—ELEVATION OF E.H.T. CELLS.

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be made on this board for paralleling the synchronous motor on the high-tension bars and regulating its excitation in order to control the power factor.

The fourth panel, practically in the centre of the board, contains on its upper half the instrument for synchronising the circuits of the three panels already referred to. These consist of a rotary Everett & Edgcumbe synchroniser, with synchronising lamp and two voltmeters all mounted on swivel brackets. These voltmeters are of the sector pattern, with scales 12 in. long. The two-phase potential transformer in the synchronising high-tension cell has already been alluded to.

Under these instruments is a wide rectangular glass window, through which the leakage indicator, fixed with the high-tension apparatus behind the passage-way, can be seen. This instrument is connected directly to the high-tension 'bus-bars, and consists of three voltmeters of the electrostatic type, which indicate the difference of potential between each bar and earth.

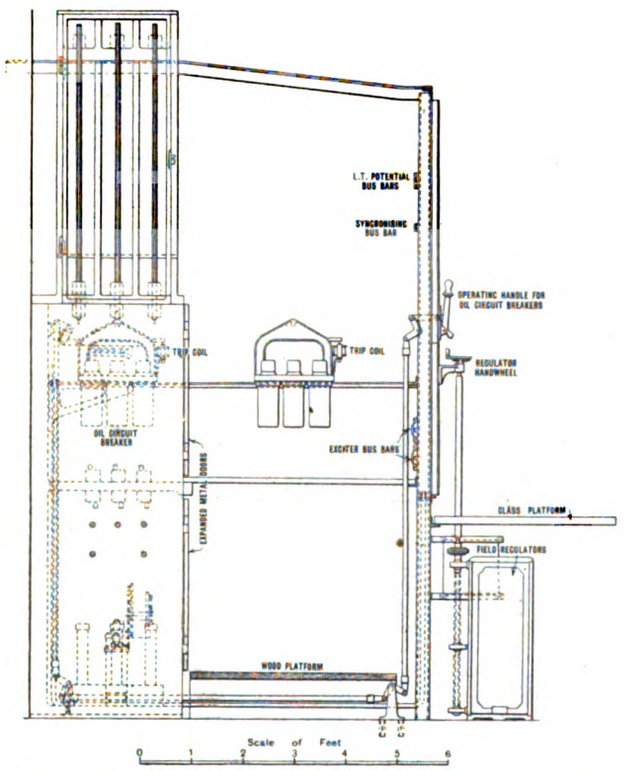


Fig. 5.—Section through Board, showing Oil Switch withdrawn for Inspection.

The somewhat novel arrangement of a window makes the instrument visible from the front of the board while still enabling all high-tension conductors to be kept away from it. The lower part of the panel is devoted to the exciters, and contains 6-in. edgewise ammeters and voltmeters for each set and a pair of quick-break double-pole knife switches for connecting either or both machines to the exciter bars. The exciter field regulators are operated by small hand-wheels and vertical spindles in a similar way to those of the alternators, but owing to lack of space on the exciter panel these have had to be placed in front of the next panel, although they really have no connection with the other apparatus thereon.

Immediately to the right of the synchronising and exciting panel is the panel for the 500 kw. motor-converter. As this is not a set which requires synchronising, the panel is practically equivalent to a feeder panel, and contains only a main switch with overload time-limit relay, three ammeters, a power-factor indicator, and an integrating watt-hour meter. The oil switch is fitted with extra contacts as in the case of the synchronous motor-generator, and the same arrangement of water resistances and spark gaps to protect the high-tension windings from abnormal rises of pressure is adopted. The starting gear of the motor-converter set is placed near the machine itself.

The remaining three panels on the right-hand side of the board are for the three special three-phase power feeders, and are equipped with similar apparatus to that in use on the rest of the board, comprising main oil switches with overload time-limit relays, three ammeters, a power-factor indicator, a pilot voltmeter, and an integrating watt-hour meter worked by suitable current and potential transformers.

As in the case of the motor generator and converter panels, the power-factor indicator can be plugged on to either phase. It should be pointed out that the feeder oil switches are not provided with additional contacts and water resistances, as in the case of the motor generator and converter circuits, but each feeder is provided with a B.T.-H. multi-gap static discharger. All high-tension connections between the 'bus-bars and the cable-boxes are of hard-drawn high-conductivity copper rod. The low-tension connections between the transformers in cells and the instruments on the operating board are of fire-proofed insulated cable, and are run in Simplex tubing.

American Patent Scandal.—A remarkable case of alleged fraud in connection with the United States Patent Office is being heard in America, in which Mr. J. A. Heany, a patentee, his agent, H. E. Everding, and N. W. Barton, one of the examiners of the United States Patent Office, are charged with having destroyed certain specifications and letters relating to a patent on metallic filament lamps. According to the *Electrical World*, Barton, by reason of his position, had access to office records, and was enabled, at a very recent date, to substitute for papers filed more than two years previously, certain other papers, and give them the same date as if they had been filed originally. The invention described in the substitute papers is thought to be very valuable, and a great advantage would attend it if a date of invention sufficiently early to antedate the prior inventions of others could be secured. To be successful in this plan it was necessary to destroy original records of the office, and file substitutes therefor, and by changing the dates of receiving stamps make it appear that such substitute papers were, in fact, actually filed upon the fictitious dates stamped on the papers.

A Rat Causes Interruption to Supply.—A serious interruption to the electricity supply of Charlottenburg, owing to a rat having caused a short-circuit, took place on Tuesday, February 18th. The engineer-in-chief has supplied us with the following particulars :—A rat crept in between the contacts of a high-tension oil switch and caused a short-circuit. As the contacts which the rat connected were on the bus-bar side of the switch, the maximum relay operated, and the main generator was switched off from the bus-bars. Had the rat shorted the opposite contacts, the single feeder only would have been disconnected by the action of the automatic oil switch. The contacts of the oil switch were badly burnt, but as soon as the fault was localised, the supply was resumed. A similar case occurred in Charlottenburg some time ago, when a rat, having entered a transformer kiosk, came in contact with both the high-tension mains and earth. The station instruments indicated a heavy earth for a short time, but there was no interruption to the supply.

Electric Lighting in Bulawayo.—Before the Judicial Committee of the Privy Council on Wednesday last, the case of the Municipality of Bulawayo *v.* The Bulawayo Waterworks Co., Ltd., came up on an appeal from a judgment of the Supreme Court of the Cape of Good Hope, of November 5th, 1906. The arguments were heard last month, before a Board composed of the Earl of Halsbury, Lord Macnaughten, Lord Atkinson, and Sir Arthur Wilson, when judgment was reserved. Lord Macnaughten, in delivering judgment on Wednesday, said that according to the original agreement, the Municipality should pay the Company for the public lighting of the town "at such rate as will yield to the company a return equal to 10 per cent. over the actual cost of generating the light." Disputes had arisen as to the charge made, and the point to be decided was, what was the meaning of the expression "the actual cost of generating the light." Their lordships agreed that the term "generating the current" was intended to include not only the generation, but also the transmission of the current, and that the "actual cost" included depreciation and insurance. Insurance was practically a necessity, and expenditure on insurance might be regarded as part of the actual cost, just as much as rent, rates, and taxes. Their lordships accordingly dismissed the appeal, the appellants paying the costs.

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PETROL-ELECTRIC SYSTEMS FOR HEAVY VEHICLES

A PAPER was read by Mr. P. Frost Smith (Chief Engineer to Messrs. T. Tilling's Motor Department) and Mr. W. A. Stevens (Messrs. W. A. Stevens, Ltd., Maidstone) before a meeting of the Society of Road Traction Engineers last Monday on the development of petrol-electric systems and their application to heavy road vehicles, in which they considered the possibilities opened up by the introduction of electric transmission gear for motor omnibuses. After referring to the "appalling" financial losses of certain of the London motor omnibus undertakings, they gave it as their opinion, in the light of very considerable experience with the accepted type of gear-driven motor omnibuses, that it was "obviously necessary that an entirely different type of vehicle to those now most generally used must be introduced." The causes of this high expenditure were analysed, and the following figures were given representing the actual experience of the company with which one of the authors is connected.

WORKING COSTS PER GEAR-DRIVEN PETROL OMNIBUSES.

	Pence per car mile.
Day running	0·265
Night running	0·750
Maintenance	2·443
Lubricants	0·241
Grease	0·080
Paraffin	0·040
Vehicle lighting	0·105
Body upkeep	0·250
Drivers	1·308
Tyres	1·750
Conductors	0·945
Petrol	1·325
Traffic expenses	0·255
Depreciation, insurance, rents, rates, taxes, water, gas, garage lighting, supervision, and establishment charges	2·189
Total	11·937

These figures, which were averages for three years, they said, showed the hopelessness of going on as they were now doing.

It was the object of the Paper to consider the saving in expense which might be obtained if the adoption of a "petrol-electric" vehicle were adopted in which an internal-combustion motor, direct-coupled to an electric generator, supplies electrical energy to electric motors, directly, or indirectly, connected to the road wheels, by which means the clutch, gear-box, and differential gear are dispensed with.

The work of earlier designers in this direction was briefly referred to, the authors proceeded to describe the design for

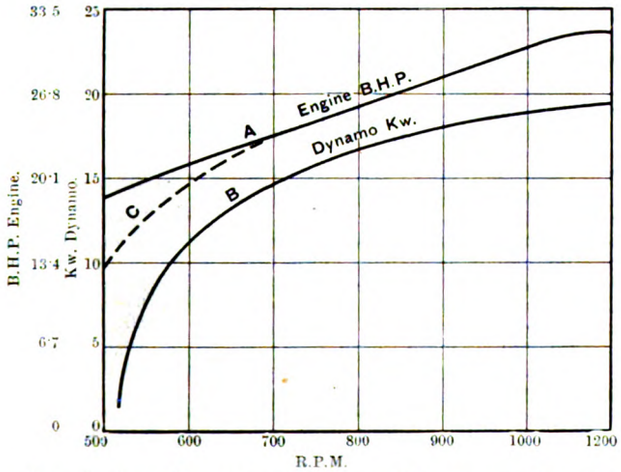
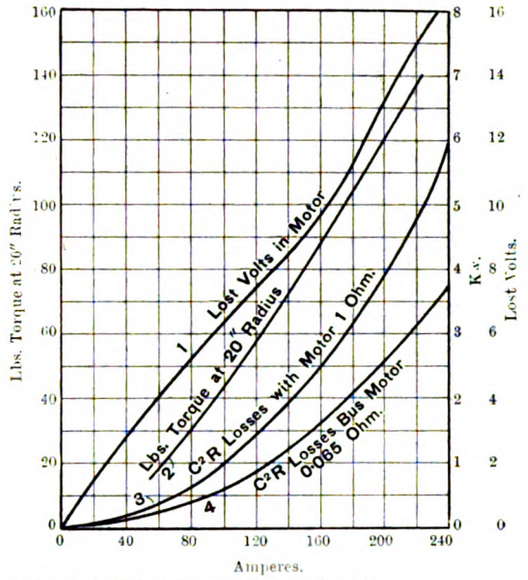


FIG. 1.—CHARACTERISTIC CURVES OF ENGINE AND DYNAMO.

which they were themselves partly responsible. This vehicle, the "Hallford" petrol-electric omnibus, which is electrically equipped on what is known as the S.B. and S. system, was described in considerable detail in ELECTRICAL ENGINEERING, January 16th, page 83. It will be remembered that it falls under the class of petrol-electric systems, in which the transmission is at all times electrical and does not employ batteries. A 30 h.p. four-cylinder engine drives a shunt-wound interpolar dynamo, which supplies current to two series-wound motors, one of which drives each back wheel through a specially-designed worm-gear. The use of a live back axle and a differential gear are thus entirely avoided. Provision is made for connecting the motor in series or parallel, but it is only in exceptional cases that the series notch is required. The control of the speed of the vehicle is effected almost entirely on the accelerator pedal and the field switch, and under ordinary conditions the main circuit is never broken, even at



1. Lost Volts in Motor at Varying Current Densities.
2. Torque of Motor at 20" Radius at Varying Current Densities.
3. C^2R Losses in Motor 1 Ohm Res. at Varying Current Densities.
4. C^2R Losses in Bus Motor 0·065 Ohm Res. at Varying Current Densities.

FIG. 2.

stopping. Before starting, unless the gradient is very steep, the controller lever is put into the parallel notch with the engine running slowly, and the generator field reduced. In order to start, the brakes are released, and the engine is accelerated by opening the throttle with the pedal, so that the voltage of the dynamo rises, the field switch is gradually moved over to raise the voltages as the vehicle gains speed. The running speed is then controlled by the throttle pedal, and to stop the throttle pedal is released, the dynamo field weakened, and the brake applied.

The actual omnibus has now run some 6,000 miles in ordinary service, and, as far as can be ascertained at present, seems to justify the hopes of its designers.

In discussing the conditions under which the petrol-electric drive will produce the greatest efficiency, the authors point out that if the petrol engine had the characteristics of the steam engine without its disadvantages, giving a heavy torque at slow speeds and a smaller torque at high speeds, or if a highly-efficient universal gear of low first cost, and low cost of upkeep could be produced, the petrol-electric system would have no claim to existence, but in the absence of these two conditions the ideal omnibus has still to be evolved, and they claim that the continuous-current petrol-electric system, with a suitable gear as the final transmission, from the electric motors to the road wheels, is the nearest approach to the ideal at present attained. In Fig. 1. the characteristic of the Hallford petrol engine is compared with the characteristic of the interpolar dynamo which it drives by means of a flexible coupling. The curve (A) represents the engine power read on the vertical divisions (or ordinates) as b.h.p. and the curve (B) the output of the dynamo in kilowatts, read directly on the vertical scale, the distance between the two curves as compared with the total engine power at any speed above 650 shows the efficiency of the conversion. To this end the scale of the engine b.h.p. is brought to odd vertical values, having the same ratio to the parallel values as the theoretical electrical horse-power has to the kilowatts. A dotted line (C) on engine characteristic indicates that the engine must be throttled down below the speed of 500 to allow the dynamo to lose its excitation, thereby

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obviating the necessity of breaking the main switch in stopping the vehicle in traffic. It is not possible to show the characteristic of the dynamo under all conditions of demand for current at varying voltages; the curve, however, shows the average efficiency under ordinary running conditions. Speaking generally, the electrical transmission should be so designed that by its characteristics the lack of flexibility of the petrol engine is so corrected that the necessity for a clutch, the gear-box, and differential gear are obviated. The construction of the dynamo has a very essential bearing upon the successful development of the system. It must run absolutely sparklessly under all conditions of load. Its characteristic must be such that it will generate, approximately, constant watts, the volts, and amperes, varying in inverse ratio, according to the requirements of the series-wound motors, which, as will be seen later, demand current in almost direct ratio to the torque demanded by them by the road conditions. As the power of the petrol engine is limited, the volts must necessarily fall to keep the load on the engine constant. To this end the dynamo is designed with a falling characteristic similar to that of a shunt-wound generator, and by the employment of commutating poles, the sparking that would otherwise be present when working on a weak field with a heavy current is avoided.

As the conditions of efficiency in continuous-current petrol-electric systems are entirely different to those obtaining in tramway practice, owing to the total energy available for the electric motors being limited by the power of the petrol engine to produce that energy, and the obvious necessity under these conditions of the voltage falling in direct [illegible] the amperes demanded, as contrasted with the constant voltage supply of the tramway system, a consideration of the curves shown in the figure may be of interest, as they have a most important bearing on the efficiency, hill-climbing powers, and gear ratio for special conditions of work. The curves are taken from the motors of our petrol-electric omnibus.

Referring to Fig. 2, in which the ordinates represent lbs. torque at a radius of 20 in. (the radius of the ordinary omnibus wheel), the abscissæ represent amperes, and the curve marked (2) the torque values at varying current densities. These torque values are, practically, constant throughout the whole of the variation of speeds of the series-wound motor; the torque with a given current at two revolutions per minute being the same as at 1,000 revolutions per minute, the speed variation at a given torque being only affected by the voltage of supply. Considerably greater torque per ampere could be attained in a motor with a very small air gap, but such a motor would not be so efficient, at average loads, as the motor with a normal air gap. The vertical divisions on the outer right-hand side correspond with the curve (1), and are divided into volts. This curve represents the lost volts in the authors' type of motor, due to the fall of potential, caused by the current shown in the horizontal divisions. The vertical divisions on the inner right-hand side correspond with the curve (4), which represents lost kilowatts at various current densities, irrespective of the speed of the motor armature. The total internal resistance of each motor, including fields, brushes, and armature is 0·065 ohm. It will be seen that the above curve rapidly increases in value, being proportional to the square of the current density, and its importance will be clearly shown on consideration of the efficiencies obtained with a highly-geared vehicle with small engine power.

In the authors' experience the best gear ratio for electric motors, of the dimensions employed, is from 12 : 1 to 16 : 1; the former for town work, and the latter for mail van and country work generally, owing to its high efficiency on hills. With the 16 : 1 gear ratio, the efficiency of transmission in a petrol-electric vehicle, weighing, loaded, 7 tons on a hill of 1 in 12, including all electrical losses, and allowing 10 per cent. for gear losses, will work out at 70 per cent. from the engine to the road wheels. The efficiency of a 12 : 1 gear ratio under these conditions is 67 per cent. On ordinary "give-and-take" roads, the total efficiency from the engine to road-wheels averages over 70 per cent. The curve (3) demonstrates the C^2R losses in the armature, brushes, and fields of a smaller motor, which has a total resistance of 0·1 ohm, showing that with a current of 200 amperes, and a torque at 20-in. radius of 117 lb., a loss of 4 kw. in the machine would have to be made up before any external work could be done. This illustration is given to demonstrate the great loss of efficiency in a vehicle driven by small electric motors having a small gear ratio to the road wheels.

In the matter of durability of electrical equipment, the petrol-electric omnibus possesses the important advantage over the tramcar, in that the total electrical load on the dynamo and motors is limited by the power of the engine, and, as the dynamo and motors are, from considerations of electrical efficiency, made sufficiently large to stand 300 per cent. overload for a considerable time, to "burn out" through an overload is impossible. On a tramway system, on the other hand, this danger is ever present, the motors being at the mercy of the motorman with the full power of the generating station behind him. It is an easy matter in this case for a careless driver to switch on the full voltage of the line to his motors with both armatures and fields in parallel, when the car is starting or ascending a gradient, with the inevitable result of a "burn-out."

The Paper concludes with a few brief comparisons between gear-driven systems and the system therein described. This vehicle has only been in actual work and on a regular London service for eight weeks—covering 6,000 miles—yet in comparison with the recent much-talked-of R.A.C. trials, it shows up very well. The R.A.C. trials occupied 22 days, and the miles done daily were 40, chiefly on good "give-and-take" roads and where very few stoppages were required. It is not hills and bad roads that tell on motor-buses, so much as the continual stopping and starting of the vehicle, the heavy application of the brakes in the former circumstance, and wrong application of the clutch in the latter case. The vehicle cannot be started from a stationary position with a jerk, it simply glides away with a gentle, steady movement; this fact alone has a great bearing on the question of abnormal wear and tear. The control, from a driving point of view, is as nearly "fool-proof" as possible. The field resistance of the dynamo requires a little manipulation on the part of the driver, but not more so than a spark advance and retard lever. It must be emphasised that for London routes the driver never need come out of his top, or parallel, position, and thus the main electric circuit never need be broken, except in such cases when the driver leaves his vehicle and places the controller lever in the neutral position. The night staff on a fleet of such vehicles can be very greatly reduced, and it is confidently estimated that only 0·5 to 0·75 man per vehicle would be required. The labour required would be engine adjusters, brakesmen, greasers, cleaners, and washers. Electrical labour has been clearly demonstrated to be unnecessary on nightshifts, as the ordinary cleaning of the commutators would be done at the most suitable point on the vehicle's route during the day, as the operation only takes a few minutes to do.

With regard to maintenance, the authors have the strongest hopes of effecting a most substantial saving from the results already obtained. An engine such as has been employed may be safely taken to cost no more than ¼d. per mile on the very low basis of 30,000 miles run per annum; this mileage is more likely to approach 40,000 miles than the figure given, and at the time of writing the Paper the engine has cost nothing.

On the same basis as the above, the frame is estimated to cost ¼d., and the back axle the same sum. This latter was stripped after the 6,000-mile run for examination, and there were no visible signs of wear. Gears, ball-bearings, and other wearing parts were perfect. The electrical equipment has shown that with a suitably-designed dynamo and motors, the maintenance cost would be extremely low, and certainly not more than ¼d. per mile, though probably this figure, low as it is, would eventually be considerably reduced. The following table shows a comparison between the working cost figures given earlier and relating to the gear-driven types now in vogue, and the system forming the subject of this Paper.

Comparison of Working Costs of Petrol-electric and Gear-driven Types.

	Gear-driven.	Petrol-electric.
	Pence.	Pence.
Depreciation, insurance, &c., &c. ...	2·186	1·805
Day and night running charges ...	1·015	0·538
Maintenance	2·445	1·000
Lubricating oil	0·241	0·060
Grease	0·080	0·020
Paraffin	0·040	0·020
Other items (same as now)	5·938	5·938
Total	11·937	9·181

In the above table the petrol consumption has been shown as the same as on gear-driven vehicles, but, as a matter of fact, the distance run per gallon has averaged ¾ mile more.

In conclusion the authors express the opinion that if the above figures can, as they think, be realised in practice, over a period of some years, the solution of the problem of operating a fleet of motor-omnibuses with commercial success has been achieved.

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THE EFFECT OF ELECTRICITY UPON PLANTS

THE *Proceedings* of the Naturalists' Society contains an interesting Paper by Mr. J. H. PRIESTLEY, B.Sc., on the effect of electricity on plants. During the last two years several attempts have been made in various localities to apply electricity as a stimulus to plant growth, and experiments upon an unusually large scale have been carried out by Mr. J. E. Newman at Bitton, near Bristol, and at Gloucester, in 1905, and at Bevington Hall, near Evesham, during 1906. Mr. Newman has kept Mr. Priestley closely in touch with his work, and has permitted him to embody his results in this Paper.

The first part of the Paper is Historical. The Scotch physician, Mambray, in Edinburgh, and about the same time Jallabert, in Geneva, carried out experiments upon the subject, and the success which they met with apparently caused the Abbé Nollet* to take up the subject in 1749. His experiments consisted in suspending iron plates upon steel chains hanging from a dry silk cord. Upon these insulated metal plates he kept animals and plants, and the whole series of trays were charged from a somewhat cumbrous influence machine requiring the continuous efforts of three men to drive; he found that maize and mustard thus electrified germinated in every case more rapidly than control plants. The Abbé Bertholon† (1783) greatly enhanced the practical interest of the subject by suggesting that atmospheric electricity was an important factor in the environment of the plant. He applied his idea practically by constructing various types of an apparatus he called the electro-végétomètre. This consisted of a head of metallic points raised in the air in the manner of a lightning conductor, and connected by a flexible conductor to a movable iron bar terminating in a series of discharge points just over the plants to be electrified. Atmospheric electricity is then collected by the upper end of the structure and discharged on to the plants from the lower end. Bertholon stated that the use of this apparatus was invariably accompanied with an improvement in the appearance of the vegetation, and with an increase in the fertility of the plants, &c. Grandeau‡ (1879) attempted to demonstrate the importance of atmospheric electricity by showing, by measurements, weights, and quantitative analysis, that when the plant was protected by means of a wire cage its leaf and stem development was greatly retarded. On the other hand Ch. Naudin, about the same time, published experiments carried out in the same manner, in which the plants left exposed to the open air had not grown so well as the ones protected beneath a wire cage.

The application of atmospheric electricity to stimulate plant growth, Mr. Priestley continues, has been a fairly common practice in France since Bertholon's time, some modification of what is termed the Géomagnétifère system being adopted. A lightning conductor is raised in an exposed position to collect atmospheric electricity, and this is connected with wires running through the earth under the plants it is desired to stimulate. With this method good results are claimed, though *Lord* Kelvin's suggestion is perhaps worthy of note, viz., that possibly the value of the treatment lies in the upturning of the earth necessary to plant the wire.

M. Pinot de Moira has used the system for several years in his garden in Clifton, always with favourable results; he has also shown the author rows of peas planted beneath a wire cage which were far less advanced than the control rows outside the cage.

Recently a great deal of work has been carried on in France, at the station for Agricultural Chemistry established at Meudon, by Prof. Berthelot,¶ who has tried the effect of the silent discharge, and particularly of atmospheric electricity upon plants. He compared the growth of plants at the top of a 28 metre tower with that of plants growing at the foot, and considered that greater growth at the higher level was largely due to the potential gradient in the atmosphere.

Electricity has been applied in a different way by Barrat in France, and Speschnew in Russia. In their experiments metal plates were sunk in the ground with a current passing through the soil between them, and apparently this stimulated the plants in this part of the soil to more vigorous growth than the plants on either side in the control plots. Speschnew‖ obtained his current simply by using plates of different metal connected by a wire, the small earth current thus obtained apparently proving amply sufficient to produce a marked result.

Rawson and Le Baron§ have used the same method at Arlington, Mass., quite recently. The plates of copper and zinc joined by a wire are sunk at either ends of forcing beds in the greenhouses, and are said to be very efficacious in bringing on lettuce at an early time; in fact, they state that the lettuce thus electrified was ready for the market a week earlier than that in the control beds. The potential difference between the plates was about 0·5 volts, and the current flowing varied from 0·4 to 15 milliamperes approximately.

Prof. S. Lemstrom* used the method of overhead discharge in a great number of experiments which he has conducted, and which were often upon a very large scale. He usually employed an influence machine of special construction driven by some continuous source of power; one pole of this machine was earthed, while the other was connected to a system of wires stretching over the plants and studded with fine discharge points. His results show a definite increase in yield in the case of many crops, whether the overhead wires were kept positively or negatively charged. The current was applied sometimes at night, sometimes in the day time, with apparently equally satisfactory results. Lemstrom points out in his book that precautions have to be taken in using his method of electrification, as in dry weather the electric discharge may easily be given for too long a time, when its effects are deleterious, also the treatment should vary according to the plants experimented upon, strawberries, for example, usually showing a very marked increase, whereas beans with the same treatment may often show considerable retardation in development.

At the Clifton Laboratory Dr. E. H. Cook† has carried out experiments the results of which seem to point to an increased power of germination, either with the use of low-tension currents (up to 20 volts and current passing up to 100 milliamperes) or with high-tension discharge from a Wimshurst machine. Apart from the increase in rapidity of germination, Dr. Cook was unable to satisfy himself that the passage of the low-tension current through the soil made any difference to the plant. Using the overhead discharge from the Wimshurst (E.M.F. from 25,000 to 40,000 volts) or from an induction coil (E.M.F. approximately 45,000 volts) he obtained a continued increase in the rate of growth of the plant.

Asa S. Kinney,‡ in 1898, and Ahlfvengren,¶ a year later, both found that the germinating power of seeds is apparently increased by an electric current passing through them. Kinney concluded that the optimum voltage for this current was about 3 volts. Ahlfvengren suggested that this optimum varied for different plants, and, also, with changing conditions, varied for the same plant. Results such as these would explain the different action of the current upon two different species, for one of them the voltage supplied may be optimum, whilst for the other it may approach the maximum, when it might exert a deleterious influence on the plant.

Lowenherz‖ seems to have come to similar conclusions; he also finds that the effect of the current on the plant is greatest during the period of germination. He is of opinion that the direction in which the current traverses the seed is of importance.

Large Scale Experiments.

This part of Mr. Priestley's Paper is of extreme interest. He commences it with a reference to the small trial apparatus with the overhead discharge system which Mr. J. E. Newman was able to instal during the winter of 1904 at the Golden Valley Nurseries at Bitton, near Bristol. The installation was completed by the spring, and, apart from occasional breakdowns, was running until the autumn. The breakdowns were accounted for by the fact that the machine used to generate the necessary electric power was simply a small influence machine of the Wimshurst type, hardly suited to continuous running, and that the oil engine first employed to drive it was scarcely powerful enough. The machine was working beneath a dust-free case in a small shed upon the grounds, and its two terminals were connected—one to the earth, the other to a system of wires running out over the grounds and through seven of the fifteen glasshouses. In the open the total area

* Abbé Nollet. Recherches sur les causes particulières des phénomenes électriques. Freres Guerin, Paris.
† Abbé Bertholon. De l'Electricité des végétaux—Didot Jeune, Paris.
‡ Grandeau. Chimie et Physiologie appliquées à l'Agriculture et la Sylviculture.—Berger, Levrault, et Cie, Paris.
¶ Berthelot. Chimie Végétale et Agricole. T. I.
‖ Referred to by R. Green, Phil. Trans. of the Royal Society.—Vol. 188, B. p. 188.

§ *The Electrician*.—Vol. 57, p. 305. 1906.
* Lemstrom. Electricity in Agriculture and Horticulture.—The "Electrician Series.
† E. H. Cook, D.Sc., F.I.C. British Association, Bristol Meeting.
‡ Hatch Experimental Station. Massachusett's Agricultural College. 1897.
¶ Ahlfvengren. Ofversigt af Kongl. Vetenskaps-Akademien Forhandlingar, Stockholm. 1898, No. 8 (Ref. Bot. Centralblatt. Bd. 79, p. 53. 1899).
‖ Lowenherz. Versuche über Elektrokultur. Botanisches Centralblatt, p. 523.

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of experimental and control plots was about a thousand square yards. The wires ran at a height of some 16 inches above the tops of the plants, or above the rows of tomatoes in the glass-houses, and upon these wires at intervals were twisted short pieces of fine wire with the free ends pointing downwards, and thus acting as discharge points. The wires were supported on ordinary telegraph wire insulators, which proved satisfactory except in wet weather, when there was such a rapid leakage of the charge that there was practically no discharge on to the plants.

From March 7th up to July 26th the machine was running during 108 days for a period of 9·3 hours daily. Until May 20th the machine was running chiefly in the day time, and after that date it was running principally at night. In all cases control plots were provided, which, apart from the electric treatment, were, as far as practicable, under identical conditions. The crops from the electrified and control plots were gathered and estimated separately, usually by weighing. The results of electrification in the case of the various crops grown were as follows :—

Cucumbers, 17 per cent. increase.
Strawberries (5 year plants), 36 per cent. increase.
,, (1 year plants), 80 per cent. increase, and more runners produced.
Broad Beans, 15 per cent. decrease, but ready for picking 5 days earlier.
Cabbages (Spring), ready for picking 10 days earlier.
§Celery, 2 per cent. increase.
Tomatoes, no difference.

One point requires special mention in the case of the cucumbers grown in the houses. On May 8th a spot disease, of bacterial nature, appeared in all the cucumber houses, and unquestionably made far more headway in the unelectrified houses. It seems probable that the ravages of the disease were largely inhibited by the electric discharge, for during one week when the influence machine broke down the disease progressed far more rapidly under the wires, and was again checked upon restarting the machine.*

The action of the electric discharge may be due to one of two causes, either the resisting properties of the host have been increased, or the attacking power of the parasite diminished. Recent work by Massee,† by Ray,‡ and by Miyoshi¶ supports the view that the greater immunity of the treated cucumbers might be due to chemical changes occurring upon electrification. Their investigations seem to show that the immunity of a plant to disease depends mainly upon the nature of the chemical substances in the cell sap in the tissues exposed to infection. This view of immunity is also supported by recent work upon the biologic forms of parasitic fungi found in the Uredineæ|| and Erysiphaceæ.§ In the bleaching of flour by means of the brush discharge, a toxic action of the discharge upon the micro-organisms present has been noted, but if this were operative in the case of the cucumbers one would have expected the disease to have appeared later, or not at all, in the electrified houses, whereas it appeared simultaneously in all the cucumber houses. The author finds it difficult to believe that when once present the bacteria within the leaf suffer more from the direct action of the current than the leaf itself.

During the whole period of the Bitton experiments Mr. Newman stated that, apart from the difficulties with the influence machine and oil engine, the electrical installation gave very little trouble, and only required attention in keeping the wires clear of cobwebs, stray shoots, &c.

A somewhat similar installation was working during the same year over a vegetable garden in Gloucester. Here a somewhat higher voltage was given by the influence machine, and the discharging points were kept 5 ft. above the ground instead of 16 in. above the tops of the plants, as at Bitton. With the crops under electrification —

Beet showed 33 per cent. increase;
Carrots showed 50 per cent. increase; and
Turnips showed an increase—not determined quantitatively, because of the destructive ravages of slugs on both crops.

§ The small increase in the case of the celery may be connected with the fact that in this case the wires used as discharge points were not so fine. As a consequence the amount of current flowing from the air to the ground was probably considerably less. In all the other cases fine wire was used for the discharge points.

* See also *Fruitgrower, Fruiterer and Florist*, p. 106. August 17th, 1907.

† Massee. On the Origin of Parasitism in Fungi. Philosophical Transactions of the Royal Society. 197 B.

‡ Ray. Etude Biologique sur le Parasitisme. Comptes Rendus. Vol. 136, p. 566. 1903.

¶ Miyoshi. Ueber Chemotropismus der Pilze. Botanisches Zeitung, p. 1. 1894.

Marshall Ward. Effect of Mineral Starvation on Parasitism of a Uredine Fungus. Proc. Roy. Soc. Vol. 71. 1902.

§ Salmon. Cultural Experiments with Biologic Forms of the Erysiphaceæ. Phil. Trans. of Royal Society. 197 B.

The amount of sugar in the beets was determined at the College.

The unelectrified yielded 7·7 per cent. total sugar.
The electrified ,, 8·8 per cent. ,, ,,

Considering the total increase in the root crop, this suggests that this method of electrification may find a valuable field of application in the cultivation of the sugar beet.*

The results of some small trials with wheat that were made at Gloucester were very favourable, and arrangements were made by Mr. Newman to try the effect of the overhead discharge system upon wheat and barley on a larger scale.

Thanks to the interest taken in the work by Mr. R. Bomford, of Bevington Hall, near Evesham, Mr. Newman was enabled to use some 40 acres of this estate for experimental work in 1906, and experiments were commenced on this ground in the spring of that year, and are still being continued. Some 20 acres of this ground were beneath the discharge field, and as it was necessary for practical purposes to have the discharge wires at a considerable height, the very high-tension current required was obtained by means of an induction coil and valve rectifiers upon the system devised and patented by Sir Oliver Lodge, who very kindly lent the necessary apparatus. It was very largely owing to the generosity of Sir Oliver Lodge, and the advice and help of Mr. Lionel Lodge, that Mr. Newman was able to complete successfully the necessary installation and to carry out the experiments.

As it was, owing to the late delivery of some of the apparatus, the work had to be carried on with a somewhat improvised generating station at the commencement on March 16th; by the end of May, however, the installation was completed, and worked fairly continuously during the rest of the season, the current being applied intermittently until July 10th, by which date the wheat had been in ear about a fortnight.

The complete arrangements for generation of the high-tension currents are as follows :—

Direct current, about 3 amperes at 220 volts, is generated by a dynamo, driven by an oil engine of about 2 h.p. The current passes from the dynamo through the primary of a large induction coil with a make and a break contact interposed in the circuit. From the secondary of the coil the high-tension current was passed through the rectifiers, and then the one pole connected to the system of overhead wires, the other pole being earthed. The overhead system of wires covered about 19½ acres of ground. The wires were mounted on insulators placed upon larch poles some 15 ft. high, which were placed in rows, the rows being separated by a distance of 102 yards, and the poles in a row being 71 yards apart. Stout telegraph wire carried the current down each row; while thin galvanised iron wires, placed some 12 yards apart, were stretched between the rows and acted as the discharge wires. In this way 22 poles were sufficient to support the wire over the 19 acres. This acreage was spread over two different fields, in one field of which some 12 acres of wheat were under treatment, in the other 6½ acres of barley and a ½-acre plot planted with potatoes, mangolds, &c. The wheat field was of 19 acres extent: the remaining 7 acres (not under electrical treatment) were sown with English (White Queen) wheat, 1½ acres, and Canadian (Red Fife) on 5½. In the electrified part Canadian wheat occupied 3 acres, English wheat 9 acres.

The results on the barley field, including the smallplot, had to be neglected owing to the great local variations produced by the very irregular manuring the field had previously undergone. The wheat field, however, as far as one could judge, had been very uniformly treated previously.

In the wheat, difference was noticeable at an early stage—the young blades on the electrified part being, in the opinion of many observers, of a darker green. The crop was judged as considerably heavier by several practised observers, and the straw was on an average from 4 in. to 8 in. higher. Both experimental and control plots came into ear at about the same time, but the Canadian wheat under treatment was ready for cutting some three or four days before the control area. The crops were gathered separately from the electrified and unelectrified plots, and the resultant yields were as under :—

Bushels per Acre.

	Electrified.	Non-electrified.	Increase.
Canadian (Red Fife) ...	35½	25½	39 per cent.
English (White Queen) ...	40	31	29 ,,

Moreover the electrified wheat sold at prices some 7½ per cent. higher, several millers in baking tests finding that it

* Lomstrom. *Loc. cit.*, p. 47 and p. 55.

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produced a better baking flour.† No theoretical conclusions can be drawn from this fact, owing to the uncertainty existing as to what factors determine the strength of wheat, but it is interesting to note that greater strength is usually accompanied by increase in percentage of total nitrogen.

Mr. J. Kirkland, of the National School of Bakery, Borough Polytechnic, found the evidence from baking tests supported by the average of dry glutens from all his tests thus :—

In the electrified	11·15 per cent.
In the unelectrified	10·35 ,,

The somewhat poor yield of wheat obtained from the unelectrified portion of the field is probably explained by a deficiency in lime, which has now been rectified. Further, the wheat was spring sown, and Red Fife, under this condition, does not usually yield good crops. The experiments are being repeated upon wheat during the present season, and strawberries are also under treatment once more.

Tests with Earth Currents.

At the College further trial has been made of the method of Barrat and Speschnew, in which plates of different metals are sunk in the ground and connected by a wire. Plates of copper and zinc were used with a copper wire soldered to them. The first trial was made with Vicia Faba, the beans being planted on February 21st, 1906; the control plants were grown between copper and zinc plates not connected with a wire.

The plants where the earth current was passing appeared two days earlier; in June they still showed markedly greater vegetative development, and though the total yield in the two plots could not well be compared, the average size and weight of beans differed in favour of the electrified plot, thus :—

	Electrified.	Unelectrified.
Average volume of bean ...	2 c.c.	1·5 c.c.
Average weight	2·26 grs.	1·71 grs.

Another series of experiments with beans was started upon May 25th, but in this case no difference in rate of germination was noted, while later the whole crop was so badly attacked by Aphis that further comparisons could not be made.

The following table shows the results obtained with other plants by this method :—

Wheat,	no difference.	
Barley,	Electrical,	matured earlier.
Maize,	,,	the weaker plants.
Cabbage,	,,	markedly better plants.
Radish,	,,	ready for pulling earlier.
Carrot	,,	larger, and with much more leaf development.
Lettuce,	,,	better developed plants.

The results are then inconclusive, though in most cases the plants where the current is passing have fared better. As an example of the strength of the currents used, with plates of area about 200 square inches, 4 ft. apart, a current of 12 milliamperes was passing, the soil being very damp.

Action of Current.

The author concludes his Paper by giving an account of some of the theories advanced to explain the physiological action of the current, and also describes some further experimental work, though the results of the latter were negative in character.

One suggestion, frequently made, is that the passage of water up the plant is aided by the electric current. Lemstrom advances this suggestion, and referred to experiments in which he had found that if a negatively charged wire is placed over a capillary tube which dips into water, the water climbs up the sides of the tube and collects in drops at a higher level. But if a positively charged pole is placed above the tube this did not happen, and with a positively charged overhead wire system he obtained the best results.

J. Chunder Bose‡ explains the rise of sap on the assumption of a pumping action of the living cells throughout the course of the xylem; the pumping action being a form of response to stimulus. If this theory is correct the current might be conceived as a stimulus giving rise to increased response, and therefore accelerating the flow of sap. The excitatory effects of kathode and anode are antagonistic, but with a current flowing through the soil, there would always be a resultant excitation of the root, because the kathode effect is always greater than the effect due to the anode.¶ But in the case of overhead discharge with the wires overhead negative, the leaves and stem would on this view be more stimulated than the root, and the result should be a tendency to pump water downwards. On the whole, then, it is difficult to make out a case for the rise of sap being aided by electric stimulation, and there is no experimental demonstration of its occurrence in the plant. Bose would more probably attribute the effect of overhead discharge to direct stimulus of the growth responses in the plant.

The acceleration of germination noted by so many observers obviously involves some different factor; the only possible explanation seems to be that the current is used by the seed as a source of energy,‖ this energy being directly used in anabolic process or in accelerating the katabolic processes of respiration.

Pollacci§ in a recent paper has suggested that the effect of a current passing through a green leaf may be to render carbohydrate synthesis possible from carbon dioxide and water, even when the plant is in the dark. Bach* has suggested that the electrolysis of carbonic acid might result in the formation of formaldehyde in the neighbourhood of the kathode, but he advanced no experimental results in support of this view. Euler,† as the result of practical investigation, found it impossible to obtain formaldehyde in this way. Waller‡ has detected the presence of small electromotive forces in a green leaf exposed to the light, but they are only found in a living tissue, and chloroplasts are necessary for their occurrence, no current being detected in a living petal exposed to the light.

The experimental evidence that Pollacci brings forward is based chiefly upon the presence of starch in leaves kept in the dark, with a current passing through them. Control leaves, also kept in the dark, contained no starch.

Before the author was aware of this work, he had, in conjunction with Miss D. Johnson, investigated the same point, at first with results which seemed to confirm those of Pollacci. As the result of further experiment, however, they were not able to demonstrate starch in an electrified leaf, if that leaf were quite free from starch at the commencement of the experiment. The presence of the starch in the earlier experiments seemed to have been due to the inhibition of the normal transformation of starch into sugar, owing to the excessive strength of current used. The experiments were made with Elodea, with Geranium and Coleus leaves, and also with green filamentous Algæ, such as Spirogya and Cladophora laid across platinum electrodes; the voltage used varied from 1 to 40 volts, above 40 the effect was usually fatal. With the object of ascertaining whether starch were produced by the action of the silent discharge in the dark, Mr. Newman kept plants beneath the discharge points at Bitton during a continuous run of 27 hours, and the leaves were afterwards picked and examined. No starch was found in them. The author is, therefore, unable to accept Pollacci's conclusion that starch can be formed by a green plant in the dark if an electric current of suitable strength be passed through it.

It has also been suggested that the effect produced on the soil by the electric current may be beneficial to the plant. Electrolysis undoubtedly takes place, and Dr. Cook found the soil slightly acid near the anode, and alkaline near the kathode, in some of his experiments. Ewart¶ suggests that the current increases the rate of solution and absorption of the insoluble food constituents present in the soil, but as the amount of electrolysis proceeding is not likely to make the soil locally very acid I do not see that this is likely to be the case.

Finally, there is the possibility that in the case of the overhead discharge, oxides of nitrogen are formed by oxidation of either the nitrogen or ammonia present in the air. Samples of the soil from the electrified and unelectrified parts of the wheat field in the Evesham experiments were analysed at College, the samples having been taken in the autumn after both crops had been gathered. They showed :—

Electrified	0·159 per cent. on dry weight.
Unelectrified	0·056 ,, ,,

But it is impossible, the author says, to draw conclusions from isolated analyses of this kind; however, following up this sug-

† Tests made by Watkin's Bros., Hereford: and by D. W. Goodwin & Co., Kidderminster.

‡ J. C. Bose. Plant Response. Longmans, Green, & Co. 1906.

¶ Loc. cit., p. 560.

‖ Reynolds Green. Action of light on Diastase. Phil. Trans. Vol. 188, p. 188.

§ Pollacci, G. Influenza dell' electricita sull' assimilatione clorofilliana. Atti Ist. Bot. Pabia II. 11; 7-10. 1905.

* Bach. Sur la correlation entre la reduction par l'hydrogene naissant, l'electrolyse et la photolyse de l'acide carbonique. Comptes Rendus. Vol. 126, p. 479.

† Euler. Berichte deut chem. Ges. Vol. 37, p. 3415. 1904. See also Meldola. Living Organism as a Chemical Agency. Trans. of the Chem. Soc. 1906. Vol. 89, p. 758.

‡ Waller. Electrical Effects of Light upon Green Leaves. Procs. of the Royal Soc. Vol. 67, p. 129. 1900.

¶ Ewart. Protoplasmic Streaming. P. 99.

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gestion, it is intended to keep a continuous check upon the soils by analysis during the present season.

Berthelot‖ considers that the clue to advantage of the electric discharge is to be found in an entrance of atmospheric nitrogen into the plant metabolism, but suggests that this is due not only to the formation of oxide of nitrogen, but also to the combination of gaseous nitrogen with carbohydrates within the plant.

‖ Berthelot. Sur les conditions de mise en activité chimique de l'électricité silencieuse. Comptes Rendus. Vol. 131, p. 772. 1900.

CATALOGUES AND PAMPHLETS RECEIVED

ANTI-VIBRATION FOUNDATIONS.—A leaflet from Mr. F. J. Down calls attention to a system of foundation cushions invented by a civil engineer of Paris, the object of which is to prevent vibrations being communicated from running machinery to buildings by interposing an elastic bed. It is claimed that this special form of foundation absolutely breaks up the vibrations, and that the twisting movements produced by sudden variations of speed are absorbed without shock. The arrangement, which is known as the Praché non-vibratory foundation, is in use in a number of installations of electrical machinery in or near London.

ELECTRIC HEATERS.—An attractive show card illustrating some of the types of heaters supplied by Simplex Conduits, Ltd., has been issued. The card is so constructed that the portions illustrating the luminous parts of the radiators are translucent, so that a very striking effect can be obtained by putting a small incandescent lamp behind the card. A leaflet giving prices of these radiators is also to hand.

ELECTRICITY IN MINES.—A handsomely produced pamphlet with the above title is being circulated by the British Thomson-Houston Co. A short introduction recapitulates the advantages presented by electrical methods for mining, and speaks of the extensive experience which the company have had in meeting requirements of this nature, the reality of which is convincingly brought home by a series of illustrations showing a great variety of electrical mining work already carried out.

PACKING.—A booklet sent us by Messrs. Turners & Manville describes the properties of the H. W. Johns-Manville Co.'s "Vulcasbeston" packing, some samples of which are also to hand. Considerable advantages are claimed for this packing over other forms. The packing is made in sheet, from which washers, jackets, flange-joints, &c., can be cut, as well as in the form of rope packing for piston rods, valve stems, &c. The material is prepared under hydraulic pressure, and is composed of long fibre asbestos, with which is incorporated graphite, and is heated with vulcanisable gums. It is claimed not to stick, so that joints can be broken and remade any number of times.

SOLDERING MATERIAL.—Pamphlets in English, French, and German relating to the special soldering materials known as "Fludor," which are particularly suited to electrical work, are to hand from Messrs. H. Classen & Co., of Berlin (Barbarossenstrasse 16), to whom all inquiries should be addressed direct, as the agency formerly held for this country by D. Joroslaw has been terminated.

TROLLEY WIRE SUSPENSION.—A pamphlet issued by the Consolidated Accessories Co. describes in some detail Mr. Pringle's patent tangential suspension for overhead conductors, and gives illustrations of the various kinds of fittings used for this system. The arrangement, which is in use on the Derby Corporation tramways, was described in full in ELECTRICAL ENGINEERING, Vol. II., p. 979.

VENTILATING FANS.—The Wilson Wolf Engineering Co., Ltd., of Bradford, have issued a preliminary pocket list of their continuous-current "Arctic" ventilating fans, which forms a summary of the new complete catalogue which they are about to issue. Some new improvements have been made in the design of these fans, the motors of which are now fitted with combined journal and thrust ball bearing, which allows of the fans to be run in any position without altering the construction. Some alterations have also been made in the design in the fan blades themselves. They are now of the open-blade type in the standard fan, which is claimed to discharge a much greater quantity of air than the box-bladed type formerly used.

Faraday Society.—In consequence of the illness of Sir Oliver Lodge, the delivery of his presidential address, which was announced for last Tuesday, has been postponed until further notice.

An Automatic Transformer Switch.—The correct present title of the firm who manufacture the automatic transformer switch described on p. 440 of our last issue is Messrs. Knapton & Co., and not Messrs. Knapton, Bagnall & Co., as there described. A slight error appeared in the description of the instruments with reference to the connection of the shunt coil, which on the left-hand side is connected through the switch on the top right-hand side.

TESTS OF A LARGE TURBO-ALTERNATOR

BEFORE the third and fourth Brown-Boveri 3,500 kw. single-phase turbo-alternators at the electricity works, Frankfort, were taken over by the municipality last year, exhaustive trials were carried out, and the summarised results of a test on one of the units are given below.

Test Figures for Steam Consumption.

Steam pressure (lbs per sq. in.)	141·5	152·5	141	142
Steam temperature (deg. Fahr.)	455	470	461	498
Vacuum (Barom. at 30in.) ...	29·23	29·17	29·1	28·65
Output (includ. excitation) kw..	1542·4	2551·2	2586·3	3521·6
Steam consumption (lbs per hr.)	23734	35904	36519	47100
,, ,, (lbs per kw.-hr.)	15·4	14·08	14·15	13·38

The above turbines were built for a steam temperature of 300° C. (572° F.), but owing to local conditions it was not possible at the time of the tests to use higher steam temperatures than those given in the above table. Based on the results of many former tests, however, it is definitely known that an increase in the steam temperature of 5·7° C. reduces the steam consumption by 1 per cent., and it is therefore safe to give the following figures for the steam consumption of these plants at the steam temperature of 572° F., as follows:—

Steam Consumption reduced to a steam temperature of 572 deg. Fahr., and under the pressure and vacuum conditions given above.

Output (including excitation) kw. ...	1542	2551	2586	3521
Steam consumption (lbs per kw.-hr.)	13·65	12·7	12·6	12·4

It must be remembered that the alternators are single-phase machines, and consequently have a slightly lower electrical efficiency than the more usual three-phase machines. The condensing plant used for the above turbine is of Brown-Boveri manufacture, and the energy absorbed by it amounts to 2·9 per cent. when running at full load, and 2·5 per cent. when running at three-quarter and half load, at the vacuums indicated above.

Police Telephone Service.—Mr. Gladstone announced in the House of Commons on Friday last that out of the 192 metropolitan police-stations, 59, or over 30 per cent., are connected with the public telephone system. Also, 123 stations, or 64 per cent., are connected by the police telephone system.

Reduction in London-Paris Telephone Rate.—We understand that two new channel telephone cables are to be laid, and that the charge for a three minutes' conversation will be reduced from 8s. to 5s. The negotiations with the French Government concerning these improvements are not yet complete, but it is hoped that the new cables will be available for public use next year.

Wireless Telegraphy.—Wireless telegraph stations are being established along the Benadir coast; the chief station at Mogador will have a range of about 1,800 miles, and may be able to communicate with India. The Mogador stations will communicate with the stations at Asmara and Pisa. A wireless telegraph station has been established at the new Admiralty building, Whitehall, in order that communication may be maintained between the Admiralty and either the coast ports or the fleets in the Channel and the North Sea.

Smoke Nuisance.—The Metropolitan Borough Councils have received a communication from the London County Council, explaining that the Public Control Committee of that authority have had under consideration the question of obtaining an amendment of the law with a view of dealing more effectively with nuisance from smoke, and giving particulars of a draft scheme of amendment. The scheme lays down that dense smoke discharged from any building, vessel, stationary or locomotive engine, or premises (other than a private dwelling-house), within an area of twelve miles from Charing Cross, shall be a nuisance for which a fine not exceeding £10 may be imposed, with cumulative penalties for subsequent offences, at the discretion of the magistrate. The scheme involves the repealing of exemption from liability to penalties implied or expressed in favour of Crown property or premises of electric power corporations. The London County Council would have power to make bye-laws, subject to the approval of the Home Office or the Local Government Board to bring under the terms of the penalty provision other instances of avoidable smoke nuisance than those mentioned, to prescribe and revise from time to time a standard of smoke nuisance, and to prohibit the adoption in new or reconstructed premises, of any furnace, grate or fuel-consuming apparatus of a type which shall have been proved, to the satisfaction of the Council, to produce an unnecessary amount of smoke. The Council propose to take power to expend money for promoting a knowledge of the principles of combustion of fuel, furnace and grate construction, and stoking, for encouraging study of the use of smokeless fuel, and for determining generally the best means of preventing smoke.

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NEW ALTERNATE-CURRENT INSTRUMENTS

THE Paper read by Dr. W. E. Sumpner and Mr. J. W. Record at last Thursday's meeting of the Institution of Electrical Engineers was to some extent supplementary to two previous papers entitled "The Use of Iron in Alternate-current Instruments," and "New Iron-cored Instruments for Alternate-current working" (*Journal, Institution of Electrical Engineers*, vols. 34 and 36 respectively), and its object was to describe the instruments as actually made on the principles enunciated in these papers, and indicate some of their uses and properties. In recapitulating the general features which form the basis of the system employed, the fundamental difference between the series magnet and the shunt magnet was pointed out. When a magnet is series excited, by a current through the field winding, the flux which is produced depends upon the current and on the physical properties of the core, but is quite independent of the resistance of the winding. But if the magnet be excited by the voltage, the flux is controlled by this voltage, and practically does not depend upon the properties of the core.

With the shunt magnet the eddy currents caused in a small piece of brass do not affect the magnetism caused by the exciting voltage. In the construction of the wattmeters now to be described it is thus permissible, within reason, to use brass clamping-pieces in the neighbourhood of the moving system. With a series magnet, on the other hand, the eddies induced in a piece of solid metal affect the magnetism caused

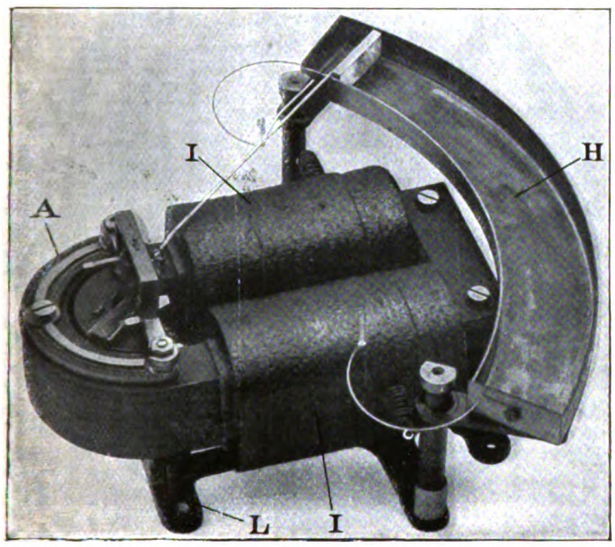


FIG. 1.—IRON-CORED ALTERNATING-CURRENT WATTMETER.

by the exciting current. The strength of the *series* magnet for a given current is dependent on the properties and the past history of its core. The field of the *shunt* magnet, on the other hand, is independent of the core, and is perfectly controlled by the voltage applied at the moment. It is not affected by any ageing effect in the core, and the field is thus even more reliable than that of a permanent magnet as used in direct-current instruments. The field of the shunt magnet, though caused by the voltage, is not in phase with it. Special means must be devised for supplying the movable coil with such a current as to make the deflection of the instrument a correct measure of the quantity to be tested. For the wattmeter a special form of current transformer is needed. For the voltmeter any ordinary condenser may be used. These accessories may be called quadrature transformers, since their function is to produce a moving-coil current which is in quadrature with the circuit current or voltage. The indicating instrument itself has the characteristics and advantages of permanent magnet instruments. Strong controlling springs can be used, and stray magnetic fields have no influence on the readings. The readings of the instrument are independent of frequency, and also of the wave-forms of the current and voltage. The field of the magnet when excited by a given voltage will be doubled if the frequency is halved, but the moving-coil current will at the same time be halved, so that the product which determines the deflection will be independent of frequency.

SHUNT-MAGNET INSTRUMENTS.

Structure of the Magnet and of the Moving System.—Almost any known form of electro-magnet which would permit a coil of wire to swing between two pole-faces could have been selected for these instruments, but partly on account of certain constructive difficulties it was decided to adopt the form of magnet with a single air-gap, shown in Fig. 1. The total

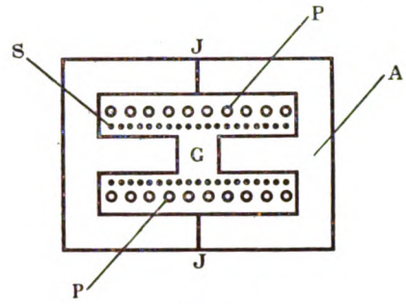


FIG. 2.

length of air-gap is only 0·08 of an inch, giving a clearance of 0·02 of an inch each side of the moving coil. This form of magnet has also been selected in order to reduce the magnetic reluctance of the circuit to a minimum, and to allow a large angular deflection of the pointer. The cross-section of the iron is about 1 sq. in., the total magnetic flux is approximately 32,000 C.G.S., and the flux density about 5,000 C.G.S. (R.M.S. values), at the normal applied voltage on 50-~ circuits. As the section of the gap is five or six times that of the iron core the flux density in it is correspondingly reduced. It is generally about 1,000 C.G.S. lines per square centimetre, and is comparable with that used in the air-gaps of good permanent magnet instruments. About 200 ampere-turns are needed to produce the flux under normal conditions. The moving-coil consists of about 40 turns of fine copper wire former wound, and fixed to an axle fitted with hardened steel pivots and supported between jewelled screws. The effect of temperature variations on the copper windings is swamped by the use in series of about 80 ohms of manganin wire wound non-inductively. An air-chamber *H* for damping down the oscillations of the pointer is provided, and the dial of the instrument forms the top of this dash-pot. The pointer *E* and damping vane *F* are placed so that their weight as nearly as possible balances the weight of the moving coil, thus the inertia of the moving system is not increased by the use of extra masses for balancing purposes. The torque on the moving-coil system is about 1·2 gramme-centimetres for 90° deflection, which is greater than that usually employed with instruments of the dynamometer or induction type.

The Quadrature Transformer.—In order that the instrument may read watts it is necessary to connect the electro-magnet in shunt across the mains, and to join the terminals of the moving coil to the secondary of a specially designed current transformer, which the authors designate a "quadrature" trans-

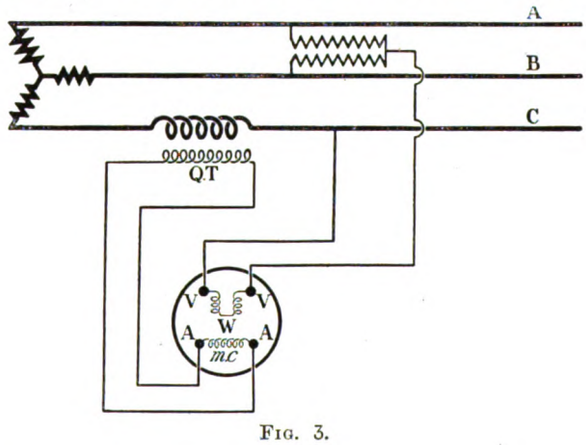


FIG. 3.

former. This transformer renders the current in the moving coil proportional to the current in the mains, and the product of the moving-coil current into the air-gap flux becomes a measure of the load whatever the voltage, current, frequency, or wave-form. The core *A* in Fig. 2 is formed of two blocks of iron stampings with butt joints at *J*, *J*, and an air-gap *G*,

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generally about one-tenth of the length of the iron circuit. P is the primary winding, and S the secondary. The latter consists of a few turns of fine wire, the ends of which are joined through a high non-inductive resistance to the terminals of the wattmeter moving coil. It is this long air-gap in the

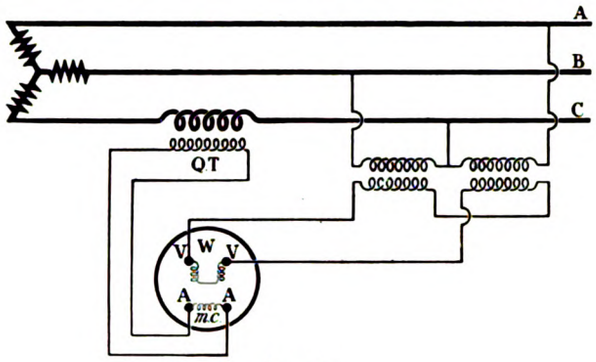


FIG. 4.

quadrature transformer that renders the flux proportional to the primary current for all changes in its value, and reduces the error due to hysteresis in the iron to a negligible quantity. For large currents two further types of quadrature transformer are made, one in the shape of a ring, to slip over cables, the other rectangular to slip over bus-bars. It is permissible, although not advisable, where series transformers are already installed, to connect the primary of the quadrature transformer in series with the ordinary current transformer secondary. The accuracy of the wattmeter will, however, be limited by the magnitude of the phase error of such series transformers.

Wattmeter Circuit Connections.—Fig. 3 shows how the instrument should be connected to the circuit for measuring the power of a 3-phase circuit, balanced load, when the neutral point is not available. A specially designed choking coil is used, with its ends connected to two of the mains, the wattmeter itself being joined to the third main and to the junction point of the choking coil. For high-tension circuits potential transformers are necessary to reduce the potential to a safe value for the instrument. Such transformers are connected with their secondaries in opposition in order to bring the voltage into proper phase relation with the current. The connections of this are shown in Fig. 4. One quadrature transformer only is used, and two potential transformers with opposed secondaries. An equivalent arrangement is possible, in which one potential transformer and two quadrature transformers are employed, the secondaries of the latter being parallel connected in opposition as regards the moving coil. The ease with which the wattmeter can be connected with, or disconnected from, the main circuit, without disturbing the latter, renders it suitable for a number of special purposes. For instance, the output of each of a number of alternators in parallel may be measured in succession by using *one* indicator and as many current transformers as there are alternators in parallel.

Magnetostatic Voltmeters.—The wattmeter may be used to

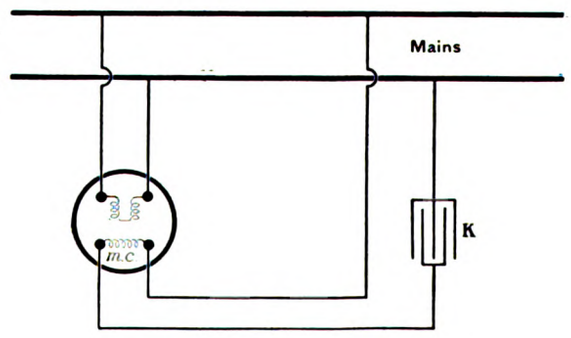


FIG. 5.

measure volts by changing the connections of the moving coil from the secondary of the quadrature transformer, and placing them in series with a condenser of suitable capacity across the mains (see Fig. 5). The readings will be correct on circuits of any frequency or waves form, provided the ratio of voltage to frequency is not made too great so that the resultant induction density in the iron is made excessive.

Portable Standard Voltmeter and Wattmeter.—The laboratory portable standard instrument is most useful, and the measurements to which it is adapted are so many and varied that it can be considered an alternating-current testing set. It consists of a mahogany case containing the movement already described, and is provided with four terminals and two switches. The internal connections can be traced from Fig. 7. It will be seen that with switch A in one position the coils of the electromagnet are connected in parallel, and the pointer will deflect to its maximum position for the rated voltage; and that with switch A in the second position the coils are connected in series, and twice that voltage will be needed to produce the same deflection. Switch B is for connecting the moving coil either in series with a condenser K across one of the field coils, or directly across terminals T and T_1. It will be noticed that the voltage applied to the condenser is the same for the same voltage per turn applied to the field coils, whether these latter or series- or parallel-connected. With switch B in the position shown in Fig. 7, the instrument is a direct-reading voltmeter having two ranges; the readings are quite independent of frequency, wave-form, hysteresis, stray magnetic fields, or electrostatic influences As the flux in the air-gap is proportional to the applied voltage, and the condenser current is also proportional to the applied voltage, it follows that the torque acting on the moving coil must be proportional to the square of the voltage. Two scales may therefore be fitted

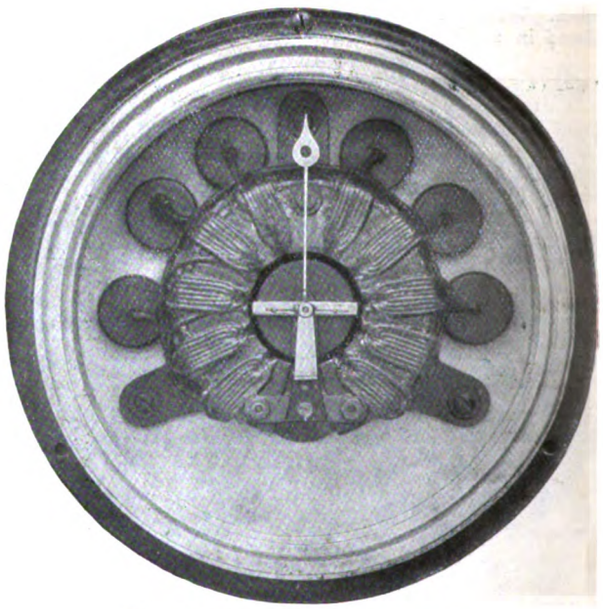


FIG. 6.—IRON-CORED PHASEMETER.

to the instrument, the wattmeter scale, having equal division, and the voltmeter scale, following a square law. A useful form of quadrature transformer for portable use consists of an ordinary quadrature transformer with a subdivided primary, the ends of which are taken to separate pairs of terminals, which can be connected in series or parallel.

Capacity Measurements.—When the switch B of Fig. 7 is turned to join the moving coil across T T_1, the instrument can be used for a variety of special purposes, one of the most useful being the measurement of capacity of cables and condensers. It is universally admitted that the present methods of testing capacity are both tedious and unreliable. The iron-cored voltmeter here described is essentially free from many of their defects. Any leakage current in the condenser, being in phase with the volts, is in quadrature with the magnetic field, and hence has no influence on the deflection, while changes of frequency and wave-form likewise cause no errors. The condenser fitted in the instrument for using this as a voltmeter can be also employed as a standard of capacity, and a special scale can be made for the instrument so that this is direct reading in microfarads for tests at any convenient fixed voltage. The readings on this capacity scale will be proportional to the readings on the watt scale, and hence proportional to the square of the readings on the volt scale.

INSTRUMENTS FOR PHASE MEASUREMENT.

Idle-current Ammeter.—For constant voltage circuits the wattmeter can be used as an idle-current ammeter. For single-phase circuits all that is necessary is to substitute for the quadrature

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transformer a non-inductive strip resistance, to which the moving coil is suitably shunted; or, alternately, an *ordinary* current transformer with a secondary coil of many turns short-circuited by the moving coil. For 3-phase circuits it is only a matter of changing the connections of the potential leads.

Iron-cored Phasemeters.—Phasemeters are instruments analogous with ohmmeters, and the theory of their working is similar and almost as simple. The phasemeter is merely an ohmmeter, having, in effect, an alternating magnetic needle due to the flux caused by an alternating current traversing a moving coil, and having two alternating magnetic fields in fixed directions (but not in in the same phase) due to the cyclic currents through

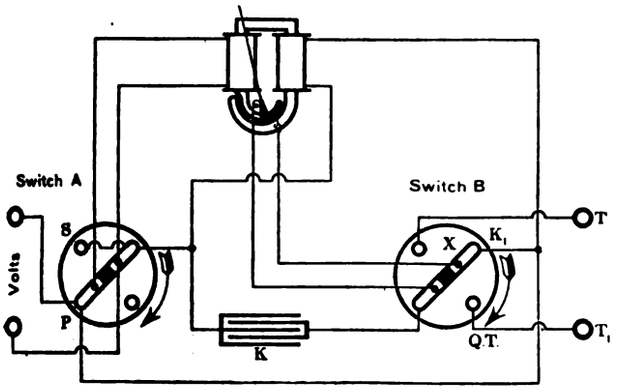


FIG. 7.

its fixed coils. Usually a phasemeter consists of a fixed and moving system of coils, one system containing two coils and the other only one. The instruments here described have only one coil in the moving system, but contain three coils, C_1, C_2, C_3, in the fixed system, the latter being traversed by currents representing A_1, A_2, and A_3, the three currents of the 3-phase mains. But these currents are necessarily such that one of them, say A_3, can always be regarded as the sum of the other two, so that the three coils, C_1, C_2, and C_3, just mentioned, can really be regarded as only two coils, having a portion C_3 in common, one of these coils being traversed by a current representing A_1, and producing the field OF_1, while the other is traversed by a current representing A_2 and producing the field OF_2. The directions OF_1 and OF_2 are approximately 90° apart, and this accounts for the total deflection of about 180° (90 for leading and 90 for lagging) to be found in most phasemeters. The three fields due to a unit current in each of the fixed coils are fixed in direction, as shown by OA_1, OA_2, and OA_3, in Fig. 8. The lengths of these lines denote the strength of the field due to a unit current in each case, this strength being determined by the winding of the corresponding coil. OF_1 is the resultant of OA_1 and OA_3, while OF_2 is that of OA_2 and OA_3. The currents A_1, A_2, and A_3, which actually flow through the coils, can be regarded as two currents only. One of them, A_1, traverses the first and third coils, and produces a field always along OF_1, while the other, A_2, traverses the second and third coils, and produces a field always along OF_2.

The introduction of the iron-cored phasemeter is a new departure in power-factor meters. A view of the interior can be seen in Fig. 6. The field magnet resembles the stator of a 3-phase generator built up with a number of iron laminæ. Instead of the rotor there is a fixed laminated iron core. This core forms one circular boundary of an annular air-gap, about ⅛ in. across, between itself and the outer stator. In this air-gap swings a moving coil, which is balanced and controlled by no other forces except those due to the interaction of the currents. The stator is wound for current, and for convenience is supplied from two series transformers, the primaries of which are traversed by two of the line currents. The moving coil has a high non-inductive resistance in series with it, and is placed in shunt across the mains. Various arrangements of transformers, analogous to those stated in connection with the wattmeter, may be used with the phasemeter.

Voltage-wound Phasemeters and Synchronisers.—A form of phasemeter is being developed, having its stator coils wound for voltage and its moving coils for current, the latter being supplied either from a shunt or from a current transformer. Experiments are also being carried out on an instrument of the above type, which has been so constructed that the moving coil is free to revolve continuously in either direction. By connecting the voltage windings to the bus-bars, and the moving coil to the terminals of an incoming machine, the phasemeter will be converted into a synchroniser. It will indicate if the incoming machine is "too fast" or "too slow" by revolving either clockwise or anti-clockwise. When the pointer comes to rest the speed will be right, and, by further regulation, the pointer will turn and become stationary in the normal position, and this will indicate the correct moment for switching in.

CALIBRATION AND ACCURACY.

Wattmeters and Voltmeters.—A simple direct-current test is used to determine the wattmeter scale. The same method may be used for the voltmeter, since the scale markings in the latter case are proportional to the square root of the corresponding scale markings in the case of the wattmeter. The instruments are afterwards adjusted on an alternate-current circuit against a standard instrument; for a wattmeter by an adjustment of the resistance of the moving-coil circuit, and for a voltmeter by the choice of a suitable condenser, followed by a final adjustment of the spring.

The error of an instrument in actual working is frequently more due to extraneous influences, such as friction or disturbing fields, than to incorrect electrical action on the moving system. From such disturbing influences the present instruments are well guarded, owing to the strong controlling springs used and to the natural shielding due to the iron employed in their construction. Moreover, the deflection cannot be influenced by eddy currents, which may be induced in the iron case or other metal parts near the moving coil. Numerous experiments have shown that the present instruments act correctly for changes in voltage, current, or frequency, and that the error for variations of power factor obeys the law applicable to all wattmeters, the error as a fraction of the true reading being given by $\theta \tan \phi$ where θ is a quantity characteristic of the instrument, and which may be conveniently called its *phase error*.

In Table I. below the wattmeter error for a phase error of 1 per cent. of a radian ($\theta = 0{\cdot}01$) is expressed in three ways for loads of different power factors.

Table I.

Wattmeter Error for a Phase Error θ of 1 per Cent.

Power factor, $\cos \phi$.	Per cent. of true watts, $100\,\theta \tan \phi$.	Per cent. of voltamperes, $100\,\theta \sin \phi$.	Millimetres on scale.
1·0	0	0	0
0·9	0·48	0·43	0·55
0·7	1·02	0·71	0·90
0·5	1·73	0·87	1·10

In the second column the error is expressed as a percentage of the true watts. The third column shows the error as a percentage of the volt-amperes, or of the watts associated with the same current and voltage on a non-inductive load. The last column expresses the error as a shift of the pointer in millimetres on the scale, assuming that a deflection measuring 5 in., or 127 mm., denotes a power in watts numerically equal to the volt-amperes.

For commercial purposes, the error is sufficiently small if kept

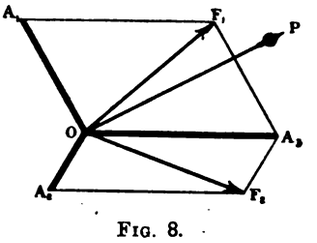


FIG. 8.

within a small fraction of the full deflection, and is always negligible if the corresponding shift of the pointer is within the error of reading under working conditions. In normal working full deflection is only attained for the circuit voltage at full-load current, when the power factor is unity. In the present instrument, if the phase error is 1 per cent., the error in the deflection is always less than 1 per cent. of the full deflection, however low the power factor, and that in nearly all cases it is less than 1 mm. measured along the scale.

The accuracy secured in the new instrument can be precisely indicated by the value of the phase error. In one of the portable standard instruments this value was only 0·0077 for 50-~ circuits, so that the corresponding errors are given by the numbers in Table I. when multiplied by 0·77. In one of the switchboard instruments θ was found to be 0·012 for 50- ~

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circuits, corresponding with the figures in Table I. when multiplied by 1·2. The error of the electromagnet is due to the phase error represented by the ratio of resistance to impedance of the field coil (see *Journal*, vol. 36, p. 439). This ratio is about 0·4 per cent. for 50-~ circuits Two distinct ways have been found to precisely compensate the total phase error of the instrument for circuits of a fixed frequency. These methods have been amply tested and verified, but they have not yet been embodied in the commercial instruments.

The voltmeter is naturally less subject to error than the wattmeter, since the voltmeter is essentially the same as a wattmeter used on circuits of fixed power factor equal to unity. The deflection for a given voltage for a range of frequency of 3 to 1 does not vary as much as 0·5 per cent.

Phasemeters.—The theory and modes of calibration of phasemeters have been already discussed by one of the present writers (*Phil. Mag.*, January, 1906), and it has been shown that the phasemeters in general are much more accurate instruments on balanced loads than they are usually credited with being; in fact, phasemeters for multiphase circuits, if properly calibrated, are all alike in normal action, and differ only in liability to disturbances. Various makes differ, not in electrical, but in mechanical properties. The actual errors arising in working are due to causes extraneous from the electrical action of the instrument, being due to friction when the deflecting forces are weak, or to the influence of stray fields, or to the want of balance of the circuit currents. In the instruments here described the moving coil is perfectly shielded by the iron, and if this coil is out of proper position the rectifying forces brought into action are strong, so that errors due to the first two causes do not arise. All phasemeters are equally subject to error when used on unbalanced loads. A similar error arises in measuring the power of a 3-phase circuit by the single wattmeter method. The error which arises from such want of balance is determined simply by the ratios of the three currents in the mains, and is not dependent on the instrument employed. It is the same for all wattmeters and for all phasemeters, however good or however bad they may individually be. It is not serious except for low power factors and for badly balanced loads.

In an appendix to the Paper, an arrangement is described whereby a wattmeter may be used to measure the total output of a set of generators in cases where, owing to the sectionising of bus-bars and feeder circuits, it is not possible or convenient to so place a transformer that its primary is traversed by the total current. One indicator is required, and the same number of quadrature current transformers as there are circuits in parallel.

A further appendix describes a neutral point reactance coil, by the employment of which it is possible to use a single wattmeter to measure in succession the power corresponding with each phase of a 3-phase circuit. A quadrature transformer is needed for each of the three mains, and a light 2-pole 3-way switch. However badly balanced the main currents may be, the true power of each phase can be measured, and the wattmeter may be normally left connected with that phase which best represents the total power supplied to the load.

DISCUSSION.

Mr. SYDNEY EVERSHED (Messrs. Evershed & Vignoles) said he felt privileged in being the first to congratulate the authors on the progress they had made in developing this series of instruments which they had been at work on for nearly four years. One of the greatest drawbacks attending the use of iron for measuring instruments was hysteresis. With alternating-current instruments, of course, this disappeared, but there were other difficulties which remained unsolved. At one time he had believed it was possible to discover an iron which had no hysteresis, and in his young days he had read in a text-book that a certain mineral named magnetite, which existed in some remote part of Italy, had no hysteresis, or rather as it was then called no retentivity. Having gone to some trouble and expense to obtain a small piece, he had been disappointed to find that it had about as much corrosive force and hysteresis as very bad cast-iron. He then set to work upon the basis that the reason for hysteresis was molecular friction in the iron, and thought that if he could make iron fluid it would have no hysteresis. He therefore dissolved some iron in mercury, and made a kind of paste. But the result was also disappointing, because it was just as liable to hysteresis as any ordinary piece of soft iron, and it also had the disconcerting habit of spontaneous combustion. If he left this alloy of iron and mercury for a day without bottling it up, he found it reduced to mercury, generally in a pool on the bench, and a mass of black oxide of iron. Since then he had made many instruments, but he had never conquered hysteresis with soft iron, and he felt that the true application of iron lay with alternating-current apparatus, although he never really understood how it ought to be applied until he read Dr. Sumpner's Papers and saw his instruments. Since the early days he had spoken of, there was the work of Prof. Ewing, from which it was clear that it would never be got rid of. It was known that hysteresis was due to the proximity of the particles to each other, and not to the nature of the iron itself. He had ventured to praise the instruments a great deal, because he considered they were worthy of it; in fact, he admired the instruments more than the Paper. He confessed that, in reading the Paper, he found some difficulty in understanding some of the explanations. He rather felt that too many subjects were dealt with, and that not one of them was dealt with exhaustively. One point he noticed they had passed over very lightly, but he would like to hear Dr. Sumpner's explanation of how he got over the difficulty, if it existed, viz., the current induced in the moving coil circuit by the induction in the shunt magnet. That current was in quadrature with the induction, and therefore it had no torque on the moving coil, provided it was exactly at right angles to the induction, although it had a very considerable value. He had made a rough estimate of the electromotive force in the moving coil circuit, and found it to be something like 1·8 volts. Then he made out that the resistance of the moving coil circuit might possibly be as much as 100 ohms. This gave, for the induced current, something of the order of 18 milliamperes. As the current moving the instrument was only 4 milliamperes, this seemed at first sight rather alarming, and so it was until one remembered that it was out of phase with the induction and did not do anything towards altering the deflection. Then, from former Papers by Dr. Sumpner, he had found out what the impedance of the moving coil circuit might be, and had come to the conclusion that possibly the current in the moving coil circuit was not so entirely out of phase with the induction as to have no effect whatever. In fact, he came to the conclusion that it might cause quite considerable error if the same wattmeter was used for measuring watts on circuits of very different voltages. Possibly, the authors did not intend their instruments to be used for a very wide range of pressures, because they were intended primarily, he supposed, for switchboard use where the pressure did not vary very greatly. But he would like to know how that matter had been dealt with, because in designing ordinary wattmeters of the dynamometer type the electromotive force induced by the mutual induction between the two coils was a great nuisance. It was the bugbear in designing a dynamometer wattmeter, and it was one of the reasons why instruments in which the moving coil was kept in a position where the mutual induction was zero really had an advantage over deflection wattmeters, and, in his opinion, the Sumpner and Record wattmeter was the first in which this disadvantage had been removed. Dealing with one or two points in the Paper, Mr. Evershed first referred to the clearance between the moving and the pole pieces, viz., an air gap of about 20 mils. on each side. This seemed to him a very reasonable clearance; it was the same as was usually found in moving coil instruments for direct currents. It was within one millimetre of the amount used in the megger between the moving coil and the pole pieces, and it also happened, curiously enough, to be the same as he was using between the core of the armature of his little generator and the pole pieces. This was a case in point, because there also he was having a clearance between a laminated core made out of punchings and the pole pieces, and he found in practice that if the press tools for making the punchings were made in his own works, there was no difficulty in making the clearance 10 mils. if it were desirable. The only reason he did not was to avoid eddy currents in the pole pieces. He therefore thought the authors had brought their air gap down to a point below which it was not advisable to go. His next point was in connection with the authors' remarks as to how the volts scale of their combined instrument was obtained from the watts scale by taking the square roots. He thought that it was not sufficiently generally realised that every alternate-current instrument must have a parabolic law if it was going to be an ammeter or a voltmeter. Mr. Evershed then called attention to the authors' description of present methods of testing capacity as both tedious and unreliable, and proceeded to demonstrate by means of an instrument on the megger system, which he had brought with him, how quickly and conveniently capacity measurements, at any rate by this method, could be carried out, although the accuracy might not be of the laboratory order. Referring to phasemeters, Mr. Evershed said that, to his mind, the action of these was not described in the Paper in sufficiently simple language to enable people to get hold of the real principle involved. He then drew a simple diagram on the blackboard, representing a phasemeter by the sections of two fixed coils at right angles to one another and a moving coil perfectly free to move, the fixed coils being connected to suitable current and potential transformers. He showed how it might be regarded that the moving coil was influenced by the working component of the current of one of the fixed coils, and by the idle component of the current in the other, and thus took up a position corresponding to the power factor of the circuit. His last point he regarded as a rather serious one. The authors had devised an instrument which was independent of frequency, independent of temperature, and independent of power factor. But no instrument in the world

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was independent of the English buyer, and the English buyer at the present time was exercising a very harmful influence on the design of instruments. He seemed to imagine that an instrument was a thing in which there were a few pieces of brass put in by the instrument-maker, and perhaps some more brass added by the sales manager. But if the buyer wanted a first-rate instrument, such as those described in the Paper, he must learn to pay for it like an honest man.

Prof. ERNEST WILSON (King's College) said he had one of these wattmeters, but before dealing with the practical points in connection with the instrument, he would like to compare its action with other methods of power measurement from a theoretical point of view. For this purpose he showed two diagrams, and directed attention first to one which was a reproduction of the diagram of connections of Dr. Sumpner's wattmeter from the paper, and proceeded to explain how the turning movement of the instrument, depending, as it did, upon the average value of the product of the current in the moving coil into the field, in which that coil found itself, would depend upon the integral of the impressed voltage, and also upon the differential of the current which was flowing in the work circuit. He also showed a few curves to illustrate these quantities, assuming that the voltage impressed, and the amperes flowing in the work circuit were true sine functions of the time. Prof. Wilson also exhibited another diagram, which showed a method of connecting up an electrostatic instrument for the measurement of power, which is often employed, and pointed out by a similar treatment to that used in the case of Dr. Sumpner's instrument, that this instrument had impressed upon its moving system and its fixed system two integrals, one of which was a quantity which might be called the rate of change of the amperes in the work circuit, and the other that of the impressed voltage. The point he wanted to bring out was that this instrument was not independent of frequency, and he showed mathematically that so long as the current and potential followed true sine functions, and so long as the frequency was absolutely constant, the electrostatic instrument, as he had shown it connected up, would act as a true wattmeter, and experiments showed this to be so. It could, however, be shown that the indications were not strictly accurate when the wave forms were anything but pure sine curves. He thought it worth while bringing forward this point, because it contrasted two important points of the problem, viz., the product of integrals and the differential and the product of two differentials. In the electrostatic case there was not a perfect instrument, whilst in the case of Dr. Sumpner there was a perfect instrument. He need hardly say that the electrostatic instrument could be turned into a perfect instrument, if one of the differentials could be turned into an integral. It was easy to turn the differential of the current into an integral by placing a condenser across the secondary of the transformer, and replace the quadrature transformer by an ordinary transformer. There would then be a potential difference impressed on the quadrants of the instrument proportional not to $\frac{da}{dt}$ but to $\int \frac{da}{dt}$, and then the equation of motion would satisfy the conditions laid down by Dr. Sumpner, and so obtain a perfect instrument. Dr. Sumpner was to be congratulated because he had been able to apply his knowledge of mathematics to a problem before making an instrument at all, and the application of his mathematics had convinced him that his instrument would be accurate when he made it. Owing to the shortness of time, Prof. Wilson was prevented from discussing the practical points which he referred to at the commencement of his speech.

Mr. K. EDGCUMBE (Messrs. Everett, Edgcumbe & Co.) wished more Papers of this class were read before the Institution. The feeling seemed to be held that it was unsportsmanlike to describe one's own inventions at the Institution, but he could not see it. He rather differed from Mr. Evershed in that he admired the Paper almost more than the instruments, but possibly that was because he did not make them. He thought that in some respects the authors had been led away by their enthusiasm for the virtues of the instrument to overlook the virtues of the dynamometer pattern. Mention was made several times of the fact that these instruments were free from disturbance by stray magnetic fields. This, however, applied equally to the astatic form dynamometer. Then, again, the quadrature transformer, which formed an integral part of these instruments was, he should say, anything but free from disturbance from stray fields. It was true that the instrument was shown surrounded by an iron core, presumably to shield it from stray fields, but it seemed to him that the shield might just as well be placed round the current coil of the dynamometer. In that case the instrument would be just as free from stray fields as the authors' particular instrument. The authors very rightly pointed out the disadvantages attending the use of iron cores in the current coils of wattmeters, but he noticed they used an iron core in their quadrature transformer. This would appear to be only transferring the errors from the instrument to the transformer. He was very glad to see the authors inveigh against the indiscriminate connection of any number of instruments on one transformer. This was a thing which all instrument makers would agree in discouraging. At the same time he did not know that he could go as far as the authors, and say that nothing ought to be connected to the transformer but the wattmeter. If the transformer was 800 to 1,200 ampere turns, there was no objection to connecting an ammeter or even an induction relay on to it. He would object to a solenoid relay, in which the back E.M.F. was very high and variable, to a large extent depending on the position of the core. He did not know that he could quite agree with the authors' way of rating instruments. As far as he could see, in the case of an instrument built for 10 amperes and 100 volts, they would graduate the scale to 1,000 watts, *i.e.*, the product of the maximum current and the maximum voltage. He did not think this advisable in view of the power factors met with in practice. He generally reckoned that the actual reading was only one half, but he noticed the authors gave the accuracy as a percentage of the volts and amperes, whereas he thought the accuracy ought to be given as a percentage of the maximum scale reading in watts. The whole question of rating wattmeters was an important one, and he hoped the Standards Committee would deal with it. He hardly thought the accuracy aimed at with the authors' portable standard wattmeter was quite sufficiently high for ordinary laboratory standardising work. They spoke of an error in the instrument itself of half a degree as being very good, but to this he presumed had to be added the error of the transformer. Again, he thought it a disadvantage with standard wattmeters not to be able to test them with direct current. It always seemed to him very essential, in the case of a complicated instrument like a wattmeter—not complicated in itself, but having to perform complicated functions—that it should be capable of being easily checked on direct current. He thought the Paper had brought forward some excellent ideas, which were applicable to other instruments than those described.

Prof. GISBERT KAPP (Birmingham University) wished to add his expression of admiration, not only for the Paper, but also for the instruments. He had tested an early pattern of the instrument, and found it very accurate, considering it was almost the first instrument made by Dr. Sumpner. It had a few faults, but he would rather call them faults of imperfection than faults of system, because Dr. Sumpner was not an absolutely perfect workman, although he was a perfect mathematician. He had found that the instrument was independent of frequency, after having tried it on several frequencies. The principle that Dr. Sumpner had introduced of using iron in such instruments as voltmeters and wattmeters was a step in the right direction. There were very good wattmeters which had no iron, but they took a large amount of power. Only the other day, in testing iron for hysteresis losses, he had found that the wattmeter might register five or six times the amount which could really be debited to the iron. It was not a serious matter in several thousands of watts, but in testing iron samples it was serious. He also thought it a very good thing to adapt these wattmeters to read capacity. Theoretically, it was possible to take the capacity and measure the charging current, but it was not possible to do much of this on a short piece of cable. It was then a risky thing to put on thousands of volts, and even if this were done it was hardly possible to measure the current. The authors had shown how it was possible to measure capacity to within something like $\frac{1}{10}$ microfarad. The method of measuring the charging current was also not very accurate as soon as they departed from the sine wave. But the authors were even independent of that error, because they had a standard condenser, and, provided that the E.M.F. wave did not alter its shape, then there was no error at all due to the departure from the sine wave. Finally, he would like to correct an impression that seemed to be about that no wattmeter was accurate for unbalanced loads. Perhaps what was meant was no wattmeter which measured the volts in one current, and asked for this to be multiplied by three. This was true, but there were wattmeters which were accurate upon unbalanced loads. He was reminded of the method by Behn-Eschenberg, in which two wattmeters were used to measure the unbalanced three-phase load. In this method, however, the wattmeters must not be too close together, or errors would be introduced. Recently, however, Messrs. Siemens & Halske had brought out a wattmeter, in which this error was avoided. It was too complicated to describe there, however, but he mentioned it in order that the impression might not get about that wattmeters could not be made from an unbalanced load.

Dr. C. V. DRYSDALE (Northampton Institute) congratulated the authors upon the beauty of the principle contained in their instruments, and the remarkable number of applications to which they were capable of being put. He would confine his remarks to the wattmeters which he regarded as by far the most interesting of the authors' instruments. Besides being beautiful in principle, it had the great advantage of being robust. He would ask them, however, to consider what the instrument really was. There were two kinds of electromagnetic wattmeters, those on the dynamometer principle and those on the induction principle, and he thought the instrument of Dr. Sumpner was really an induction wattmeter in a new form. In tracing out a diagram of an ordinary induction wattmeter upon the blackboard, Dr. Drysdale compared the shunt wind-

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ing with the shunt magnet in the authors' instrument. Similarly, the disc, or cylinder, when eddy currents were introduced, was, in reality the quadrature transformer of the authors. He thought they were undoubtedly induction type instruments, in which the induction took place outside instead of inside. When this was realised, it smoothed away all difficulties and theories, and they really found that this new instrument was an old friend. This being so, it was interesting to consider what were the advantages and disadvantages as compared with the ordinary induction instrument. The first important advantage, that of the inclusion of a large manganin resistance in series with the moving coil, the temperature difficulty could be eliminated; another advantage was that by having the transformer in the position indicated with a large number of fine turns on the secondary, and also by having a moving coil, it was possible to switch over from one circuit to another in a manner not permitted by any other type of wattmeter. A third advantage was that, by having the circuits independent, it was possible to introduce the pretty principles of condenser measurement referred to. Considering the disadvantages, he thought that, after all, the instrument must be regarded as an induction pattern wattmeter, spoilt by additional complexity. The original induction wattmeter was one of the simplest of all instruments, because it happened to have almost everything needed on an instrument. One disc served for three things; it served as the coil; it served for the interconnection of the two magnets, and, by putting a damping magnet on the back, it was possible to obtain all that was necessary in such an instrument. If it were not for the temperature variation, he thought they would have to say that the induction instrument in its old form was better. It was certainly cheaper and extremely effective and simple. He had himself endeavoured to improve the dynamometer wattmeter as a defectional instrument, and the only way of doing this was to put in iron. In his opinion the best place for the iron was in the series circuit, to keep it out of the shunt, and thus preserve the dynamometer principle. The authors were really measuring these things as the product of $\frac{dA}{dt} \int Edt$, whereas all that was wanted was to simply multiply the amperes by the volts. Clearly, it was preferable to stick to the original instrument if it were possible. The independence of frequency could only go over a certain range—a very considerable one, he agreed—but not extending to no frequency at all, *i.e.*, direct current. It was an advantage to be able to check on direct current, and all that was wanted was to take great care that the ratio of the amount of iron in the circuit was not too great for the air in the gap. He had made an instrument on this principle, of the iron-clad type, with a very simple moving coil, which was fairly accurate and very cheap to construct. Further, they had only to put two systems at right angles on the same shaft to get the Behn-Eschenberg arrangement for a three-phase wattmeter.

Mr. J. T. IRWIN referred to the method of compensating for the errors in the wattmeter mentioned by Dr. Sumpner. He had brought the method to the notice of the author of the Paper a short time ago, but Dr. Sumpner had found, on looking up his notes, that it had also occurred to him. It is required to measure the power given to the circuit AB. R_1 and L_1 are the resistance and the effective inductance of the magnet coil; L_2 and R_2 are the inductance and the resistance of the moving coil circuit. M is the mutual inductance of the two coils of the quadrature transformer, and R_3 is a small resistance inserted in the main circuit. The vector diagram shows the phases of the various quantities. V is the voltage across AB. C_1 is the current in the main circuit lagging behind V by the angle ϕ. F is the flux in the shunt magnet, which lags behind the voltage V by an angle equal to $\frac{\pi}{2} - \frac{R}{L_1 R_1}$ and is inversely proportional to the frequency. The current C_2 in the moving coil is at least $\frac{\pi}{2}$ radians behind the current C_1, and is directly proportional to the frequency. The angle between the flux and the secondary current is $\phi + \frac{R_1}{L_1 P}$ if the inductance of the secondary circuit is negligible. To make the angle between them equal to ϕ the current C_2 has to be advanced by an angle $\frac{R_1}{L_1 P}$. To do this all that is necessary is to open the secondary circuit at AB and join the circuit up through the resistance R_3 in the main circuit. There are now two E.M.F.'s in the secondary circuit MPC_1 and $C_1 R_3$, and the resultant E.M.F., if the resistance R_3 is joined up in the right direction is $\left(\frac{\pi}{2} - \frac{R_3}{MP}\right)$ radians behind the current in the primary. When $\frac{R_3}{MP} = \frac{R_1}{L_1 P}$ the wattmeter would be correctly compensated for the resistance of the magnet winding, and would read correctly on any power factor or frequency. Further corrections could be introduced to compensate for the small self-induction of the moving coil circuit, and for the iron (if any) in the quadrature transformer. Thus the total angle of lag of the current in the secondary circuit behind the flux in the magnet when there is no compensation is equal to

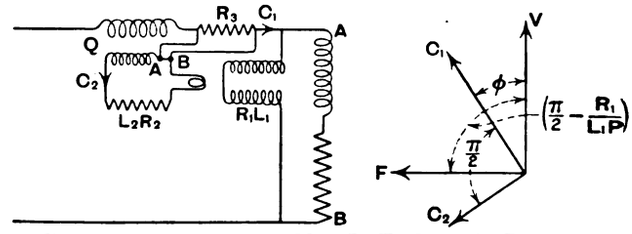
$$\phi + \frac{R_1}{L_1 P} + \frac{L_2 P}{R_2} + \theta.$$

where $\frac{L_2 P}{R_2}$ is the angle of lag of C_2 behind the E.M.F., and θ is the angle by which the flux in the transformer lags behind the main current. To compensate for these last two phase errors, it is necessary to increase the value of R_3 so that

$$\frac{R_3}{MP} = \frac{R_1}{L_1 P} + \frac{L_2 P}{R_2} + \theta.$$

When this is true the wattmeter will read correctly at any power factor for this one particular frequency. The resistance of the magnet will be correctly compensated for any frequency, but the phase errors, owing to the self-induction of the secondary and to the iron in the transformer will only be partially compensated for when the frequency is greater than this particular frequency. Of course, there will be over-compensation for a frequency less than the particular frequency chosen for exact compensation. For any practical frequency the phase error will be only a small fraction of the error when uncompensated, which Dr. Sumpner has shown can be made very small.

Mr. J. W. RECORD, in the course of a few remarks, dealt briefly with the points raised by Mr. Evershed, viz., hysteresis and capacity. He was very interested to hear that Mr. Evershed had tried fluid iron, although he had not met with much success. The same idea had occurred to him a short while ago, and he had thought of trying an electromagnetic instrument with some iron filings in a small tube or pouch. He had not carried out the experiment, but from Mr. Evershed's remarks he gathered that it would practically be no good. With regard to measuring capacity, there was considerable trouble with commercial condensers for about twelve months: he had had an ohmmeter connected up for measuring capacity, and one of his assistants had named it the capaciometer. But there were obvious objections. With a condenser of the roll type, there was a series of creases at regular intervals, *i.e.*, wherever the paper was bent. He was speaking of continuous plate condensers with one plate over another, and in addition



DIAGRAMS ILLUSTRATING MR. J. T. IRWIN'S REMARK.

to the creases already referred to, there were probably some others due to winding. If the capacity was measured on a ballistic galvanometer, it would be found that if this crease was nearly broken through, the current would begin to come in at one end and spread out at the crease and round, and so on at all the creases, although it charged the whole plate, and the usual deflection was obtained upon the ballistic galvanometer. If such a condenser were put upon alternating current, and measured by means of one of their instruments, it would be seen that although the condenser measured correctly on a ballistic galvanometer, it was really a bad condenser. He had confirmed this many times by comparing tests on several condensers. He had found nearly the best of condensers, as tested by ballistic galvanometers, to break down completely on the alternate current test, and on unwinding the condensers he had invariably found it was due to the breakage of the metal conductor in building up, or else due to creases in the winding of the plates. Regarding the errors in these instruments, broadly speaking, he thought they could be summed up into saying that it was better to have errors that were known than errors that were not known. In this wattmeter the error could be calculated and checked, and whenever that had been done, the calculated error came very close to the measured error, and it could be depended upon. Although it was not possible to check the instrument on direct current, it could be calibrated on direct current, and instruments so made had always proved perfectly accurate, both on alternate current and direct current.

Dr. SUMPNER intimated that he would send in a full reply to the *Journal*, but said that, referring to Mr. Evershed's remarks, his assumptions with regard to the E.M.F. induced in the moving coil circuit were approximately correct. He had gone into that question very fully in a Paper which had not yet appeared in print, but which had been accepted by the Royal Society, and Mr. Evershed would find every point he had raised dealt with there.

A vote of thanks was accorded the authors at the conclusion of the discussion.

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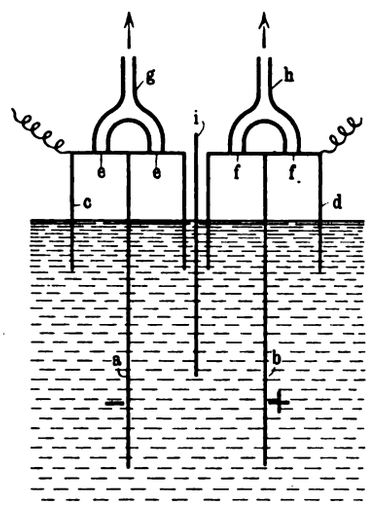
ELECTROCHEMISTRY AND ELECTROMETALLURGY

F. HABER has recently, *Chemisches Zentralblatt*, 1908, Vol. I., p. 1022, carried out experiments in order to ascertain whether, when porcelain becomes conducting upon being heated, it obeys Faraday's law. It is well known that when cold a piece of magnesium oxide or calcium oxide will not conduct the electric current, but when heated the current is able to pass, this principle being employed in the Nernst lamps. A piece of glass, also, which is considered to be one of the best of insulators, can also be made to conduct the current by heating it. For example, if two platinum wires are sealed into a glass rod, so that within the rod the distance between the two pieces of wire is about 1 cm., and the two free ends are connected through a lamp resistance with the 100-volt circuit, a milliammeter being in series, no current, of course, will pass. But if the glass rod is heated to redness, a deflection is shown upon the ammeter scale. The question in such cases is, with what kind of conduction are we dealing? Now glass consists of fused silica, sodium silicate, and calcium silicate. In such a case we may suppose the conduction to be somewhat similar to the conduction of aluminium oxide in fused cryolite. The silicon dioxide being ionised, just as the aluminium oxide is ionised. Now porcelain also becomes a conductor when heated. The porcelain will contain Al_2O_3, Fe_2O_3, CaO, KCl, NaCl, and $Mg_2P_2O_7$, but is, of course, mainly composed of aluminium silicate. Haber has actually determined the amounts of these oxides which are transported when the porcelain becomes heated, and is in an electric circuit.

His method of procedure was as follows. He took an unglazed porcelain crucible (Rose crucible), such as is used for determining sulphides, &c., in a stream of hydrogen. The crucible was filled with tin, and was also bedded in tin, which was contained in a steel crucible. The tin inside the crucible was made the cathode, that outside being the anode, and care was taken to keep the cathode out of contact with the air. The whole was then heated to 800-1,000°C., and connected up in a circuit of 55 volts. A current of 15 to 20 millimetres passing (4·5 milliamperes per square centimetre). The electrolysis was continued from 8 to 10 hours, at the end of which time contact was broken, and the whole allowed to cool. The cathode tin was then dissolved and analysed, and the transport coloumbs for Al_2O_3, Fe_2O_3, CaO, $Mg_2P_2O_7$, KCl, and NaCl calculated, the numbers being compared to those given by a silver coulometer. It was found that the numbers agreed very closely with the numbers required by theory, *i.e.*, the agreement with Faraday's law was good. At the temperature 800-900°, aluminium silicate appears to have very little to do with the transport of current, but CaO and MgO entered largely into the transport. The anode tin was also found to have penetrated considerably into the porcelain, which is another proof of electrolytic conduction. From 300° upwards porcelain shows electrolytic conduction, and from 300-900° the aluminium silicate which makes up the bulk of the porcelain is not a conductor, but acts simply as a solvent (in the solid state) for the alkaline oxides. The action is therefore somewhat similar to the solution of alumina in cryolite, although in this latter case we are dealing with a completely fused electrolyte.

When lead peroxide is electrolytically deposited upon carbon or graphite electrodes, the difficulty is to get an adhering deposit. A carbon electrode upon which lead peroxide has been deposited is very useful as an anode in the electrolysis of alkali chloride solutions, and for the production of hypochlorites or chlorates; it is, however, of course, essential that the peroxide coating should be adherent, otherwise it falls off into the bath and contaminates the product. According to the *German Patent*, 195117 (1908), of the Konsortium fur Elektrochemische Industrie, a perfectly adherent deposit can be obtained by, before hanging the carbon in the lead peroxide-producing bath, impregnating it with some substance which will fill in the pores. The impregnating substances suggested are paraffin or fats, solid fatty acids, ceresin, &c. The bath for the peroxide deposit consists of nitric acid and lead nitrate. The peroxide deposit is then obtained of such firmness and density that the electrode may be broken across without the peroxide flaking off, the break of the carbon and peroxide being coincident.

On March 5th we referred to the electrolytic production of hydrogen and oxygen by the process of the Elektricitäts-Aktiengesellschaft vormals Schuckert and Co. The particular form of cell which they employ is described in the *British Patent* 3,000 (1907). The apparatus, as is shown in the illustration, consists of screens which are used between the electrodes in order to keep the evolved gases separate, and the object of the invention is to provide means for obtaining pure gases or mixtures of any required proportion. The invention is based on the observation that gas, as evolved at the electrode sur-



faces, forms eddies whose diameter is proportional to the surfaces from which they are produced, and to the volume yielded per unit of time. The electrodes *a* and *b* are metallically connected to the bells *c* and *d* respectively, and from these bells the gases are led away by the pipes *g* and *h*. The screen *i*, if of metal, is insulated from the bells, and projects so far below the bells that the current lines do not touch them. Naturally, if the screen is of metal it is necessary to keep the voltage below the pressure which would cause the screen to become dipolar. By carefully proportioning the electrode surfaces projecting below the screen, practically pure gases can be obtained. For example, hydrogen and oxygen can be obtained having a purity of 98 to 99 per cent. It is possible to so adjust the electrodes with their integral screens that the gases may be generated in any desired form of mixture.

K. A. Kuehne, *American Patent* 878,210 (1908), describes a modification of the Goldschmidt Thermit Process. He recommends for the production of pure metals or metalloids in the fused state, which cannot be readily obtained by means of reduction with aluminium alone, the use of chlorates, perchlorates, or other substances which readily evolve oxygen. It will be remembered that in the original Goldschmidt process, barium peroxide was employed as the ignition powder. Kuehne proposes to employ larger quantities of the peroxide, in other words, to use a mixture of aluminium and barium peroxide as the reducing agent. Other peroxides, such as lead peroxide, sodium peroxide, or persulphates, may also be employed. In order to produce a readily fusible slag, so that the reduced metals may easily collect at the bottom of the crucible, a flux of fluospar and lime may be added.

Aluminium, it is well known, is only very slightly attacked by nitric and sulphuric acids, but most other metals interact vigorously with these metals. According to *Elektrochemische Zeitschrift*, of March, the German military authorities at Siegburg have been testing aluminium vessels for the last two years, to ascertain if they are really able to withstand the action of acids. It has been found that the metal is practically unacted upon by nitric and sulphuric acids, either dilute or strong. Also that a mixture of strong nitric and sulphuric acid, such as is employed for the manufacture of explosives, has very little action upon it. Aluminium vessels which have been used over two years with these acids were found still to be in good condition, and quite capable of extended use. It follows, therefore, that aluminium vessels can very well be used for working with either nitric or sulphuric acids.

ELECTRICAL SCIENCE

British and American

Electric Discharges Through Gases.—At the Royal Institution on Saturday last Prof. J. J. Thomson delivered the third of the course of lectures on this subject. The lecturer commenced by referring to the conductivity of a layer of ionised air (see report of last lecture, ELECTRICAL ENGINEERING, March 19th, page 444), and showed an experiment illustrating how the conductivity increased with increased thickness of layer. Prof. Thomson then described some experiments which had been made to determine the nature and character of the charged particles in an ionised gas. The speed of the particles under the action of a known force had been determined, and this allowed of their mass being calculated. The velocity of a positive particle in hydrogen at a pressure of one atmosphere, and under the influence of an E.M.F. of 1 volt per cm., was

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6·7 cm. per sec.; of a negative particle 7·95 cm. per sec. For complicated gases the velocities were more nearly equal, but the velocity of the negative particle was generally greater than that of the positive particle. This was a lower velocity than that of a single molecule, so it was presumed that each particle was an aggregate of three or four molecules round a charged body, and there was one such particle to about a million ordinary molecules. As the conducting portion of the gas was heavier than the rest of the gas, it should be possible to separate out this portion, as it would liquety sooner than the rest of the gas. Ladenburg had frozen out an explosive product from ionised oxygen, which was probably an allotropic modification, perhaps 5 or 7 atoms to the molecule. Prof. Thomson had himself tried to obtain a similar product from nitrogen, but on account of the many impurities in the gas used these experiments had not been very successful. The lecturer showed by experiment that ionised air passed through a tube immersed in liquid air lost its conductivity. The velocities of the charged particles in a flame were very high the negative particles, according to E. Gold, attained to a velocity of 13,000 cm. per sec., or practically the calculated velocity of the negative corpuscles of the cathode rays. The positive particles in a flame had a velocity of only 80 cm. per sec. To illustrate this the lecturer showed an experiment in which the current was conducted across a flame between two metal plates. As practically all the current was carried by the negative particles, which were driven away from the cathode, practically all the E.M.F. was required at the surface of the cathode. At low pressures the negative particles appear to simplify, and after a certain pressure is reached the velocity of the negative particles increases rapidly.

The Scattering by Matter of the β-rays from Uranium.—The law of the absorption of β-rays by matter has been practically settled by the work of numerous experimenters. It is expressed by the formula

$$I = I_0 e^{-\lambda d}.$$

where I and I_0 are the intensities of the rays before and after passing through a layer of matter of thickness d and λ is the coefficient of absorption. If ρ is the density of the absorbing matter, then it is known that λ/ρ for the chemical elements is a periodic function of the atomic weight, the periods corresponding to the well-known periodic law of the elements. These facts concerning absorption of β-rays are now supplemented by J. A. Crowther's work on the scattering of β-rays. The research is chronicled in the March number of the *Proceedings* of the Royal Society. The observers of absorption have usually obtained the β-rays by covering a layer of radioactive matter by aluminum foil sufficiently thick to cut off the α-rays from the radioactive matter. The absorbing matter studied was then placed in the beam of β-rays coming from the aluminium plate, and the reduced intensity, as well as the original intensity, measured by the ionisation method. Of course, the β-rays falling on the absorbing plate arrive at all angles and pass through at all angles, because of scattering. The case is analogous to that where the intensity of the light transmitted through a ground-glass plate is being considered. The scattered light might be estimated in this example by placing a large number of small blackened tubes close together with their ends on the glass and with their lengths perpendicular to the glass. In this way the light leaving the plate normally, that is, the light not scattered, might be measured, and hence the scattered light computed. The present observer has followed this process exactly in his experiments on the scattering of β-rays. A large number of equal brass tubes, about 5 mm. diameter, are bound together, and such a bundle placed on each side of the absorbing plate. With this arrangement the greatest possible angle of incidence and emergence was about 9°. It was found that the intensity of the emergent β-rays was only 5 per cent. of the intensity obtained without the tubes in position. This enhanced the difficulties of measurement incidental to the ionisation method, so extremely thin layers of absorbing material had to be used. With gold there was complete scattering with a thickness of 2 thousandths of a millimetre, and with aluminium at 150 thousandths. The law followed by the intensities of the β-rays before and after transmission is given by

$$I = I_0 e^{-\sigma d}.$$

where d is the thickness traversed and σ is the coefficient of scattering. The ratio of the coefficient of scattering to the coefficient of absorption for the same material is practically identical for all the substances experimented upon, its value being approximately 13. From this it is clear that the value of σ/ρ, where ρ is the density, is a periodic function of the atomic weight of the elements.

Continental

A New Magnetic Detector.—An instrument based upon Sella's magneto-elastic principle is described by A. G. Rossi in the January number of the *Nuovo Cimento*. It consists of an iron or nickel wire in a magnetic field traversed by an alternating current and subjected to simultaneous tension and magnetic torsion. Incident wave-trains reduce the amplitude of the torsion and shorten the track of the spot of light cast by a small mirror attached to the wire. This circumstance paves the way for direct photographic registration. The wire has a diameter of 0·1 mm. and a length of 20 cm. Two bar-magnets, each 10 cm. long, are mounted parallel to the wire, both their N.-poles being near its middle and their S.-poles near its ends. The magnets are weak, and the alternating current very feeble. The torsional vibrations of the wire are attuned to the incident wave frequency. The wire from the antenna is brought to the centre of the stretched wire without touching it, and winds round it in two opposite coils. The main advantage of the new detector lies in the small mass—about 15 milligrammes—which prevents any transformation of the energy into undesirable forms, such as takes place in Marconi's magnetic detector.

Reception of Waves in Wireless Telegraphy.—An elaborate investigation into the conditions under which electric waves are absorbed is contributed to No. 3 of the *Annalen der Physik* by R. Rudenberg. His results emphasise the hopelessness of transmitting energy by wireless means in a quantitative manner. The dissipation is enormous even in the best systems. The amount of energy absorbed from a given wave is proportional to the square of its wave-length, so that there is a rapid increase of efficiency on lengthening the waves. On the other hand, the somewhat surprising conclusion is arrived at that the effective length of the antenna is without any influence upon the proportion of energy absorbed. This, however, does not appear to apply rigidly to a single vertical antenna. It does apply to the "umbrella" form of receiving antenna, whose effective length is about half the height, since downward currents along the ribs reduce the radiation from the vertical wire. The author gives some interesting diagrams illustrating the distortion of the wave-train by a receiving antenna. This distortion extends over about 24 wave-lengths. The area from which energy is absorbed has a radius equal to about one-fifth of the wave-length.

Electrolytic Detectors.—Several methods of increasing the sensitiveness of electrolytic detectors are studied by E. Branly in the *Comptes Rendus* for March 9th. These include heating, mechanical agitation, and bubbling of gases. With a positive electrode 0·01 mm. in diameter, the sensitiveness increases on heating as far as 80°, with a maximum at 60°. This effect is lost after several successive heatings, but is gradually recovered. Another expedient consists in mounting the cell on a carrier which slides to and fro about an inch, say, twice per second. The effect is well marked, but the noise of the motion necessitates a separate room in order not to interfere with the telephone observations. The best effect is obtained by bubbling gases through the electrolyte. Almost any gas will do. A good method is to produce the decomposition of water within the electrolyte itself by means of two separate electrodes and an auxiliary current. The effect so obtained persists for some time. The author has also obtained an increase of sensitiveness by arranging two electrolytic detectors in series and doubling the E.M.F. applied to them.

Sensitiveness of Selenium.—In the *Physikalische Zeitschrift* for March 1st, C. Ries discusses the means of enhancing the photoelectric sensitiveness of selenium. This sensitiveness is shown either in the solid conductor, which increases in conductivity on illumination, or in a galvanic cell, where illumination of the selenium electrode produces an E.M.F. As regards the former, the author finds that the best results are obtained by mounting the selenium layer first in the amorphous state, and subsequently getting it into the crystalline form by heating it slowly to 195°, keeping it at that temperature for half an hour, and then cooling it rapidly. The maximum resistance, with or without illumination, depends upon the temperature. In one cell the author found it to be 23°C. six years ago, and it is the same now. As regards the electrolytic selenium cells, their behaviour may be summarised by saying that the "photo-electric current" always passes in the direction of the beam of light which travels between the electrodes. Thus, if the selenium electrode is positive, illumination tends to charge it negatively, and reduces the current. Positive polarisation has a well-marked effect in increasing the sensitiveness, so long as it remains within 1 or 2 volts. Negative polarisation has a maximum effect at 0·5 volt, and then rapidly decreases and becomes negative.

New Telephone Charges.—At the annual meeting of the Association of Chambers of Commerce last week, a resolution was moved by Lord Brassey, and seconded by Mr. Bonar Law, M.P., expressing the hope that the Postmaster-General would modify the present system of charging for telephone service as applied to the needs and requirements of the commercial community in the provinces. The resolution was adopted unanimously, without debate. Representatives of the London, Sheffield, Dundee, Bradford, Southampton, Leeds, Hull, Nottingham, Birstall, Birmingham, Kendal, Newcastle, and Liverpool Chambers of Commerce were appointed a special permanent committee to confer with the Postmaster-General and the National Telephone Co., whenever necessary.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published March 19th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

1907 Patents

4,333, J. H. Webb. A method of wireless signalling by continuously generated electric oscillations. The oscillation generator is continuously operated, and the amount of energy translated to the radiating circuit is varied by different means. For instance, the inductive coupling between the oscillating and radiating circuits may be varied by causing the transmitting key to alter the relative positions of the coupling inductive coils in these circuits; or an additional translation circuit may be arranged, which will translate the oscillations from the oscillating to the radiating circuit, when it is brought into harmony with the oscillating circuit. In this case the transmitting key may vary the capacity of a condenser in the translation circuit so as to alternately harmonise and deharmonise the circuit. Seven claims, three figures.

5,506A, B. G. Lamme. Methods of obtaining regenerative and braking action with a single-phase commutator traction motor of the series type. The field winding is so highly inductive that the field flux produced lags nearly 90° behind the impressed E.M.F.; consequently the E.M.F. generated by the armature is considerably out of phase with the line E.M.F. In order that this generated E.M.F. may be in phase with the line E.M.F., the field winding must be separately excited by means of a phase changing device as an induction motor or motor-generator. When it is required that the motor should generate, the armature is connected direct to the main transformer, and the field winding is supplied with an E.M.F. of suitable phase and value from the generating winding of the phase-changing device. The field winding can be connected permanently in series with the armature, the generating winding of the phase-changing device being connected across the field winding as a shunt. Other modifications are described in the specification. Four claims, seven figures.

5,508A, B. G. Lamme. For the same purpose as the above arrangement (No. 5,506A), the field winding of a series commutator motor is excited separately from the armature of an auxiliary commutator machine, the field winding of the auxiliary machine being excited from the line supply. As the E.M.F. generated by the auxiliary machine is approximately 90° out of phase with the line E.M.F., the E.M.F. generated by the main motor will be nearly in phase with the line E.M.F. It has been found that power can be returned to the line in this way with a power-factor of 98 per cent. If several motors are on the same car, one of these can be used as the auxiliary machine supplying current to the field windings of the other motors. Three claims, four figures.

8,284, M. C. Thiellet and M. J. Denard. Compositions for the active materials in the plates of accumulators, harder and less liable to disintegration than those in use. The active material for the negative plate is composed of 80 per cent. lead oxide, 10 per cent. minium, and 10 per cent. sulphate of magnesium, with gelatinous bichromated silicate added to form a paste. The material for the positive plate consists of 80 per cent. peroxide of lead, 10 per cent. lead oxide, 5 per cent. pumice stone, and 5 per cent. sulphate of magnesium, with gelatinous bichromated silicate as before. The preparation of this last is described in the specification. One claim, no figures.

13,354, F. P. Driver. A cement for attaching the filaments to the leading-in wires of incandescent lamps, and consisting of a finely divided refractory metal as tungsten or molybdenum made into a paste with a solution of silicate of potassium or sodium. The filaments are cemented on with this composition, and the joint is then heated, either by passing current through it or by means of an electric arc, in an atmosphere of hydrogen. A good metallic contact free from carbon is obtained, and only a very small amount of troublesome gases is given off during exhaustion One claim, no figures.

20,600, E. Heitmann and F. W. Young. Wedges of cast iron or high-resistance steel for closing magnetically the slots of alternators or induction motors. The wedge is thin along the centre in order to reduce the flux round the slot, and the thick sides, nearest the teeth, are slotted transversely in order to reduce the eddy current loss. Five claims, four figures.

22,833, F. Conrad. An armature winding for alternating-current commutator motors of the type in which the number of field poles is altered when changing over from commutator motor working to induction motor working. The winding is provided with cross connections which act as equalising connections in the former case and as short-circuiting connections in the latter case. These cross connections divide the winding into groups, each of which contains coils connected to two or more commutator segments. The cross-connections permit of a single pair of brushes being used for a multipolar machine, and by this means only one coil is directly short-circuited at a time, the coils in parallel with the directly short-circuited coil have other coils in series with them, in which opposing E.M.F.'s are induced. Resistance conductors between winding and commutator segments are rendered unnecessary. Two claims, four figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Names in brackets indicate communicators of inventions from abroad.

Summaries of the more important of these patents will appear in our next issue.

1906 Patents

19,378A, Bounevialle. Electrical signalling apparatus.
29,647, Merk. Automatic telephone exchange systems.

1907 Patents

2,383, Mitchell. Electric contact devices.
2,587, Howard. Arc lamps.
2,588, Albrecht. Transmission gear for motor vehicles.
4,709, Fessenden. Signalling by electromagnetic waves.
4,710, Fessenden. Transmission of energy by electromagnetic waves.
4,910, Dassomville. Electrolytic bleaching.
5,133, Leitner. Compound wound electric motors.
5,187, Carbonnelle. Transmission of illustrations.
5,300, Garrod. Joint arrangements of the side slot conduit system of electric traction
5,402, Suchostawer. Surface contact traction system.
5,564. Mershon. Control of alternating-current motors.
5,671, British Thomson-Houston Co. and Hopps. Control of electrically propelled vehicles.
5,733, Golby (*Soc. Alsacienne de Constructions Mecaniques*). Polyphase commutator motor.
5,741, British Thomson-Houston Co. (*General Electric Co.*). Commutating poles.
5,749, Griffiths and Bedell. Cable for the stud-contact traction system.
5,925, Triquet. Primary cell.
6,006, Bowden, Robinson, and Jacks. Prepayment mechanism for electric meters.
6,135, British Thomson-Houston Co. (*General Electric Co.*). Signalling systems for railways.
6,992, Notarianni. Electric railway signalling.
8,881. Parsons. Inter-communication telephone systems.
9,029, Borgnet. Electrolytic apparatus.
10,152, Siemens & Halske Akt.-Ges. Conversation counters.
11,582, Fleming. Wireless telegraphy.
11,814, Scott. Electric circuit-breakers.
14,203, British Thomson-Houston Co. (*General Electric Co.*). Dynamo-electric machines.
15,441, Conrad. Voltage regulation.
15,773, Powles and Moore. Double sounders.
16,346, Turbayne. Systems of distribution.
17,539, Gilstrap. Elevated electric railways.
17,832, Sawyer. Trolley wheels for electric traction.
18,242, Schöppe. Electric fire-alarm system.
18,243, Szubert. Arc lamps.
20,128, Eisenstein. Multiple wireless telegraphy.
21,407, Garratt. Brush holder.
21,982, Drewet. Trolly heads or collectors.
22,832. Lamme. Armatures for electric motors.
23,681, Steinthal and Jessop. Contact plugs.
23,877, Barth and Lökken. Electromagnetic sound producers.
23,894, Moscicki and De Modzelewski. Condenser.
24,587, Keller. Flexible electrical connectors.
24,697, Viel. Electric furnace.
24,770, Wolhaupter. Insulated rail joints.

Complete Specifications open to Public Inspection before Acceptance.

1908 Patents

4,181, Lassen. Electrically propelled motor car.
4,274, O'Keenan. Compensating for friction in meters.
4,372, Felten & Guilleaume Lahmeyerwerke Akt.-Ges. Pressure regulation.
4,621, Friedheim. Manufacture of heat exchangers.
4,692, Siemens-Schuckert-Werke Ges. Brush holders.
4,744, Friedheim. Electrolytic deposition on hollow articles.
4,762, Allgemeine Elektricitäts-Ges. Arc lamps.
4,843, Scheller. Receiver for undamped oscillations.
4,844, Scheller. Apparatus for determining the damping and frequency of electric oscillations.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid, *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ld.	10	7	5/-*	11¼—12¼	−¼
Do. 4½% Cum. Pref.	10	4½	4½	10—11	
Do. 6% Cum. Second Pref.	10	6	6	10—10½	
Do. 4½% Debenture, Red.	Stock	4½	4½	100—103	
Bromley (Kent) E.L.& Power Co.,Ld.	5	5½	2/-*	4⅝—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	96—99	+1
Brompton & Kensington E. S. Co.,Ld.	5	10	10	7⅛—5⅛ xd	
Do. 7% Cum. Pref.	5	7	7	6¾—7¼ xd	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4*	98—101	+1
Ch. Cross, W. E. & City E. S. Co.	5	5	5	4—4½ xd	−⅛
Do. 4½% Cum. Pref.	5	4½	2½	4¼—4½	
Do. 4% Deb. Red	Stock	4	4	96—99	−1
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½	4¼—4⅝	−⅛
Chelsea Electric Supply Co., Ltd.	5	4½	4½	3⅝—3⅞ xd	+⅛
Do. 4½% Deb. Red	Stock	4½	4½	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	5%	10—11	
Do. 6% Cum. Pref.	10	6	6*	11½—12½	
Do. 5% Deb. Red	Stock	5	5	122—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	101—104	+1
City of Durham E. P. Dis. Co.	5	4	4	3—3⅜ xd	
Do. 5% Pref.	5	5	5	4¼—4⅜ xd	
County of London Elect. Sup. Co. Ld.	10	5	4%*	7⅝—8⅛	
Do. 6% Cum. Pref.	10	6	6*	11—11½	
Do. 4½% Deb. Red	Stock	4½	4½	106—109	+1
Do. 4½% 2nd Deb. Red	Stock	4½	4½	97—100	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅜—⅝	
Do. 6% Cum. Pref.	5	3½	—	½—1½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	60—70	
Folkestone Elec. Supply Co., Ltd.	5	5½	2/-*	4⅝—5½	
Do. 5% Cum. Pref.	5	5	2/6*	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	4/-*	6½—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	10%	7¾—8¾ xd	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N'tng Hill E.L. Cos. Db. Rd.	Stock	4	4%*	99—103	
London Electric Supply Corporation	3	4	4%	1½—1⅝ xd	
Do. 6% Pref.	5	6	6%	4½—5 xd	+⅛
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6¾%	5—5½ xd	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E.Corp.for P. Dist. 1st Mt. D.	100 & 500	4½	4½%	97—100	−1
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	9¼—10½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	10½%	6½—6¾ xd	
Do. £2 Pm.	5	8	10½%	5⅞—6⅛ xd	
Do. 5% Pref. (fully paid)	5	5	5%	5⅝—5⅞ xd	
Do. 10/- Pm.	5	5	5%	5⅛—5⅜ xd	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11¼—12¼	+¼
Oxford Electric Co., Ltd.	5	7	7%	5⅜—6¼ xd	+⅛
Do. 4% Deb. Red.	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7½—8½	
Do. 7% Non-Cum. Pref.	5	7	7%	6¼—7	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	½—1½	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2⅜—3½	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅜—⅝	
Do. 7% Cum. Pref.	1	7	7%	1½—1⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	101—104	
Urban Elec. Supply Co., Ltd.	5	5	2/6*	1½—2¼	
Do. 5% Cum. Pref.	5	5	2/6*	2—2½	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%*	89—92	−1
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¼—8	−½
Do. 4½% Cum. Pref.	5	4½	4½%	5—5⅛	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	89—92	
Central London	Stock	4	3%	65—68	+2
Do. 4% Preferred	Stock	4	4%	82—84	
Do. Deferred	Stock	4	2%	42—45	
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	81—84	
City and South London Cons.	Stock	2½	4½%	37—39	
Do. 4% Perp. Deb	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	−1
Do. 5% Perp. Pref. 1896	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11s.d.	1—1½	
Gt. Northern, Piccadilly & Brompton	10	4	4%	5½—6¼	
Do. 4% Perp. Deb.	Stock	4	4%	87—90	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	½%	36—37	+½
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½%	71—74	
Metropolitan District	Stock	nil	—	9⅛—10½	
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Deb.	Stock	4	4%	70—75	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pr. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co of London 5% Profit Sha. Sec. Notes	Various	5	5%	40—44	
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅜—¾	
Do. 5% Cum. Pref.	1	5	5%	1⅛—1⅜	
Do. 4½% Deb. Red.	Stock	4½	4½%	91—96	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅝	
Do. 6% Cum. Pref.	10	6	6%*	4½—4⅝	
Do. 5% Perp. Deb.	Stock	5	5%	97—100	
Do. 4½% 2nd Deb.	Stock	4½	4½%	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4⅜—4⅝	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	98—101	

NAME.	Amount of Share.	Dividend Paid, *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%	%		
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%*	97—100	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅞—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	2/-*	⅜—½	
London United Trs., Ld., Cm. Pf.	10	5	5%	7—8	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—85	−1
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—92	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	⅜—⅝	−⅛
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	97—99	
National Elec. Construction Co. Ltd.	1	10	2/-	½—¾	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	½—1	−¼
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	½—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9⅜d*	½—⅝	
Do. 5% Cum. Pref.	1	5	5%	⅞—1⅛	−⅛
Do. 4½% Deb. Red	Stock	4½	4½%	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4½—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	1/1½	¾—1½	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	73—75	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1½	
Do. 6% Cum. Pref.	5	nil	—	3—3½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	3½%	54—57	
Do. 6% Pref. Crd.	Stock	6	6%	97—99	−⅜
Do. Def. Ord.	Stock	1¾	1%	131—133	−¼
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	87—90	
Direct Spanish Telegraph Co. Ltd.	5	4	2/-*	3¼—3½	
Do. 10% Cum. Pref.	5	10	5/-*	8¼—9½	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4½	4½%	13⅝—14½	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	123—131	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5⅜	5%	130—135	
Do. 3½% Pref.	Stock	3½	3½%	83—86	
Do. 4% Mort. Deb.	Stock	4	4%	100—103	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	31—33	
Indo-European Telegraph Co. Ltd.	25	13	65/-	54—57	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅞—1	−⅛
National Telephone Co., Ltd., Pref.	Stock	6	6%	106½—108½	−½
Do. Deferred	Stock	5½	6%	108—110	
Do. 6% Cum. 1st Pref.	10	6	6%	10—12	
Do. 6% Cum. 2nd Pref.	10	6	6%	10—12	
Do. 5% 3rd Pref.	5	5	5%	5⅜—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	97—99	
Do. 4% Deb. Red.	Stock	4	4%	101—103	
West African Telegraph Co. Ltd.	10	4	4/-	10—10½	
Western Telegraph Co., Ltd.	10	7	6%	13½—13⅝	
Do. 4% Deb.	Stock	4	4%	98½—101½	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅛—⅜	−⅛
Do. 6% Cum. Pref.	1	6	7½d	⅜—½	−⅛
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅜—3⅝	
Do. 6% Pref.	1	6	7½d	1⅛—1⅜	
British Insulated & Helsby Cables, Ld.	5	10	4/-*	6¾—7½	
Do. 6% Cum. Pref.	5	6	6%	5⅝—6½	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	101—104	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	86—91	+2
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—¼	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—½	
Do. 6% Pref.	2	nil	—	⅜—⅝	−⅛
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	77—80	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10⅜—11¼	
Do. 5% Cum. Pref.	5	5	5%	5⅜—5⅝	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106—108	
Consolidated Electrical Co., Ltd.	1	3	8¾d*	⅞—1	
Crompton & Co., Ltd.	3	5	5%	1⅝—2	−⅛
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1⅝—1⅞	
Do. 6% Cum. Pref.	1	6	7½d	1⅛—1⅜	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	+1
Edison & Swan United "A." £3 paid	5	4½	2/6	¾—1	
Do. do (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%*	87—90	
Electric Construction Co., Ltd.	2	—	—	½—¾	
Do. 7% Cum. Pref.	2	7	—	1½—1⅝	
Do. 4% 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8½	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%*	89—92	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10¾—11½ xd	−⅜
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15¾—16½	
Do. 4% Deb. Red.	100	4	4%*	99—101	
Tel. Const. & Maintenance Co.	12	15	5%*	31—33	
Do. 4% Deb. Bds. Red.	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres.	1	nil	1/-	¾—1¼	
Do. 6% Cum. Pref.	5	nil	6%	3½—3¾	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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THE PROPOSED HOME OFFICE REGULATIONS

(Special Report. Strictly Copyright)

SINCE the adjournment of the inquiry before Mr. James Swinburne, F.R.S., on Wednesday, the Committee of Objectors, in conference with the advisers to the Home Office, have completed consideration of the whole of the Regulations. In our last issue we gave the agreed amended draft up to Regulation 20, with the exception of Regulations 17 and 18, the discussion of which had been postponed. These two Regulations have now been agreed upon, and, together with the remaining thirteen Regulations, are given below. Other modifications have been introduced into the definitions and exemptions, and these are also given below.

In the draft regulations as they now stand, the definition of "Cable" has been omitted, and consequently in several of the regulations the word has either been omitted or changed to *conductor*. The definition of circuit now reads as follows :—

"Circuit" means an electrical circuit forming *a system or* branch of a system (the words in italics have been added).

Some slight alterations have been made in the exemptions.

Exemption 4, as given on p. 381 of our issue of March 12th, has been added to, and now reads as follows :—

Nothing in these Regulations shall apply on the premises of an occupier, being a consumer of an authorised electricity supply undertaking, to any service lines or apparatus on the supply side of the occupier's terminals, belonging to and under the control of the *suppliers, provided such suppliers are subject to Board of Trade Regulations in respect of such supply.*

The next exemption takes the slightly shortened form below :—

If the occupier can show with regard to any requirement of these Regulations that the special conditions in his premises are such as to adequately prevent danger, that requirement shall be deemed to be satisfied.

An entirely new exemption has been added, reading :—

Nothing in these Regulations shall apply to any process or apparatus used exclusively for electro-chemical or electro-thermal or testing or research purposes; provided such process be so worked and such apparatus so constructed and protected and such special precautions taken as may be necessary to prevent danger.

Of the Regulations themselves, apart from the substitution of the word conductors for cables in Regulation 2 and an unimportant verbal alteration in Regulation 9, there is no alteration until Regulation 17, the consideration of which was postponed until after the others. We give this regulation in its amended form below :—

17. At the working platform of every switchboard and in every switchboard passage way, if there be bare conductors exposed or arranged to be exposed when live so that they may be touched, there shall be a clear and unobstructed passage of ample width and height with a firm and even floor. Adequate means of access, free from danger, shall be provided for every switchboard passage way.

The following provisions shall apply to all such switchboard working platforms and passage ways constructed after the 1st January, 1909, unless the bare conductors, whether overhead or at the sides of the passage way, are otherwise adequately protected against danger by divisions or screens or other suitable means :—

(*a*) Those constructed for low pressure and medium pressure switchboards shall have a clear height of not less than 7 ft., and a clear width measured from bare conductor of not less than 3 ft.

(*b*) Those constructed for high pressure and extra high pressure switchboards other than operating discs or panels working solely at low pressure shall have a clear height of not less than 8 ft. and a clear width measured from bare conductor of not less than 3 ft. 6 in.

(*c*) Bare conductors shall not be exposed on both sides of the switchboard passage way unless either the clear width of the passage is in the case of low pressure and medium pressure not less than 4 ft. 6 in., and in the case of high pressure and extra high pressure not less than 8 ft., in each case measured between bare conductors, or the conductors on one side are so guarded that they cannot be accidentally touched.

It will be seen that important alterations have been made. Sub-sections (*a*) (*b*) and (*c*) are entirely new, and although they embody a portion of the restrictions previously contained in the first part of the Regulation, the effect of the changes is to reduce the permissible width of a passage way in the case of high-tension apparatus from 4 ft. to 3 ft. 6 in., and to reduce the minimum width allowable in the cases with bare conductors on both sides of the passage from double that required in other cases to the figures given above.

In Regulation 18, the words shown below in italics have been added :—

(*a*) Every *high pressure and extra high pressure switchboard* conductor within reach from the working platform or in any switchboard passage way shall be so placed or protected as to prevent danger.

The remaining Regulations, the consideration of which by the committee was subsequent to our last report, are given in full in their amended form below :—

Regulation 21. Where necessary to prevent danger adequate precautions shall be taken either by earthing or by other suitable means to prevent any metal other than the conductors from becoming electrically charged.

The only alteration is a rearrangement of the wording.

Regulation 22. Adequate precautions shall be taken to prevent any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon.

Regulation 23. Where necessary to prevent danger, insulating stands or screens shall be provided and kept permanently in position and shall be maintained in sound condition.

These two regulations are unchanged.

Regulation 24. Portable insulating stands, screens, boots, gloves, *or other suitable means* shall be provided and used when necessary to prevent danger, and shall be periodically examined by an authorised person.

The words in italics have been added.

Regulation 25. Adequate working space and means of access, free from danger, shall be provided for all apparatus that has to be worked or attended to by any person.

Regulation 26. All those parts of premises in which apparatus is placed shall be adequately lighted to prevent danger.

Regulation 27. All conductors and apparatus exposed to the weather, wet, corrosion, or to inflammable surroundings or explosive atmosphere, or used in any process or for any special purpose other than for lighting or power, shall be so constructed or protected, and such special precautions shall be taken as may be necessary to prevent danger in view of that exposure or use.

These three regulations have not been altered, but the subsequent numbering has been retained to avoid confusion.

Regulation 28 has been deleted.

Regulation 29. No person except an authorised person, or a person acting under his immediate supervision, shall undertake any work where technical knowledge or experience is required in order to avoid danger.

This remains as before.

Where a contractor is employed, and the danger to be avoided is under his control, the contractor shall appoint the authorised person, but if the danger to be avoided is under the control of the occupier, the occupier shall appoint the authorised person.

The latter clause was suggested by the Institution of Electrical Engineers.

Regulation 30 is left to be dealt with by the Commissioner.

Regulation 31. Every sub-station shall be substantially constructed, and shall be so arranged that no person other than an authorised person can obtain access thereto otherwise than by the proper entrance, or can interfere with the apparatus or conductors therein from outside, and shall be provided with efficient means of ventilation and be kept dry. (This is agreed to subject to Mr. Sparks' clients desiring to raise any further point in their own interest.)

It will be noticed that the words "and substantially constructed of fire-resisting material" have been omitted.

Regulation 32. Every underground sub-station shall be under the control of an authorised person, and none but an authorised person or a person acting under his immediate supervision shall enter any part thereof where there may be danger.

No alteration has been made here.

Regulation 33. Every underground sub-station not otherwise easily and safely accessible shall be provided with adequate means of access by a door or trap-door, with a staircase or ladder securely fixed and so placed that no live part of any switchboard or any bare conductor shall be within reach of a person thereon : Provided however that the means of access shall be by a doorway and staircase : (*a*) if any person is regularly employed therein, other than for inspection and cleaning; or (*b*) in any such sub-station not of ample dimensions, either if there is moving machinery therein, other than ventilating fans, or if there is extra high pressure therein.

The only alteration is verbal.

Regulation 34. *Adequate periodical inspections shall be made by an authorised person to ensure that these Regulations are fully complied with.*

This Regulation has been added.

TUESDAY, MARCH 24TH.—EIGHTH DAY.

At the commencement of the proceedings Mr. GRAY outlined the agreement that had been come to on Regulations 21 to 33, which are given above.

With regard to a suggestion by Mr. Vesey Knox that docks should be included in Exemption 2, he stated that he was willing to add the words, "or for docks constructed under

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statutory powers" after the word "traction" in this exemption.

With regard to Exemption 4, he submitted the following draft modification, which had been prepared by Mr. Ram:—

"The Secretary of State may exempt from these regulations any service lines and apparatus on the premises of an occupier being a consumer supplied by an electricity undertaking on the supply side of the consumer's terminals, provided that such suppliers are subject to Board of Trade regulations in respect of such supply.

Mr. Vesey Knox, K.C., pointed out, with regard to Regulation 4, that he found a good many people were troubled about the word "inadvertently." With most switches it was possible for careless workmen to leave them in partial contact, and it seemed to him that instead of the word "inadvertently," which it was perhaps rather difficult to understand, the words "with ordinary care" might better express what they meant.

Mr. Gray then stated that the committee of objectors and the advisers of the Home Office, had come practically to an agreement upon the whole regulations, although the amended draft did not bind anyone definitely, and he would like an indication as to what now would be the attitude of the objectors.

Lord Robert Cecil, K.C., M.P., on behalf of the London electric lighting companies, outlined his course of action, which he dealt with more fully in his speech later on in the day. Most of the other objectors stated their intention of adopting Lord Robert Cecil's argument to a large extent.

Mr. W. B. Woodhouse, on behalf of the Yorkshire Power Co., and other objectors asked for an explanation with regard to one or two of the altered clauses. The wording in Regulation 11, for instance, was not quite clear. Was it intended that a bank of transformers, if controlled by one switch, would satisfy that regulation?

Mr. James Swinburne stated that he did not quite see this point, as if the whole bank of transformers could be turned off this would meet the case. There was no need to have arrangements for turning off each individual transformer.

Mr. Woodhouse then asked if "line shafting" was included in Regulation 12 under the word "machinery." If this were so, he thought they would be as badly off as ever. For instance, with line shafting running in three rooms, if that line shafting was to be treated as machinery, then in each of the rooms there must be means for stopping the motor.

Mr. Gray said he was afraid the word "machinery" did include shafting, and, in his opinion, if the shafting was dangerous it ought to be included.

Mr. Woodhouse next referred to Regulation 15, which referred to an area being set apart for the construction of a switchboard. Was it to be taken that a generating station was an "area" set apart for a switchboard, and that no special fencing of the switchboard would be required?

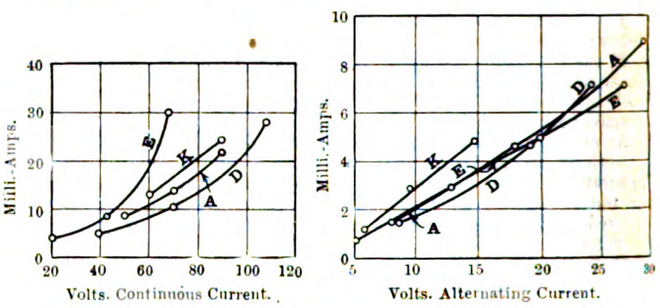
Mr. Gray said that no special fencing would be required.

Mr. Woodhouse, on Regulation 20, mentioned a small point, and suggested that the words "at a lower pressure" should be struck out so as to make the regulation include transforming up as well as transforming down.

Mr. Gray agreed to this.

Mr. Woodhouse, referring to underground sub-stations, dealt with in Regulation 33, mentioned the existence of a Board of Trade regulation on this point for high pressure and extra high pressures. It was occasionally convenient to use the basement of a factory for a transforming chamber, and if these were to be considered "underground sub-stations," then they would come up against the Board of Trade regulations.

Mr. W. H. Patchell was then called on behalf of the Home Office, and said he had made two sets of experiments during the past three weeks upon the question of voltages, the results of which are set out in the diagram. He said he had, at one time, held the opinion that the pressures of 130 volts for continuous current and 65 volts for alternating current were too low, but having made the experiments in question, he had rather changed his mind. In the first set of experiments there were three experimenters, and they first investigated the relative effect of continuous and alternating current. They first tried 72 volts continuous current with two bare copper contacts ¾ in. in diameter, and they found it quite comfortable. It was later found that 50 volts alternating current was about the equivalent of 100 volts continuous current; 16 volts alternating current could hardly be felt, and the same remarks applied to 50 volts continuous current. Then at 50 volts alternating current they gripped the copper contacts as hard as they could, but they could all leave go easily. There was no sort of contraction of the muscles whatever. At 65 volts alternating current, however, he could not grip hard, because he felt a distinct contraction of the muscles. At 130 volts continuous the effect was just about the same. They then tried, having in view the fact that possibly the quantity of current that went through the body was an important factor, how much current they could take comfortably. One experimenter took 2·8 milliamperes, another 7, whilst he himself could take 10 milliamperes without discomfort. With continuous current one experimenter took 12-13 milliamperes, another 25, whilst he took 27 milliamperes. A very important point in these experiments was the state of the skin. Following these experiments, he had others made for him by three other people. In this case the copper bars were one inch in diameter, and experiments were made on both continuous and alternating current. Dealing first with continuous current, one experimenter with 20·2 volts took 4 milliamperes and hardly felt it. At 42 volts he took 8·1 milliamperes, and distinctly felt it. At 68·5 volts and 30 milliamperes there was a painful burning of the hands, and a blister on one of the fingers. The next experimenter at 40 volts took 5 milliamperes, and was slightly shaken; at 70 volts and 10 milliamperes his muscles were contracted, and at 100 volts and 20·3 milliamperes he felt his hands burn. The third experimenter at 50 volts and 8·6 milliamperes felt his right hand slightly warm. The same experimenter at 70 volts and 13·8 milliamperes felt a pricking in the finger points, and at 90 volts and 42 milliamperes there were sharp pains. With a workman 60 volts and 12·9 milliamperes were hardly felt at all, whilst at 90 volts and 24·2 milliamperes there was a distinct pricking in the right thumb. The alternating-current experiments were taken in the same order. The first experimenter at 5·2 volts and 0·2 milliamperes could hardly feel it. At 12·9 volts and 2·9 milliamperes it was distinctly felt; at 18 volts and 5·2 milliamperes it was only with difficulty that he could move his hands, and at 27·4 volts and at 7·1 milliamperes he could not keep his hands on the bars, the effect was so painful. The next experimenter took 8·6 volts and 1·4 milliamperes, and then 19·3 volts and 4·7 milliamperes. With the latter the wrists and muscles were badly contracted. At 24 volts and 7·2 milliamperes the arm muscles were contracted. The third experimenter at first took 10 volts and 1·5 milliamperes, and then 19·9 volts and 4·8 milliamperes. With the latter he had what were described as convulsive pains; 29·6 volts and 8·7 milliamperes were quite as much as this man could stand. The workman then tried 9·7 volts and 2·8 milliamperes, and found it very disagreeable, whilst with 14·7 volts and 4·8 milliamperes his wrists were contracted.



Curves showing Variable Susceptibility to Electric Shock of Different Persons, illustrating Mr. Patchell's Evidence.

Mr. Gray: Having regard to your own knowledge of these matters and to the experiments you have made, what is your view with regard to 65 volts alternating current and 130 volts continuous current as regards risk of accident to workmen by accidentally touching one of these voltages?—I think the risk is greater through carelessness, and unless proper precautions are taken, serious accidents are likely to occur.

Lord Robert Cecil: My contention is that these laboratory experiments are not of much use for the purposes of this inquiry. As a matter of fact the pressure at which you had to leave go in your experiment is half what is given in the regulations.

Mr. Patchell said that they must look at these things from the point of view of a lower pressure than that which had proved to be dangerous in the past.

Lord Robert Cecil, in a further course of questions, pointed out that in Mr. Ram's report as Electrical Inspector of Factories for 1906, in a table of fatal accidents, there was only one accident which had occurred upon a system where the voltage was less than 250, which was at Derby, upon a 200-volt alternating current system. In the continuous current there was nothing below 500 volts, and these were all electric railway accidents.

Mr. Patchell, in further cross-examination, said that he did not know of any commercial alternating current system as low as 65 volts, but there were continuous current systems at under 130 volts, and he agreed that whereas these systems would be exempt from the regulations, no alternating current systems would be, and in London, where there was competition between companies supplying on the different systems, the 110 volts continuous current supply would receive preferential treatment.

In answer to Mr. Vesey Knox, Mr. Patchell stated that the periodicity of the alternating current experiments was 88 volts in the first set, and 50 volts in the second. He admitted that it would be difficult to reproduce in a factory the condition of perfect contact obtained in the experiments, but he knew of many cases of bad contacts which would approximate to the experi-

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mental conditions. Further questions by Mr. Vesey Knox directed towards showing the unreliability of the experiments were to the effect that if the results indicated were obtained with 30 volts alternating current and 60 volts continuous current, there was every possibility, as the experiments were continued up with the higher pressures, that the degree of danger with direct current might overtake that of alternating current, because the resistance of the body would fall considerably as indicated by Mr. Patchell.

Mr. PATCHELL replied that it was very difficult to argue which way the tests would go if the experiments were extended. About five seconds was the longest time during which the experimenter could stand the current.

Mr. COZENS HARDY asked whether in the first exemption Mr. Patchell would agree to raise the voltage of the exemptions as regards authorised persons only. Mr. Patchell replied that he thought this would leave an enormous number of dangerous points in existence in various installations, although they might not necessarily be dangerous *qua* shock. This closed the evidence of the Home Office.

Mr. C. P. SPARKS was then called on behalf of the Electric Lighting Companies of London, on the question of voltage. As the exemptions stood at present, he suggested that there should be no limit of voltage specified at all, as there was no commercial alternating current systems under 65 volts, and consequently all alternating current system came within the regulations. Up to 1895 the Board of Trade set the limit of voltage for the application of their regulations at 150 volts alternating, and 300 volts continuous current, but subsequently a committee, consisting of Lord Kelvin, Sir William Preece, and Major Cardew, reported in favour of having the same limit of pressure for both systems, and this was fixed at 250 volts. He could not call to mind any accident upon his undertakings at a less voltage than 250. With regard to the regulation stipulating that rules for resuscitating persons suffering from electric shock should be exhibited in all factories, he thought nothing would prejudice the use of electricity in favour of gas or other forms of power more than this. With reference to sub-stations, the County of London Electric Supply Co. now had 161 transformer boxes placed under the highways, and they were inspected twice daily by their own staff. There was a space of 3 ft. 3 in. between the side of the panels and the inside of the boxes, and under the present regulations such boxes would be illegal. He asked that Regulations 25 and 31 to 33 should not apply to sub-stations or transformer stations constructed in accordance with plans prescribed or approved by the Board of Trade, or to any extension of such systems upon similar construction.

Mr. SPARKS, in answer to various questions, expressed the opinion that personally he thought the transformer boxes, to which he had referred, were quite safe, but they did not comply with the regulations; he therefore wished to have them definitely exempted.

Mr. GRAY indicated that he would be prepared to agree to a letter from the Secretary of State exempting such sub-stations or extensions of them.

Lord ROBERT CECIL replied that this would not hold good in a case of prosecution, and there must be a specific exemption in the regulations.

In answer to further questions by Mr. GRAY, Mr. Sparks stated that he thought the regulations in their modified form were preferable to what they were originally, and he did not think they introduced bad workmanship; in fact, he thought they would maintain a good standard. He did not regard Mr. Patchell's experiments as indicating a commercial danger.

Lord ROBERT CECIL then addressed the Commissioner on behalf of the London Electric Lighting Companies and others, and dealt first of all with the question of voltages. He said he desired to press upon the Commissioner the unfairness introduced by the first exemption, for it put upon all alternating current systems the obligation to comply with the regulations whilst continuous current systems under 250 volts were exempt. He therefore pressed for the alteration of the limit of pressure to 250 volts in both cases. He urged that the difference in danger between the two forms of current was not sufficiently well established to justify a distinction such as was proposed. Presumably the Home Office had some reason for fixing 150, but no real explanation had been given. With regard to regulation 30, dealing with instructions for resuscitating persons suffering from electric shock, his clients felt strongly that under no circumstances ought this to be put upon them, and even if the Commissioner did not exempt supplies below 250 volts they hoped he would exempt them from Regulation 30. Reverting to the question of supply in London at 100 volts direct current, which would be subject to the regulations in competition with alternating current supply which will come under the regulations, Lord Robert Cecil pointed out that the St. James' Co. supplied about half their consumer at 107 volts direct current, and all the West End district of the Charing Cross Co. were supplied at 100 volts, and in many cases the two systems were in competition. He was not aware that any serious objection had been raised to this course by the Home Office, except the departmental one that it was not desirable, and also on the score of expense, but in his view the cost of arbitration would be no more than that attaching to proceedings in a court of summary jurisdiction, and subsequently in the court of petty sessions, while the result would certainly be much more satisfactory.

Mr. SWINBURNE: Is there no set of regulations except the Coal Mines Regulation in which there is an appeal?

Mr. GRAY: I am told there is no such case. Many of the sets of regulations have no appeal whatever.

Lord ROBERT CECIL, continuing, said that under the Factory Acts even with regard to fire it was not thought necessary to enforce the regulations upon existing buildings, and before any structural alterations were required a factory inspector had to say definitely, "This is dangerous," and even then the occupier had an appeal. There was a large number of precedents in existing work which were exempted, and he asked for Regulation 55 of the Coal Mines Regulations with a few drafting alterations which were necessary.

In the course of further remarks, Lord ROBERT CECIL asked that the new Regulation 34 should be struck out altogether.

Mr. GRAY interposed that he had a grievance in this connection, as he was given to understand at the conference that the objectors agreed with this. However, he was willing to strike it out.

Mr. VESEY KNOX, on behalf of the Newcastle and other power companies, and the Mersey Docks and Harbour Board, first referred to a point raised by the latter, on the question of responsibility for the "authorised person," as defined in these regulations. He pointed out that under the Factory Acts the "occupier" of a dock was defined as the owner, but the owner of the dock was also joint occupier of a ship, and was liable to prosecution. Now, under these regulations, the "authorised person" was introduced, and apparently the dock company was also to be liable in respect of the electrical contractor's men on board a ship, if they turned out to be not competent. With regard to exemption from prosecution, he suggested the following provision:—"No person shall be deemed to have acted in contravention of or to have failed to comply with these regulations unless the Electrical Inspector of the Home Office shall have certified that there is, in his opinion, good ground for proceeding against such person." In other words, he asked for the *fiat* of the Chief Electrical Inspector.

The inquiry was continued yesterday, and will be concluded this morning.

LOCAL NOTES

ACTON: *Electricity Charges.*—The District Council is considering the views of a deputation of local traders protesting against any increase in the charges for electricity. The Electricity Committee had resolved upon the substitution of the charges first in force in the district for present rates, it being proposed to supply current for lighting at 4d. per unit to churches and chapels, and 5d. to all other consumers, and for power at 2d. per unit. The deputation complained that it was unfair to revert to the old scale, after only six months' trial of the new charges. The present 4d. rate was higher than the Hammersmith rate. Two members of the deputation expressed themselves as being in favour of traders having private installations if charges were increased. Mr. John Beauchamp remarking that he knew a firm who would give a written guarantee that he could generate his electricity for a penny. The chairman of the Council promised that the views of the deputation should be taken into consideration.

BIRMINGHAM: *Chairman of Tramways Committee.*—Alderman Beale, the present Chairman of the Tramways Committee, has been offered the Chairmanship of the Water Committee. If this offer is accepted it is anticipated that Councillor Harrison Barrow will be elected Chairman of the Tramways Committee.

On Monday, the 23rd inst., the Lord Mayor opened an exhibition of arts and industries in the Bingley Hall. Among the exhibits is an interesting display by the Corporation Electric Supply Department, which includes a great variety of electric light fittings, radiators, fans, and motor-driving machines of different types. There is also a considerable section showing machinery in motion.

BRADFORD: *Tramway Employees' Grievances.*—The Tramways Committee has received a reputation in connection with certain dismissals of drivers who have been accused of failing to comply with the regulations in reference to speed of cars. The deputation represented that owing to the slow speed regulations, and the time-table to be maintained, it is impossible to comply with both. The Committee has decided to adjourn the matter in order to obtain fuller information.

BRIGHTON: *Shoreham Harbour and the Electricity Works.*—Mr. J. Christie, the Engineer and Manager of the electricity undertaking, has reported that he has driven in a row of dwarf piles in the harbour alongside the electricity works, and

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that the sky line has been restored to its original level. In his opinion, everything is now quite safe.

BURY: *New Electricity Works.*—At a largely-attended meeting of manufacturers and others at the Town Hall on Friday it was decided to ask the Mayor or convene a public meeting to discuss the question of the new electricity works which it is proposed to erect at a cost of about £100,000, before the Local Government Board inquiry with regard to the necessary loan is held. The general feeling, although not antagonistic to the proposal, seemed to be that sufficient opportunity had not been given to the ratepayers and others interested to consider the proposed scheme.

COWDENBEATH: *Electric Lighting.*—The Fife Electric Power Co. announce that they are extending their mains to Cowdenbeath, and anticipate giving a supply in the district next year.

DUNFERMLINE: *Electricity Supply.*—The Town Council being unwilling to take the responsibility of deciding as to what course shall be pursued in connection with the proposed electric lighting scheme, has decided to take a plebiscite of the ratepayers in order to ascertain their views: (1) Whether the Corporation shall erect a generating station; (2) whether a supply shall be taken in bulk from the Fife Electric Power Co.; (3) whether the Council's Provisional Order shall be disposed of as recommended by Sir Alexander Kennedy.

EDINBURGH: *Edinburgh Exhibition.*—The proposal to construct an electric tramway from the Murray Fields terminus of the present cable tramway system to the Edinburgh Exhibition, referred to on page 452 of our last issue, has been rejected by the Corporation. Sir Alexander Kennedy, as Consulting Engineer to the Corporation, severely criticised the system on several points of detail at the meeting of the Tramways Committee last week, and also objected to the system on the ground that it had not yet been experimented with upon private land. He did not think the system should be subjected to the strain of heavy traffic such as would be involved at the Exhibition until experiments had been made with it.

GILLINGHAM: *Electricity Deficit.*—The accounts of the electricity undertaking show a deficit of £1,000. At the last meeting of the Council, it was stated that the estimated expenditure during the current year is £2,300, making altogether £3,300 to be provided out of the rates, or a rate of 5d. in the £. The Engineer reports that there are three old 100-frequency transformers now out of service, and the committee recommends that he should apply to stations, where these will be suitable, for offers.

GRAVESEND: *Electricity Finances.*—At the last meeting of the Town Council, a motion by the Chairman of the Electricity Committee that, in view of the criticism to which the electrical undertaking had been subjected, the Town Clerk, the Treasurer, and the Electrical Engineer should prepare a joint report as to the financial position of the undertaking, was adopted.

HALIFAX: *Tramway Returns.*—The Finance Committee reports that there will be a heavy loss on the tramways for the past year, owing to the accident on the Sowerby Bridge route in October. It is suggested that the loss can be met by making use of the surplus for the previous year.

HANLEY: *Tramways.*—The Board of Trade has intimated to the Council that after careful consideration of its objections to the Potteries and North Staffordshire Tramways (Amendment) Provisional Order, they see no sufficient reason to refuse to allow the promoters the benefit of Clause 5, which prevents the Corporation from imposing special conditions as to the manner in which certain street widenings shall be carried out. In connection with this matter, a conference has been convened by the Town Clerk to the Stoke Corporation for the purpose of considering the desirability of petitioning against the Order referred to above. A deputation from Hanley will attend this conference.

Electricity Matters.—It has been decided that the wiring of consumers' premises carried out on the deferred payment system shall be charged against a wiring account into which receipts therefrom shall be paid. Meters, indicators, spare or renewal parts for plant, hand tools, and small testing instruments are in future to be paid for out of revenue, as they are purchased. A stores stock account is to be kept at the electricity works, and a prime cost clerk is to be engaged.

HANWELL: *Condition of Tramway Track.*—The District Council, at its last meeting, considered a letter from the Board of Trade on the subject of the condition of the rails and substructure of the London United Tramways in Hanwell. The letter in question enclosed a copy of a communication, which the Board had received from the company, which expressed the opinion that there were no grounds for the complaints which had been made. The tramway track in Hanwell, the company asserted ,is in good order and condition, both as to rails and paving, no expense having been spared by the company to fully maintain its obligation in this connection. The statements contained in the letter from the Hanwell surveyor concerning the condition of the track were described as being grossly exaggerated. The company's permanent way in Hanwell was in equal condition to that in Ealing at the date of the inspections, to which reference has been made. The surveyor of Hanwell refers to reconstruction work now being carried out by the company in Acton. This track was laid with 80 lb. rails and put into service in 1895. The track in Hanwell was laid with 92½ lb. rails, and put into service in July, 1901. The Acton reconstruction was undertaken because it was considered by the company to be necessary, and was not the result of any pressure whatever." It was agreed to inform the Board of Trade that the company's letter was a gross mis-statement of the facts.

HASLINGDEN: *Electricity Supply.*—The negotiations between the Council and the Rawtenstall Urban District Council with regard to electricity supply have failed, and the Haslingden Council will now erect a separate generating station. Arrangements have been come to, however, with regard to tramway running powers over the lines in the respective districts.

HEBBURN: *Tramways.*—The Urban District Council has been informed by the Gateshead & District Tramways Co. that the company does not see its way clear at the present time to undertake the necessary expenditure for extending their system to Hebburn, but should the Council obtain the necessary powers and construct the lines, the company will be willing to work the extension under a lease.

HESTON AND ISLEWORTH: *Electricity Profits.*—A report has been issued by the Clerk of the Council, giving some particulars of the electricity undertaking. It appears that the loss for the first three years working amounted to 11s. 10d., and a profit of £237 is anticipated for the current year The report calculates that under private management the results would have justified the payment of a 5 per cent. dividend, and the placing of a substantial sum to depreciation account.

HULL: *Telephone Undertaking.*—During the past year, 257 additional instruments have been fixed in connection with the telephone undertaking. The number added during the last three months has been 170, which is a record increase for any quarter since the undertaking was first started.

LEEDS: *Proposed Tramway Extensions.*—The Tramways Committee has promised to consider a proposition by the Farsley Urban District Council that the Leeds Corporation Tramways should be extended from Rodley to Farsley.

LIVERPOOL: *Workmen's Trams.*—Mr. C. W. Mallins, the Traffic Manager, has prepared a report upon workmen's tram fares in Liverpool in consequence of a suggestion that the present facilities should be extended. The report points out that the receipts between 4.30 a.m. and 8 a.m., when the service is chiefly operated for workmen, was less per car mile by 2·28d. than during the other hours of the day, and the comparative loss per annum is £914 over actual working expenses. If the earnings were equal to the remaining portion of the day, a sum of £6,090 per annum would be received, and adding this to the loss of working expenses, there was a total loss on the workmen's traffic of £7,004 per annum. London, Glasgow, and Bradford all report a loss on workmen's fares, and to extend the system in Liverpool to include school children would mean an increase of rolling stock, the cost of which, says Mr. Mallins, would probably turn the small margin of profit on the undertaking into a loss.

LLANDUDNO: *Sunday Trams.*—The shareholders of the Llandudno Tramways Co. have decided to support an application to the Llandudno Council for permission to run the cars on Sundays.

LONDON: *London County Council.*—At the weekly meeting on Tuesday last, Mr. Hayes Fisher, in moving that the report of the auditors on the tramways accounts be received, said that though the report showed conclusively that the tramways had never earned a legitimate penny of profit, he thought that they would be able gradually to write out the losses on the horse tramways, build up a renewal fund, and pay a proper proportion of the establishment charges. The development of tramways in parts of London where they would not pay, and any yielding to improper pressure to reduction in fares, must be guarded against. Mr. McKinnon Wood did not see why the losses on the displaced assets of the horse system should have to be met from the working charges of the undertaking. The Metropolitan Railway had been paying a little, but had not written off its old lines. They (the Council) had followed the practice of other municipal corporations (for instance, Liverpool) who had tramways, and he denied that they were being judged on commercial lines.

London County Council: Tramways.—In a report by the Highways Committee, it is stated that among tramway works to be undertaken during 1908-9, is now included the reconstruction of the lines transferred to the Council from the South London Tramways Co., namely, (1) from Nine Elms via Wandsworth Road, Lavender Hill, and St. John's Hill, to East Hill Wandsworth, and (2) from Lavender Hill, via Queen's Road, Battersea, to Chelsea Bridge. An estimate of £7,000 in respect of the removal, lowering, or diversion and mains, pipes, wires, &c., along the first-named route has already been sanctioned, as also have estimates for the reconstruction of the lines for the underground conduit system. It is now proposed that the tramways in Queen's Road should also be constructed for the same system, and the estimate for this route, which is about 1¼ miles long, double track, is as follows:—track work, &c., including special work, £7,100; for rails, £46,500; cables, &c., £1,223; cable ducts, &c., £1,040; rolling stock, £4,250; making a total of £53,013. Owing to the low headway of certain railway bridges which cross Queen's Road, it will only be practicable to run single deck cars on this route.

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Battersea.—The Borough Council, after having taken the advice of counsel, have decided to defend an action brought by Messrs. Mather and Platt, Ltd., for £800, the price of a spare armature, and to make a counterclaim. The dispute arises out of the firm's contract for the supply of steam generating plant.

Hackney.—On January 23rd, the Borough Council adopted a scheme drawn up by the Electrical Engineer, for a hire-purchase installation system. A joint report of the Town Clerk, the Borough Electrical Engineer, and the Borough Accountant was circulated this week in regard to the financial arrangements for the scheme. The Council have power to borrow for this work, but in the opinion of the joint authors of the report it will be better to defer as long as possible the taking up of short loans. They therefore suggest that for the present this branch of the undertaking be financed by the uninvested surpluses of the electricity undertaking.

Hampstead: London Electric Power Bills.—The General Purposes Committee report having instructed the Town Clerk to communicate with the member of Parliament for the Borough, with a view to his opposing the motion to refer the London Electric Supply Bill and the London and District Electricity Supply Bill to a joint committee of the House of Lords and the House of Commons, when the same comes before the House of Commons, as the Committee are of opinion that the opposition of the borough councils to the two measures would be more likely to receive a sympathetic hearing from a Committee of the House of Commons than from a joint committee as proposed.

Shoreditch: Tramway Dangers.—The Borough Council has decided to call the attention of the London County Council to the possibility of danger arising from the congestion of tramway traffic in Kingsland Road. It is proposed to ask the County Council to receive a deputation on the question of widening the road in question.

Stoke Newington.—On the 17th inst., the Borough Council considered resolutions passed at an informal conference of representatives of Metropolitan Borough Councils who are electric lighting undertakers, to the effect that steps should be taken to formulate a scheme for the development of the electricity supply of London by a combination of existing undertakings. It was resolved to reply that in the opinion of Stoke Newington Council it was undesirable that a bulk supply should be provided at the risk of the rates, and that the promotion of any such scheme should be left to private enterprise subject to proper provision being made for purchase by the Local Authority at a reasonable price.

MONMOUTH: *The* £10,000 *Loan.*—Having borrowed £10,000 from the local bank on the security of a local nobleman for the electric lighting works, and the Local Government Board having objected to the rates being used for payment of the interest on this sum, the Corporation has applied for an extension of their borrowing powers to the amount in question as a way out of the difficulty. Mr. J. F. Willis, of the Local Government Board, held an inquiry into the matter last week, when it was stated that the total indebtedness to the bank is £10,533, but there are a few assets available, which will reduce this sum to about £9,000.

OXFORD: *Tramway Position.*—With reference to the arrangements come to between the Oxford Tramways Co. and the National Electric Construction Co., mentioned in our last issue, it appears that the shareholders of the existing company will get a return of 72 per cent. of their capital, 60 per cent. of which will be paid in cash, or 4½ per cent. mortgage debentures, and the remaining 12 per cent. in cash or ordinary shares.

QUEENBOROUGH: *Electric Lighting.*—The Sheerness & District Electric Power & Traction Co. are to be asked to revise their charge for electricity. In event of a refusal, the Council threatens to consider the advisability of using another form of power in connection with the water undertaking.

RAWMARSH: *Dolter Surface Contact System.*—At the last meeting of the Urban District Council, the Town Clerk reported a correspondence with the Mexborough & Swinton Tramways Co., with reference to the many complaints that had been made as to the danger arising from live studs on the tramway system. As a result of negotiations between the Mexborough, Swinton & Rawmarsh Councils, a conference has been arranged between their representatives and the managers of the tramway company, at which certain suggestions made by the latter will be considered.

ROCHDALE: *Tramway Assessment.*—The Tramways Committee has lodged an appeal against the assessment of the tramways, and a deputation has been appointed to wait upon the Assessment Committee with a view to a settlement.

ST. ANNE'S-ON-SEA: *Charges for Electric Lighting.*—The local Tradesmen's Association is approaching the Urban District Council for a reduction in the charge for electricity to private consumers. The present rate is 5½d. per unit.

SANDOWN (I.O.W.): *Electric Lighting.*—A meeting of the ratepayers was recently convened for the purpose of considering whether the public electric lighting should be continued or whether there should be a reversion to gas lighting. A resolution to continue the electric lighting was carried by 155 votes to 57. Mr. A. E. Mayes, Chief Electrical Engineer to the Isle of Wight Electric Light and Power Co., was present, and a somewhat spirited discussion took place between him and the representative of the local gas company.

SOUTHAMPTON: *Tramway Receipts.*—The estimate for the working expenses upon the tramway undertaking last year were £35,249, but the actual expenses were £35,517. The actual income, on the other hand, was £54,365, an increase of £3,289.

WALTON-LE-DALE: *Electric Lighting Order.*—A communication having been received from the Board of Trade with reference to the Electric Lighting Provisional Order, granted to the Council in 1904, the Clerk to the Council has been instructed to inform the Board that no steps have been taken to put this into force, and asking for an extension of time.

WEST HAM: *Tramway Matters.*—The Electric Lighting and Tramways Committee has adopted the recommendation of the Tramways Manager (Mr. H. E. Blain) that the extension of the Barking Road tramway to the Iron Bridge, Canning Town, the estimated cost of which, after allowing credit for the old materials, is approximately £2,600, be now proceeded with. The Tramways Manager has been informed by the Chief Officer of the London County Council tramways that the L.C.C. has not arrived at any decision with regard to extending their present terminus at Poplar to the county boundary. A communication is to be addressed to the L.C.C. inquiring whether, pending the latter authority dealing with their own extension in the East India Dock Road, they would be willing to construct their permanent way from the boundary with West Ham westwards to the foot of the Bridge approach (the portion in question not involving any widening), and, subject to the Poplar Council not objecting, allow the line to be temporarily equipped on the overhead trolley system, and run by West Ham upon terms to be agreed. The Electric Lighting and Tramways Committee have decided that the practice of allocating the anticipated surplus on the Tramways Revenue account to the relief of the rates be discontinued, and that the disposal of such surplus be left over until the amount is ascertained at the close of each year.

WOOD GREEN: *Electric Lighting.*—The North Metropolitan Electric Power Supply Co. has made an offer to the Urban District Council for an electric lighting scheme, which is now under consideration. The cost of the Council's electric lighting Provisional Order up to date is £1,200.

YARMOUTH: *Tramways Electrical Energy.*—The electricity committee is to be asked to reduce the charge of 1¾d. per unit now made for the supply of energy to the tramways.

TENDERS INVITED AND PROSPECTIVE BUSINESS

AUSTRALIA: *Melbourne.*—Tenders are invited for the supply of 30½ miles of bare hard-drawn copper cables. Particulars from Messrs. Mellwraith, McEacharn & Co., Proprietary, Ltd., agents for the Melbourne City Council, to whom tenders by April 7th.

BOSCASTLE.—A scheme for electric lighting is before the Council. The estimated expenditure is to be only £1,000, and there is a strong feeling that a local company should be formed.

BUXTON.—The Local Government Board has sanctioned a loan of £965 for electric lighting purposes.

DORKING.—A Local Government Board inquiry was held last week into the application of the Council to borrow £1,160 for the electric lighting undertaking.

EDINBURGH.—Tenders are invited for the wiring and fittings for electric supply at the Public Washhouse, Simon Square, Edinburgh. Full particulars from Mr. F. A. Newington, Electricity Supply Station, Dewar Place, and tenders to the Town Clerk by April 1st.

FAREHAM.—The Urban District Council has decided to make an application to the Local Government Board for a loan of £10,000, for the purpose of erecting a new generating station. Messrs. May & Hawes, the consulting engineers, estimate that the cost of carrying out the scheme would be £9,300. The scheme includes two 80 kw. generating sets and one 40 kw. generating set, two 120 b.h.p. Diesel engines, and one 60 b.h.p.

FARNWORTH.—The District Council have decided to enter into an agreement with the Lancashire Electric Power Co. for the supply of current in bulk. Application has been made to the Local Government Board for sanction to borrow £7,000 for the erection of a sub-station.

GLASGOW.—The Tramways Department invite tenders for the following during the year ending May 31st, 1909:—Axles, steel tyres, and steel wheels; fuel for depôts; fuel for Pinkston power station; chilled iron brake blocks, car wheels, &c.; carbon brushes; V.I.R. cables; cartage; cast-iron castings; malleable iron castings; cast-steel castings; granite and whin metal and chips; plumbers' material; indiarubber and asbestos goods; springs; tiebars; water, gas, and steam tubes, &c.; galvanised wires; tool steel. Full particulars from the General Manager, 46 Bath Street, and tenders to the Town Clerk by April 6th.

GILLINGHAM.—A Local Government Board inquiry was held

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last week into the application by the Council for sanction to borrow £5,000 for the electricity works. There was considerable opposition.

HANLEY.—The application to the Local Government Board for sanction to borrow £18,000, is to be amended so that the amount shall be £21,969, which will cover the estimated capital requirements for the next eighteen months.

HESTON & ISLEWORTH.—The District Council has decided to provide a new feeder cable for the Hounslow district covering a distance of about 2,000 yards at an estimated cost of £1,400.

HOLYWOOD.—A scheme for electric lighting is now under consideration by the Council.

LANCASHIRE.—We understand that the Earl of Ellesmere, Clifton & Kersley Coal Co., Wigan Coal & Iron Co., Ltd., Messrs. Pearson & Knowles Coal & Iron Co., Ltd., and other powerful colliery concerns in south and south-east Lancashire, are about to introduce electrical coal-cutting machines into certain of their collieries.

LANCASHIRE & YORKSHIRE RAILWAY.—Tenders are invited for stores during the twelve months ending April 30th, 1909, including signal and telegraph fittings and telephonic and electric light wires. Full particulars from Mr. Waring, Stores Department, Osborne Street, Manchester, and tenders to the Secretary by March 30th.

LEEK.—Tenders are invited for engine, dynamo, and other foundations and extensions at the generating station buildings. Full particulars from the Surveyor to the Council, fee £2 2s., returnable, and tenders to the Chairman of the Electricity Committee by April 10th.

The Council invite tenders for gas-producer plant and a gas-driven generator. Full particulars from the Electrical Engineer, and tenders to the Chairman of the Electricity Committee by April 11th.

LONDON: *Poplar.*—The Electricity Committee invite tenders for the supply of various switchboards and gear at the electricity works and sub-stations. Particulars from the Electrical Engineer, and tenders to the Town Clerk by April 29th.

PARTICK.—The Town Council invite tenders for the supply of stores for the electricity department during the year ending May 15th, 1909, including cables, meters, service cut-outs, incandescent lamps, arc lamp carbons, &c. Particulars from the Electrical Engineer, to whom tenders by April 4th.

PERTH.—A new cable is to be laid from High Street Port to the top of old High Street, at an estimated cost of about £150.

SALFORD.—Tenders are invited for the following stores during the year ending March 31st, 1909:—Cables, cable accessories, bitumen, cable conduits and pipes, wood troughing and bends, house service cutouts, meters, demand indicators, ammeters (gravity type), circuit breakers and ironclad switches, steel conduits for electrical wiring, electrical fittings and arc lamp globes and motor carbons, glow lamps, arc lamp carbons, electric motors, motor starting resistances, iron castings, brass and gun metal castings, iron and steel bars, plates, &c.; ironmongery, wrought-iron tubes and fittings. Specification, &c., from the Borough Electrical Engineer, Mr. V. A. H. McCowen, Electricity Works, Frederick Street, Pendleton, and tenders to the Town Clerk by March 30th. (See an advertisement.)

SUNDERLAND.—Tenders are invited for the supply of stores in connection with the Tramways Department, including general electrical and car supplies and overhead line material. Particulars from the General Manager, Mr. A. R. Dayson, and tenders to the Town Clerk by April 9th.

WEYMOUTH.—Tenders are invited for (1) a 300-kw. steam turbine and direct-current generator, surface-condensing plant, and (2) extension switchboard panel for same. Full particulars from the Consulting Engineers, Messrs. Kennedy & Jenkin, 17 Victoria Street, London, S.W., and tenders to the Town Clerk by April 18th (see advertisement this week).

TENDERS RECEIVED AND ACCEPTED

AUSTRALIA.—The D.P. Battery Co. have received an order for a battery for telegraph work from the Commonwealth Government of Australia, and a repeat order for additional cells for their battery from the Bunbury Electric Light & Power Co. of Western Australia.

BECKENHAM.—The following tenders have been accepted by the Council:—New battery house, Messrs. W. H. Hyde & Co.; cable trough, Mr. H. R. Mansfield; engine and cylinder, Messrs. C. C. Wakefield & Co.; crank chamber oil, Messrs. Englebert & Co.

BRISTOL DOCKS.—The Docks Committee has placed an order with Johnson & Phillips, Ltd., for complete installation of cable, switchgear, arc lamps, &c., for Avonmouth Docks.

CROYDON.—The Board of Guardians has accepted the tender of Messrs. Pryke & Palmer for the supply of electrical fittings and appliances.

DAVY ARC LAMPS.—Arc Lamps, Ltd., have just received a large order from Messrs. J. Walsh, Ltd., of Sheffield, for 164 of their flame and enclosed arc lamps for lighting their premises. Some eight years ago Messrs. Walsh took alternating current from the Sheffield supply, and 150 Davy arc lamps were installed. The order for 164 lamps, however, is an extension of the lighting in consequence of Messrs. Walsh having decided to instal their own plant, and intend running all the lamps on direct current.

HESTON AND ISLEWORTH.—The District Council have accepted the following tenders for annual supplies for the electricity department:—W. T. Henley's Telegraph Works Co., cables, disconnecting and house-service boxes, and compound. British Insulated & Helsby Cables, house fuse boxes. A. Duckham & Co., engine oil, 1s. 3d. per gallon; cylinder oil, 1s. 8½d. Middleton Bros., castor, 2s. 6d.; resin, 1s. 6d.; rape, 2s. 9d.; sperm, 2s. 9d.; linseed, 2s.; boiled oil, 2s. 1d.; Russian tallow, 5d. per lb. W. Sparrow, paraffin oil, 5½d. per gallon. Geipel & Lange, carbons, £3 7s. 6d. per 1,000. Leeds Contract Co., earthenware troughs (square), £1 6s. 6d. per 100; earthenware troughs (U-shaped), £1 per 100; hard burnt tiles (various sizes), £2 0s. 6d., £3 4s. 6d., £2 5s. 9d., and £1 8s. per 1,000.

HUCKNALL COLLIERY.—An order has been placed with Johnson & Phillips, Ltd., for the supply and erection of three-phase H.T. overhead transmission line.

MANCHESTER.—The Corporation have placed an order with Johnson & Phillips, Ltd., for supply and erection of three-phase transformers for one of their sub-stations.

LONDON: *Battersea.*—The Borough Council has provisionally accepted the tender of Appleby's, Ltd., to carry out works to the crane at the central generating station, so as to enable it to work longitudinally by electricity in lieu of by manual labour as at present, for the sum of £124 10s.

Islington.—The Borough Council has accepted the following tenders in connection with the electricity department:—Boilers for extension at the generating station, Babcock & Wilcox, £10,694; turbo-generator, Willans & Robinson, £8,968. Tenders were also accepted for the supply of coal at prices ranging from 11s. 4d. to 12s. 4d. per ton.

Islington.—The Board of Guardians has accepted the tender of Pryke & Palmer for the annual supply of electrical fittings and sundries.

RAWTENSTALL.—The Corporation have just entered into contracts for a generating station, equipment, part of the main cables for the electric tramways, &c., involving expenditure of £41,051.

YARMOUTH.—The tender of the British Griffin Chilled Iron and Steel Co., Ltd., has been accepted for forty steel tyres at 35s. 6d. each.

COMPANIES' MEETINGS AND REPORTS

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY.—The report for the year ended December 31st, 1907, states that the capital expended during the year amounted to £31,[illegible], making the total expenditure to date £421,198. The net revenue, including £1,634 brought forward from last accounts, amounts to £33,506. Deducting interest on debenture stock, interim dividends, leasehold and special redemption funds and interests, £1,423, and amount carried to reserve for depreciation, repairs, renewals, &c., £5,000, there remains £13,229 for distribution. The directors recommend a final dividend on the ordinary shares for the half-year ended December 31st, 1907, at the rate of 9 per cent. per annum, less income tax, leaving a balance of £938 17s. to be carried forward. The total applications received at December 31st last amounted to the equivalent of 184,841 30-watt lamps (5,545 kw.), being an increase of 25,150 for the year. The total number of Board of Trade units sold for all purposes was 2,860,534, being an increase of 251,057 for the year. The boiler-house at the company's Bourne Valley station has been reconstructed, and additional boilers installed during the year. The business of the Richmond (Surrey) Electric Light & Power Co., Ltd., continues to be satisfactory. A dividend at the rate of 7 per cent. has been declared on the ordinary shares of that company in respect of the year ended December 31st last.

At the annual meeting on Thursday, the report and accounts were adopted. Mr. A. H. Sanderson, the Chairman, who presided, said he thought the result of the year's trading must be regarded as satisfactory, for in spite of the fact that there had been several adverse factors to contend with, there had been a record increase in every department. The expenditure upon capital account during the year—namely, £31,030—had been chiefly on account of mains, buildings, and machinery. The total receipts for the year had increased by £4,652, and so long as their revenue showed this rate of increase they would have nothing to complain of. This increase, however, would have been much better but for the reduction made last year in the

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rate charged by them for electrical energy supplied to the Bournemouth Municipal Tramways. The equivalent number of 50-watt lamps applied for to December 31st last showed an increase of 26,130, which was a record in the company's history, whilst the units sold increased by 251,037. Since January 1st, 1908, the units sold were 73,916, an increase of 17 per cent. over the corresponding period of last year. The total number of consumers up to date was 4,042, an additional 71 having come on to the mains since January 1st. With a view of keeping their business prominently before the public, considerable improvements had been made at Verulam House, Bournemouth, where the local offices and central transformer and distributing stations were situated. These improvements consisted of elaborate decorations in front of the buildings, providing the means of showing the latest designs and appliances for electric lighting, heating, and cooking.

BRITISH INSULATED & HELSBY CABLES.—At the annual meeting in Liverpool on Monday, Mr. E. K. Muspratt presiding, the report and accounts given in our last issue were adopted. The chairman stated that the orders on the books were very satisfactory, and the conditions obtaining last year, namely, the high price of copper and the tightness of the money market, had now changed.

CITY OF LONDON ELECTRIC LIGHTING.—Mr. J. B. Braithwaite presided at the ordinary general meeting on Wednesday last week, when the report and accounts given in our last issue were adopted. He stated that the capital expenditure during the year had amounted to £39,710, and that the capital account now stood at £291,671. Prior to December 31st, 1906, they had written off, out of revenue, £129,077 from capital account, and seeing that, in addition, they had reserves amounting to over £300,000, he thought the shareholders would agree with him that they were in a very sound position. In addition to paying a dividend of 6 per cent. for 1907, they had applied about 7½ per cent. on their ordinary stock towards strengthening the company's reserves in various ways. The net revenue showed an increase of £12,775, in spite of the fact that the sales to the London County Council tramways in 1906, which amounted to £5,518, did not appear in the accounts for 1907. Further, in spite of the higher cost of coal, their works costs had been reduced by 0·2d. per unit. With regard to the London electric power question, he thought the position was now more satisfactory than it was two or three years ago. He regarded the idea that London was in need of a cheap supply of electricity as fallacious and a myth. Last year they had sold over six million units for power purposes, whilst the County of London Co., in 1907, sold more than half its entire output for power purposes. The Board of Trade return, published in December, showed that no fewer than 66,287,518 units were sold by companies and local authorities in London for power and heating purposes at an average cost of about 1½d. per unit. He maintained there was no demand for a new bulk supply company, and that the existing stations of local authorities and companies were quite capable of improving the electric supply for the metropolis. He was pleased to see the President of the Board of Trade was making an endeavour to treat this as a business problem, and not as one of party politics, and the Board of Trade would render great service to London if it would take the initiative by calling a conference of all parties concerned. At a subsequent special meeting the promotion of the London Electric Supply (Joint Committee) Bill was confirmed.

DIRECT SPANISH TELEGRAPH.—At the annual meeting on Thursday, the report and accounts, given in our last issue, were adopted. Lord Tweeddale, referring to the interruptions to the company's cables, said that the cost of repairing the Bilbao cable—namely, £3,294—had been charged to revenue. He also pointed out that the depreciation of the company's securities, which a short time ago amounted to 16 per cent., had now been reduced to 14 per cent.

LIVERPOOL DISTRICT LIGHTING.—The report for the year ending December 31st, 1907, states that the directors have to record with regret the death of another of their colleagues, Mr. Harold Cunningham, one of the original founders of the company, and, until his last illness, one of the most active workers in promoting the interests of the company. The demand for electricity still shows a satisfactory rate of increase, the units sold for the year amounting to 354,750 units, an increase of 13,325. Owing, however, to the increased cost of fuel and other causes, the resulting profit has not increased *pro rata*. The balance-sheet shows that the value of the "free wired" installations is less than at the corresponding period of last year. This is accounted for by the fact that the directors have decided not to carry out any more of this work, as practically all the houses now being built in the company's area are wired for the electric light during construction. Two of the old installations have been purchased outright, and one written off. The equivalent number of 16 c.p. lamps supplied at December 31st, 1907, was 24,281, an increase of 2,530 during the year. Owing to the continued expansion of the business, it will shortly be necessary to lay down additional boiler plant to provide for the supply next winter, and this matter is having the careful attention of the directors. The gross profits for the year, together with the amount brought forward from 1906, after payment of dividend, leaves a profit available for distribution of £2,315. Of this £20 has been written off the cost of fitting up the offices in Tithebarn Street, and £835 set aside for depreciation, leaving a balance of £1,461, out of which it is proposed to declare a further dividend at the rate of 5 per cent. per annum, less income tax, for the half-year ending December 31st, 1907. The meeting was held yesterday.

LLANDUDNO & COLWYN BAY TRAMWAYS.—Mr. Stephen Sellon presided over the annual general meeting of this company in London on Monday. The accounts show that the expenditure on construction has amounted to £88,218, and closely approximates to the estimates. The number of passengers carried during the year was 174,654, and the average fare per passenger was 2d. About five miles of lines are at work, and the total receipts worked out to 8d. per car mile. The chairman stated that he personally considered the results very satisfactory. The capital issued to date is £99,400. The delay in the construction of the Colwyn Bay section has been due to a difference of opinion with the local authorities as to the material to be used for paving. This matter, however, has been satisfactorily adjusted by the Board of Trade, and the structural work upon the extension has been commenced at both ends. The report and accounts were adopted.

MELTON MOWBRAY ELECTRIC LIGHT.—The report for the year ending December 31st, 1907, states that the lamps connected during the year increased from 16,391 to 17,528. The total number of consumers is now 535. Including the balance of £80 brought forward from last year, the accounts show a net profit of £2,014. After payment of debenture and loan interest, £1,041, writing off the last instalment of £81 in respect of the exhibition expenses, and £75 depreciation and loss on wiring account, there is a balance of £816. The directors recommend that a dividend be declared at the rate of 2 per cent. per annum, which will require £400; that £400 be placed to reserve for renewal of plant, and the balance, £16, carried forward to next year's account. The report and accounts were adopted at the meeting recently.

NEWMARKET ELECTRIC LIGHT.—The report for the year 1907 states that the equivalent of 989 8-c.p. lamps were connected during the year, making the total connections equivalent to 22,713 8-c.p. lamps. Applications for the equivalent of a further 383 lamps have been received during the present year. It has been found necessary to install an additional generating set to the engine-house plant, and the total cost, including buildings, is estimated to be £2,000. In order to meet this liability, it is proposed to raise new capital. The profit on the year's working, together with the sum brought forward from the previous account, amounts to £2,672. Debenture interest absorbs £710, and out of the balance the directors recommend a dividend of 5 per cent., carrying forward £600. The report and accounts were adopted at the annual meeting last week.

NORTH METROPOLITAN ELECTRIC POWER DISTRIBUTION.—At the ordinary general meeting on Tuesday last, Mr. James Devonshire presiding, the report for the year 1907 was adopted. An extraordinary general meeting was held subsequently, in which a resolution to increase the capital to £100,000 by the creation of 5,000 new shares of £10 each was adopted.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY.—The report for the year 1907, a summary of which was given on page 458 of our last week's issue, was adopted at the meeting of the company on Tuesday last. Sir Ernest Spencer, who presided, said that the increased output was due to the opening up of new lines by the Metropolitan Electric Tramways Co., the larger supply to the Willesden and Stoke Newington Councils, and to the increased output by the Distribution Company at Barnet, Hertford, and Enfield. From the commencement of 1908, a bulk supply had been given to the Hendon Electric Supply Co. The increase in expenses was mainly due to the higher price of coal.

SALISBURY ELECTRIC LIGHT & SUPPLY.—The report for the year ended December 31st, 1907, states that the company continues to make progress. During the year the number of consumers has increased from 983 with 31,769 lamps connected to 1,012 with 33,560 lamps connected. The profit on the year's working, including £59 brought forward from last account, amounts to £5,332, and after paying £1,448 18s. interest on debentures and temporary loans, an interim dividend at the rate of 4 per cent for the half year, amounting to £700, and writing off £125 from exhibition account, there remains a balance of £3,059 to be dealt with. The directors recommend that a further dividend at the rate of 7 per cent. for the half year be paid, making, with the interim dividend, 5½ per cent. for the year, and that £1,500 be carried to reserve, leaving £334 to be carried forward to next account. At the meeting recently the report and accounts were adopted.

VICKERS, SONS & MAXIM.—At the annual meeting on Thursday, the report and accounts, given in our last issue, were adopted.

WINCHESTER ELECTRIC LIGHT & POWER.—The directors' report for the year 1907 states that the equivalent of 3,214 8-c.p. lamps have been added during the year, making the total connections at the end of the year 54,491 8-c.p. lamps. Including the balance of £299 brought forward from last year's account, the statement shows a net profit of £7,221, which, after payment of debenture and loan interest, £2,050, and writing off

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£79, balance of the cost of the Electrical Exhibition, leaves a balance of £5,092 2s. 6d. available for distribution. An interim dividend for the half-year at the rate of 5 per cent. per annum, amounting to £1,105, was paid in September last, and the directors now recommend that a dividend at the rate of 7 per cent. per annum be declared for the half-year, which will absorb £1,547 16s. 6d., making 6 per cent. for the year; that £1,500 (instead of £1,000 as last year) be placed to depreciation account, and that £627 be placed to reserve fund account, leaving a balance of £313 to be carried to the next account. At the meeting recently the report and accounts were adopted.

YORK TRAMWAYS.—At the half-yearly meeting last week the Chairman stated that the Corporation are now awaiting the confirmation by the Board of Trade of the order recently granted by the Light Railways Commissioners for the extension and conversion of the tramways to electric traction. When this confirmation was received, which might be expected in the course of the next two or three months, the Corporation would under their agreement purchase the company's undertaking.

PARLIAMENTARY INTELLIGENCE

LONDON COUNTY COUNCIL (TRAMWAYS AND IMPROVEMENTS) BILL.—Lord Sanderson presided over a Committee of the House of Lords which had this Bill under consideration on Wednesday last week. Mr. Erskine Pollock, K.C., who appeared for the County Council, said there was only one opposition, viz., the Southwark Borough Council, which asked for the insertion of a clause giving them compensation for the removal of a convenience near Blackfriars Bridge Road on the line of route of tramway No. 7, which connected Blackfriars and Southwark Bridges on the southern side. It was proposed to construct a convenience elsewhere with the amount awarded as compensation, but as this method of procedure would be outside the notices, there was a danger of the Bill being thrown out on Standing Orders, and consequently the County Council could not agree. The committee decided not to insert the clause asked for, and the Bill is proceeding unopposed.

MOTHERWELL BURGH (EXTENSION) BILL.—This Bill has been before a Committee of the House of Commons during the week, presided over by Mr. Luke White. The main object of the Bill is to extend the burgh boundaries so as to include certain districts now outside, which are developing into industrial areas, and which are bound up with the trade of Motherwell. Incidentally, the Bill proposes to extend the limit of electric supply to the new area, and to this there is a certain amount of opposition, objections having been deposited by the Clyde Valley Electrical Power Co. and the Lanarkshire Tramways Co.

PROGRESS OF ELECTRICAL BILLS.—The West London, Barnes & Richmond Tramways Bill, and the London Motor Roadways Bill, are down for second reading in the House of Lords on April 2nd.

The London United Tramways Bill was read a first time in the House of Commons on Thursday.

The Wishaw Borough Electricity Bill has been referred to the unopposed Committee in the House of Commons.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION BILL.—This Bill was before a Committee of the House of Lords, presided over by Lord Wenlock, on Friday. Mr. H. Lloyd, K.C., on behalf of the promoters, first gave the history of the company, and, dealing with the present position, said that a total capital of £800,000 had been raised, a quarter of which was in debentures. The situation was that the whole of the company's resources had been exhausted, their credit was gone, and they were unable to raise any further capital. In 1907, after long negotiations, a scheme was devised which would enable the company to contine its operations, at any rate temporarily. The chief cause of the company's bad condition was that a large number of local authorities, colliery proprietors, and others had been supplied at ruinous rates. The result was that a limited company, being formed with a capital of £100,000 for the purpose of working such parts of the undertaking as could be carried on as a commercial success, but it had been found quite impossible to carry on the generating station at Neath or Brigend, and agreements had been entered into with the Urban District Councils to purchase the station at £7,000 and £3,000 respectively, although in the first place these had cost £40,000 and £30,000 respectively. One of the objects of the present Bill was to receive sanction to these agreements. With regard to the works at Treforest, a limited liability company was working the undertaking, and sanction to this arrangement was also sought, as well as to a similar arrangement in regard to the Cwmbran station. There were creditors to the extent of £85,000, and these they proposed to pay off in preference shares in the statutory company to the extent of £150 of stock for every £100 of debts. The Bill also asked for sanction to modify the existing agreement with the Rhhonda, Llanelly, Mountain Ash, Caerphilly, Abercarn, Neath, and Briton Ferry Councils, all of whom were now satisfied, and did not oppose the Bill. The debenture-holders were supporting the proposals contained in the Bill, and the only opposition was by the local authorities of Aberdare and Pontypridd, who desired to be left out of the company's area. He would conclude by saying that the scheme had been devised with the object of saving the three-quarters of a million of money invested in the undertaking, all of which would be lost if the Bill did not pass. Mr. S. Boulter, on behalf of the debenture-holders, supported the Bill, and Mr. W. A. Chamen, the general manager and engineer, gave evidence as to the progress of the company. He stated that during the whole of their difficulties the consumption of electricity had consistently increased, in spite of the loss of many of the largest consumers in consequence of the uncertainty of the company's position.

The opposition of the Pontypridd Urban District Council, who were represented by Mr. Ram, K.C., was that although they had not a Provisional Electric Lighting Order when the company was originally sanctioned, they now wished to be put in the position of those authorities owning orders—namely, that the company should not come into their area without consent. In cross-examination, Mr. Chamen agreed to give them a clause to the effect that the power company would not attempt to secure customers who took a less consumption than 30,000 units per annum.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., informs us that the price of electrolytic wire bars net c.i.f. port of arrival, quoted on Tuesday night, was £61 5s. to £61 15s. per ton (last week, £59 10s. to £60 per ton).

R. W. PAUL.—Mr. R. W. Paul, the scientific instrument maker, informs us that he has removed from 68 High Holborn, and has opened a new showroom at 33 Leicester Square, where samples of his various patterns of electrical instruments may be inspected. Customers are requested to address all correspondence to Newton Avenue Works, as heretofore.

US LAND AT TRAFFORD PARK.—We learn that one of the largest firms on this estate has decided to offer for sale, at cost price, about 50 acres of its freehold land not required for extensions.

MISCELLANEOUS CITY NOTES

BRUSH ELECTRICAL ENGINEERING CO.—A petition for confirming a resolution reducing the capital of the Brush Electrical Engineering Co., from £650,000 to £489,512, will be heard in the Chancery Division before Mr. Justice Neville on April 4th.

CHARING CROSS, WEST END AND CITY ELECTRICITY SUPPLY.—Applications have been invited during the week for £600,000 4½ per cent. debenture stock at 98. Holders of debenture bonds of the City undertaking, which fall due on January 15th, 1909, are invited to subscribe, in addition to applications from subscribers in cash. The proceeds of this issue will be applied in acquiring all or any of the £337,000 five per cent. bonds falling due as above, in payment of temporary loans secured against similar bonds to the extent of £123,000, and for the general purposes of the City undertaking. The stock now offered will be secured by a trust deed which will create a first floating charge of the City undertaking, the trust deed providing that no mortgage or charge shall be created ranking in priority to or *pari passu* with the stock, but the company is to be at liberty from time to time to issue further debenture stock ranking *pari passu* with the present issue to the extent of one half of the capital expenditure on the City undertaking. The stock falls due on January 15th, 1941, at 100 per cent., but may be redeemed previously at the option of the company, or in case of voluntary liquidation, at 102.

CITY OF LONDON ELECTRIC LIGHTING CO.—Warrants in payment of the balance of dividends for the year 1907 on this company's preference and ordinary shares have been posted.

MELBOURNE TRAMWAY AND OMNIBUS CO.—A dividend of 4½d. per share, equal to 15 per cent. per annum, for the quarter ended March 1st, has been declared.

NORTH METROPOLITAN ELECTRIC POWER SUPPLY CO.—Subscriptions have been invited during the week for 30,000 5 per cent. mortgage debentures of £100 each at par. This is part of an issue of £126,500, of which £96,500 have already been allotted. The debentures are redeemable at 105 per cent. at the option of the company after October 15th, 1914, at six months' notice. The trust deed provides that from January 1st, 1908, a sum of not less than £2,000 per annum shall be set aside out of the company's profits and invested in securities outside the company's business as a reserve fund, and the company undertakes not to realise or create a charge on this fund without the consent of the trustees for the debenture-holders.

SIR W. G. ARMSTRONG, WHITWORTH & CO.—The directors recommend a final dividend making 15 per cent. for the year on the ordinary shares, carrying forward £161,198. Although the dividend is the same as in previous years, the sum carried forward is higher by nearly £60,000.

SOUTH LONDON ELECTRIC SUPPLY CO.—A dividend of 4 per cent. is recommended upon the ordinary shares for the year 1907.

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ELECTRICAL ENGINEERING

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SUMMARY

NEGOTIATIONS are in progress for the sale of the present site and building of the Institution of Civil Engineers to the Government, owing to the projected extension of certain public offices. A scheme is on foot for the acquisition of a new and larger site, at the corner of Great George Street and Princes Street. One of the features of the proposed new building is a lecture hall with greatly increased accommodation. (Page 502.)

THE date of opening of the Electrical Exhibition to be held at Platt Fields Park, Fallowfield, Manchester, has been fixed for October 3rd, and it is to remain open until the end of the month. The preliminary arrangements are well advanced. (Page 503.)

CONSIDERABLE progress has been made with the scheme for securing adequate representation of the electrical industry at the Franco-British Exhibition. (Page 503.)

THE Dublin and Central Ireland Electric Power Bill is now before a Committee of the House of Commons, presided over by Mr. LUKE WHITE. The object of the Bill is the supply of electrical energy over portions of the counties of Kildare, King's County, and Queen's County. Gas engines will be used in connection with 500 kw. generating sets, and the utilisation of peat as a fuel. The promoters estimate that the cost of fuel will be 0·05d. per unit, which is compared with the lowest cost for fuel in England at steam generating stations, namely, 0·13d. at Newcastle and 0·19d. at Salford. It is estimated that there is sufficient peat in the area scheduled to give 35,000 h.p. for 300 years. Captain H. RIALL SANKEY, who gave evidence on behalf of the promoters, stated that whereas it was estimated that the cost of the peat would be 4s. 2d. per ton, the return by the sale of the by-products, sulphate and ammonia, would be 4s. per ton, and other minor by-products were estimated to produce a similar amount, but he did not think it would pay to instal the plant necessary for dealing with the by-products unless a load of 10,000 kw. was obtained. In this event the quantity of peat burned would result in 650 tons of sulphate of ammonia. (Page 503.)

AN article by Mr. J. B. SPARKS contains the results of an investigation made to determine the limiting economical pressures for transmission by underground insulated cables. One example is worked through in order to explain the method adopted in the investigation. On account of the increased cost of the insulation and lead covering at high pressures, and the comparatively small saving in copper obtained by further increasing the working pressure, about 25,000 volts is found to be the

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maximum economical pressure for the longest practicable distances of transmission. (Page 505.)

The inquiry before Mr. James Swinburne into the proposed electrical regulations of the Home Office was concluded on Thursday, and we give the amended regulations as they now stand. In the final speeches for the objectors, the general position was taken that although an agreement had been come to, to a large extent, upon the details of the regulations, the opinion was still held that no regulations were necessary, and that in regard to the limit of voltage, if the regulations were enforced, this should certainly be raised to 250 volts for both alternating and continuous current. In Mr. Gray's summing-up speech for the Home Office, he said that the only reason he could gather from the opposition that the regulations should not be enforced was that before it could be proved an industry was dangerous there should be a heavy toll of human life. (Page 508.)

The adoption of electrical driving at the South Crofty Tin Mines, Cornwall, has resulted in a reduction of the cost of the treatment of the product to less than half the cost when the mill was steam-driven, and has placed the undertaking, which was formerly unprofitable, on a paying basis. The tin and wolfram ores are separated magnetically, and the whole of the stamp mill and other machinery is now driven electrically. (Page 513.)

A letter from Messrs. Handcock & Dykes criticises the action of the Council of the Institution of Civil Engineers in calling a meeting to authorise a scheme in connection with the proposed new building before the matter has been fully ventilated. The correspondence on telephone matters between Mr. A. R. Bennett and Mr. H. L. Webb is continued, and a letter from the Union Electric Co. relating to no-volt releases for polyphase motors is published. (Page 514.)

The Exhibition of commercial vehicles and motor-boats now open at Olympia contains a few purely electrical vehicles, ranging from omnibuses to carrier tricycles, and several examples of petrol-electric systems as applied to motor omnibuses. (Page 515.)

The water-power plant on the Chicago drainage canal at Lockport at present consists of a group of four 4,000-kw. alternators, driven by horizontal shaft turbines, but provision is made for extensions, bringing the ultimate output up to 32,000 kw. Power is transmitted at 44,000 volts to Chicago over an aluminium line 30 miles long. (Page 517.)

A service of accumulator omnibuses is running in Philadelphia, the garage and battery-charging and repair shops adjoin the generating station, and special appliances are provided for rapidly changing the batteries. (Page 518.)

The design and use of telephone and telegraph trunk cables was dealt with by Mr. F. Tremain in a Paper read last week before the Newcastle Local Section of the Institution of Electrical Engineers. The author discussed the different arrangement of cores possible in paper-insulated lead-covered cables for various numbers of conductors, and went into the question of superimposed circuits, the extended use of which he strongly advocated. A number of practical points were brought out by the various telephone engineers and others who took part in the discussion. (Page 519.)

Some further contributions have been received to the discussion on the Paper read recently by Mr. R. K. Morcom and Dr. D. K. Morris on artificial loads for testing electric generators before the Birmingham Local Section of the Institution of Electrical Engineers, in which several forms of liquid resistance are described. (Page 523.)

Two lectures on "Standardisation" in Mechanical and Electrical Engineering respectively were delivered by Dr. R. T. Glazebrook at the Royal Institution on Thursdays, March 19th and 26th. The lecturer dealt chiefly with the historical side of the matter, but described also in some detail the work of the Engineering Standards Committee. (Page 524.)

Under Electrochemistry and Electrometallurgy attention is drawn to the patent of E. Viel, in which it is stated that aluminium can be successfully obtained from silicates. A note is also given on Dr. Kuzel's work on colloidal solutions and their application to the manufacture of metallic filaments. (Page 525.)

Under Electrical Science, in the British and American Section, appear some notes from the annual report of the Magnetic Department of the Carnegie Institution. An account is also given of Prof. J. J. Thomson's fourth lecture on "Electric Discharges through Gases," at the Royal Institution. It was shown by experiments how secondary ionisation was effected in an ionised gas under the influence of an electric field, by collision between the charged particles and the molecules of the gas, and also between the positive particles and the negative electrode. In the Papers abstracted in the Continental Section, Schild investigates the magnetic properties of electrolytic iron; Dember deals with the fatigue of photoelectric cells; Doglio determines the duration of cathode emission; and Ludewig criticises the theory of electrolytic interrupters. (Page 525.)

The signalling system employed on the newly-opened Hudson River tunnels is of the automatic electrically-worked type. Self-acting train-stops are provided, and at junctions, &c., illuminated track diagrams are used. (Page 526.)

Amongst the Patent Specifications published last Thursday are two by R. A. Fessenden, the first of which describes an improved receiving system for selective wireless telegraphy, and the second of which relates to a method of wireless signalling in which the magnetic component of the electromagnetic waves is used instead of the electrostatic component. In this system, no vertical antenna is required. The British Thomson-Houston Co has one relating to magnetic wedges constructed of iron wire, and another describing an improvement in their system of control for petrol-electric vehicles. A specification by Griffiths and Bedell relates to an improved form of cable for the "G.B." surface-contact system of electric traction. (Page 527.)

The Mexborough, Swinton, and Rawmarsh Urban District Councils are considering the possibility of substituting the overhead trolley system for the Dolter system now being used in their districts. An arrangement has been come to for a supply of electrical energy to be given in Port Glasgow by the Greenock Corporation. A proposition to reduce the number of street arc lamps in certain streets in Newcastle is reported upon adversely by the Tramways Manager and the Lamps Inspector. The new electric lift on the East Cliff at Bournemouth is now in operation. (Pages 529 and 530.)

Derby Electric Lighting Committee estimate their capital requirements during the coming financial year at £7,500. A Local Government Board inquiry has been held at Wimbledon with regard to a loan of £21,000 for electric lighting purposes. Wallasey Council requires automatic overload and reverse-current single-pole circuit-breakers; and the Limerick Council invites tenders for stores. (Page 531.)

Both the South Wales Electrical Power Distribution Bill and the North Metropolitan Tramways Bill were passed by a Committee of the House of Lords last week. The London and Windsor Motor Roads, Tramroads and Tramways Bill has been abandoned. (Page 533.)

The half-yearly report to December, 1907, of Messrs. Willans & Robinson shows a profit at Rugby of £22,946.

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and a loss at Queen's Ferry of £3,128. For 1907 the South London Electric Supply Corporation is able to distribute £15,479, after meeting depreciation and interest on debentures. (Page 534.)

The present position with regard to the proposed Home Office Regulations as to the use of electrical energy in factories is decidedly peculiar. While still protesting against the imposition of any regulations at all, a Committee of objectors—representing practically every supplier of electrical energy, a number of large electric power users, and the Chambers of Commerce—have been compelled to discuss the regulations already drafted, and to agree provisionally on an amended code which will probably be adopted by the Home Office without much further adjustment if the threat of imposing regulations is put into execution. We publish the amended draft in full this week, and it will be seen that the alterations in form are considerable. Where previously certain precautions were ordered to be taken in every factory in which electricity is employed, some of these safeguards are now only to be introduced compulsorily "where necessary to prevent danger," and other requirements are to be followed "so far as is reasonably practicable." But, although the amendments have certainly relaxed the stringency of the regulations, there is no doubt that the regulations are still in a form likely to give a considerable amount of annoyance and vexation to the supplier and user of electrical energy. We cannot but think that, throughout the detail work of revision, the method that would be employed for enforcing the regulations has not been kept sufficiently in the foreground.

Apparently it is proposed by the Home Office that the existing staff of factory inspectors are to have electrical inspection added to their duties. The rank and file of factory inspectors can perhaps best be classified as highly intelligent, polite, and observant machines. They are not necessarily engineers, and they are certainly not electrical engineers: probably not one factory inspector in ten knows the difference between an electrostatic voltmeter, a no-voltage release, an isolating link, and a transformer. Such men are doubtless eminently capable of seeing that rules as to "fencing" of machinery, the size of workshops, posting-up of regulations and copies of Acts, and similar requirements easy of interpretation are carried out, but they are certainly not able to form judgments on highly technical questions. Yet in the draft electrical regulations as amended the words "so far as is reasonably practicable" and "if necessary to prevent danger" constantly recur, and it is presumably the well-meaning, but in this respect inexperienced factory inspector who is to decide whether each particular precaution is "reasonably practicable," or whether it is "necessary to prevent danger" in the particular case before him. We will imagine a factory inspector of the old school entering an electrically-driven works armed with this code of regulations. He will possibly start conscientiously at Definition 1, and ask for a hot-wire or electrostatic voltmeter to enable him to ascertain whether the pressure is "low," "medium," "high," or "extra high." On being told that there is no such instrument on the premises, he will read through the regulations, and, finding that the provision of such an instrument is not obligatory, will perhaps pass on to another definition and ask to be shown all the "conductors" on the premises, in order that he may see whether they comply with Regulations 1 and 2. He will possibly be told that most of the conductors are in pipes and inaccessible for inspection, and will again wonder when he finds that there is nothing in the regulations forbidding the concealment of conductors in pipes or within walls. Yet this man will have to decide whether all apparatus and conductors are "sufficient" in size and power for the work they are called upon to do, and whether they are protected "so far as is reasonably practicable." He will have to pass judgment as to whether every switch, circuit-breaker, or isolating link is constructed and placed "so as to prevent danger," and whether portable insulating stands, screens, boots, or gloves are "necessary," and, if so, whether those in use are "of such size, quality, and construction, according to the circumstances of the use thereof that a person is thereby adequately protected from danger." In fact, almost every one of the thirty-two regulations requires technical knowledge for its interpretation; the words "adequate," "sufficient," "efficient," "proper," "suitable," are constantly repeated, in addition to the phrases "so far as is reasonably practicable" and "where necessary." The whole idea of placing such regulations as these in the hands of an ordinary factory inspector is not only ludicrous but dangerous.

Serious "electrical" accidents, occasioned by the neglect of proper precautions on the part of the employer or his electrical engineer or contractor, are so rare in this country that no code of regulations or systematic Government inspection is necessary. Were accidents frequent enough and serious enough, however, to call for the enforcement of such regulations as these, an adequate inspection to ensure their proper observance would require an army of fifty or a hundred highly-paid officials, possessing at least equal experience in electrical engineering, tact, firmness of character, and consistency of purpose as has been exhibited by his Majesty's one and only Electrical Inspector of Factories during the six years he has occupied this position.

The Paper on telephone and telegraph cables, read by Mr. F. Tremain before the Newcastle Local Section last week, shows that the design of multiple telephone and telegraph cables has undergone considerable modification at the hands of the Post Office during recent years. In order that each section of cable on a long route may be taken into service as soon as it is laid, and so that the utmost and speediest return can be obtained from the heavy capital expenditure on new lines, cables are now designed to include a number of pairs of comparatively light copper wires which can be used for the short distance work initially, and can subsequently be employed in parallel for long-distance lines. This is but one of the modifications in design dealt with in Mr. Tremain's Paper; the whole essay is worthy of careful study by the telegraph and telephone engineer and the cable-maker. It is surprising that, while progress is made in the design of large multiple cables for underground work, the submarine telegraph cable with its simpler construction and fewer conductors has remained almost unaltered for a quarter of a century. It is true that there have been slight improvements in detail, and that a few comparatively short paper-

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insulated cables have been laid with success by the German Government, but the great question of constructing a cable with insulation of a much lower specific inductive capacity than guttapercha for long-distance submarine work has remained almost untouched. We are convinced that, by supplementing our present knowledge of the theory of telegraphic and telephonic transmission and of the properties of cable insulating materials, with a certain amount of special experimental research, submarine telephony over far greater distances than at present would be possible, greater telegraphic speeds could be obtained over the next long cables that are laid, and the necessity of retransmission of messages in the case of long routes could be much reduced. The majority of the difficulties to be overcome in the manufacture of submarine cables with lower capacity and higher inductance are purely mechanical ones.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, APRIL 2ND.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at 25 Great George Street, Westminster, S.W. Paper to be read :—"High-speed Electrical Machinery," by G. Stoney and A. H. Law.

Civil and Mechanical Engineers' Society.

8 p.m. Meeting at Caxton Hall, Westminster, S.W. Paper to be read :—"Efficiency of Boiler-heating Surface," by C. H. Wingfield.

Röntgen Society.

8.15 p.m. Ordinary General Meeting at 20 Hanover Square, W., when the following Papers will be read :—(1) "The Measurements of Short Exposures and Production of Uniform Sparks," by F. H. Glew; (2) "The Technique for Production of X-Ray Negatives by Very Short Exposures," by Dr. P. L. Hope.

SATURDAY, APRIL 4TH.

Royal Institution.

Afternoon Lecture, V., by Prof. J. J. Thomson, F.R.S., on "Electrical Discharges through Gas."

Institution of Electrical Engineers, Manchester Students' Section.

2.30 p.m. Visit to works of Messrs. Browett, Lindley & Co.

MONDAY, APRIL 6TH.

Institution of Electrical Engineers, Newcastle Local Section.

8 p.m. Meeting at the Armstrong College, when the Paper by G. Stoney and A. H. Law on "High-Speed Electrical Machinery" will be read.

Dick, Kerr Engineering Society.

8 p.m. Meeting at Messrs. Dick, Kerr's works at Preston. Paper to be read :—"Elevators," by R. V. Morse.

TUESDAY, APRIL 7TH.

Institution of Electrical Engineers, Manchester Students' Section.

7 p.m. Annual General Meeting at the Municipal School of Technology.

8 p.m. Ordinary Meeting. Paper to be read :—"General Testing," by J. Roberts, Jun.

WEDNESDAY, APRIL, 8TH.

Institution of Electrical Engineers, Birmingham Local Section.

7.30 p.m.—Meeting at the Technical School, Suffolk Street, when the Paper on "New Alternate Current Instruments," by Dr. W. E. Sumpner and J. W. Record will be discussed.

Association of Engineers in Charge.

7.30 p.m. Meeting at St. Bride's Institute, Fleet Street, London. Paper to be read, "Indicators and Indicator Diagrams," by W. A. Tookey.

Royal Society of Arts.

8 p.m. Ordinary meeting. Paper to be read, "Technical Education in America," by Sir William Preece, K.C.B., F.R.S.

Incorporated Institution of Automobile Engineers.

8 p.m. Meeting at the Institution of Mechanical Engineers, St. James's Park, London. Paper to be read, "A System of Costing, Book-keeping, and Recording, suitable for a Motor or other Engineering Factory," by J. S. Napier.

THURSDAY, APRIL 9TH.

L.C.C. School of Photo-Engraving.

8 p.m. Lecture by Sherard Cowper-Coles, on "Some Notes on Electrotyping."

FRIDAY, APRIL 10TH.

Physical Society.

8 p.m. Meeting at the Royal College of Science, South Kensington. Agenda :—(1) "An Experimental Investigation of the Nature of X-rays," by Prof. W. H. Bragg, F.R.S., and Mr. Madsen. (2) "Short Spark Phenomena," by W. Duddell, F.R.S.

Royal Institution.

9 p.m. Evening discourse on "The Carriers of Positive Electricity," by Prof. J. J. Thomson, F.R.S.

SATURDAY, APRIL 11TH.

Royal Institution.

3 p.m. Afternoon Lecture VI., on "Electrical Discharges through Gas," by Prof. J. J. Thomson, F.R.S.

Birmingham and District Electric Club.

7 p.m. Meeting at the Colonnade Hotel, New Street. Paper to be read, "Electrical Train Lighting," by S. H. Bridcut.

Institution of Electrical Engineers, Students' Section.

Visit to the Electric Lighting Station of L.N. & W. Railway, at Chalk Farm.

PROPOSED NEW BUILDING FOR THE INSTITUTION OF CIVIL ENGINEERS

IT has been known for some time, and was stated in the President's inaugural address, that the acquisition by the Government of the present premises of the Institution of Civil Engineers, in which most of the meetings of the Institution of Electrical Engineers are held, was imminent, and a meeting is to be held to-morrow to authorise the council entering into certain agreements in the matter with a view to the sale of the present building and site. The question of a new site has engaged the close attention of the council for a long time past; and after much negotiation and discussion of alternative proposals, they have arrived at an understanding with H.M. Office of Works which will afford the Institution opportunities of improved accommodation impossible to be obtained on the present site. The proposed new site occupies a position at the corner of Great George Street and Princes Street, the latter street being widened at its northern end, and other alterations made in connection with the completion of the public offices which will add to the advantages of that situation.

It has been arranged that the new site shall comprise a considerably larger area than that of the present building; and special attention has been given to the possibility of including within the new building a hall of a character similar to those possessed by the great legal societies, which will afford facilities for the conduct of examinations and the holding of special meetings and gatherings, when the numbers present largely exceed those which the existing building can accommodate, and in which the memorials of eminent engineers may find a place.

In order to provide the additional funds which are considered necessary to avoid drawing upon the invested capital of the Institution to a greater extent than is desirable, and to ensure the additional revenue which the larger building will entail, a scheme has been proposed which will be submitted to the meeting of introducing the payment of a fee of £10 10s. on transfer to full membership, and to make the entrance fee to be paid by those who may be in future elected in the first instance as full members £21. No alteration in the annual subscriptions is proposed. With regard to the building fund itself, about £8,000 has already been promised from prominent engineers, and the council suggest that many of those who are already full members will voluntarily contribute the same additional sum as that proposed to be levied upon those who may hereafter be transferred to full membership.

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THE FORTHCOMING ELECTRICAL EXHIBITION AT MANCHESTER

To be held in special buildings at Platt Fields Park, Fallowfield, Oct. 3—31, 1908

SINCE the notice which appeared in Electrical Engineering of March 19th (p. 425), announcing the progress which has been made regarding the arrangements for the holding of an Electrical Exhibition in Manchester next October, and contradicting an unfounded rumour that the scheme was to be abandoned, the movement has advanced a good deal, and we are glad to say that the scheme is now taking definite shape, and that a number of details have been settled. A meeting of the general committee organising the exhibition was held in the Electricity Committee Room, Town Hall, Manchester, on Tuesday, March 24th, when the executive committee reported fully as to their proceedings up to date, and it was unanimously resolved to confirm the recommendations of that committee and to proceed with the final details in connection with the holding of the exhibition.

The Secretary was instructed to enter into a contract with the Manchester Corporation for the use of Platt Fields Park, Fallowfield, as the site, and to accept the lowest tender received for the erection of the necessary buildings. These buildings have been licensed by the Manchester Corporation for one year, and the plans have been passed by the city architect.

In the meantime a draft prospectus and plans of floor space available for exhibitors had been prepared, and already the large number of applications and inquiries for space, indicate the prospect of a thoroughly representative exhibition, and are very encouraging. The Secretary has been instructed also to enter into the necessary contract with the Manchester Corporation Electricity Committee for a full supply of electrical energy, and it will be of interest to intending exhibitors to know that, in addition to a 200-volt continuous-current supply for lighting, there will also be available for power purposes either continuous current at 400 volts, or a three-phase alternating supply at the same voltage.

A preliminary prospectus or circular has been approved, and will be circulated forthwith, and rules and regulations, with a plan of the floor space available, are in course of preparation.

It has now been definitely decided that the exhibition shall open on Saturday, October 3rd, and close on Saturday, the 31st of the same month. The committee have appointed Mr. S. G. Castle Russell as honorary consulting electrical engineer, and Mr. Albert Jennison, Deansgate Arcade, Manchester, consulting architect.

We are glad to see such evidences of the vitality of the scheme, and it is very satisfactory to learn that the activity of the members of the committee, and the interest which is being taken in the project by all branches of the electrical industry, has placed the undertaking in such a position that its success is now assured—a success which cannot fail to be of mutual benefit to all those who participate in it.

THE FRANCO-BRITISH EXHIBITION

Co-operative Electrical Exhibit

WE are pleased to be able to announce that a good deal of progress has been made with the movement for ensuring a thoroughly representative and effective demonstration by the electrical industry at the forthcoming Franco-British Exhibition at Shepherd's Bush. The committee which was formed with this object by the Institution of Electrical Engineers have acquired a space of about 7,000 square feet, upon which it is intended to erect four fireproof pavilions, in and around which will be exhibited electrical apparatus of every description in general use. A meeting was held last Friday, at which about twenty of the largest electrical firms made formal application for space, and a circular and plan of the exhibition stands is being prepared to send out to those firms who have already expressed their intention of taking part in the exhibit but were prevented from being present. The committee are anxious to receive the names of other firms who are desirous of taking part in the movement. The space now available is rather limited, as nearly half has already been allotted. Applications, which should be addressed to Mr. C. S. Northcote, 2 Queen Anne's Gate, Westminster, S.W., are obliged to be dealt with in strict rotation, and it is anticipated that within the next week or ten days, the whole of the space will be taken up. The committee of conference of chief officials of the London Supply Companies have donated a substantial sum of money towards the cost of this electrical display, and although it is the first co-operative exhibit arranged for the electrical industry, its success seems likely to be undoubted, and the cost to individual exhibitors is, on account of the combination of interests, quite nominal. The committee are particularly desirous of obtaining offers from manufacturers of incandescent lamps or cooking apparatus which may be exhibited, to arrange for demonstrations of lamp-making, heating, and cooking, and it is hoped that an effective combined exhibit will be got together.

ELECTRICITY FROM PEAT

Dublin and Central Ireland Electric Power Bill

THE House of Commons Committee, under the chairmanship of Mr. Luke White, commenced consideration of this Bill on Monday. Counsel for the Bill were Mr. G. M. Freeman, K.C., Mr. Roger Wallace, K.C., Mr. Jeeves, and Mr. Seely. The opponents to the Bill are the Dublin Corporation, County of Dublin County Council, Rathmines and Rathgar Urban District Council, Pembroke Urban District Council, Dublin United Tramways Co., Alliance and Dublin Consumers Gas Co., and the Blackrock Urban District Council.

Mr. Freeman, K.C., in opening the Bill, said its object was to incorporate a company to supply electrical energy over an area in Ireland comprising portions of the counties of Dublin, Kildare, King's County, and Queen's County. A main generating station will be erected upon the Grand Canal, close

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to Robertstown. This canal forms a highway practically throughout the whole of the proposed area of supply, and it is interesting to note that the promoters of the Bill have made arrangements with the owners of the canal for carrying overhead wires along the banks. Owing to the presence of peat in the district, it was intended to make use of a process which was not familiar in this country, but was very familiar in other countries on the Continent. Gas engines would be used, supplied with peat as fuel, and arrangements had been made with an owner for the purchase of about 500 acres of the nearest peat bogs to the generating station; and the depth of peat available on this land would enable the promoters to supply for a great number of years, even on a most favourable assumption of the business they were likely to procure. Even were this supply to be exhausted, there were plenty of other bogs in close proximity, and these other lands were situated upon such an incline that it would be possible to get the peat by mechanical means to the works, at a very low cost. The great difficulties hitherto in reference to the utilisation of peat, continued counsel, had been the amount of moisture—about 90 per cent. was the correct amount—found in the peat, and if this were dried, the expense of doing so was too great in proportion to the return. But under the process now commonly used in Germany and various other parts of the Continent, it was not wise to dry the peat too much, as for economical working it was necessary to have 50 per cent. or 60 per cent. of the moisture in the peat. The surplus moisture was dried out by leaving the peat in the sun and in the handling on the way to the works, so that without any artificial drying the peat was got into the receivers at the works. It was estimated that the cost of fuel would be 0·05d. per unit, and this cost was compared with the two lowest fuel costs in England, viz., 0·19d. per unit at Salford, and 0·13d. at Newcastle. Sulphate of ammonia would be recovered in the process, and it was estimated that the cost of the peat would be met by the return from the by-product. The capital is £450,000 in shares and £150,000 in borrowing powers. Dealing with the amount of support which the Bill is receiving it was stated that the Dublin Industrial Development Association, which is an association endeavouring to encourage and attract fresh trade to Ireland, was in favour; the Dublin Lucan Tramways Co. was willing to take a supply; the Dublin and Blessington Tramways would favourably consider the taking of a supply; an agreement had been made with the Blackrock Urban District Council for giving a supply, subject to the Bill being passed; and the Kingstown Urban District Council and Rathdown Union were also in favour of the Bill. The fact that at present there were few industries in the proposed area was no argument against the scheme, for at Niagara, when that scheme was first thought of, there was not a factory within 50 miles, but in a very short time the whole district was filled with industries. The industries which, it was hoped, would be attracted to Ireland were the electro-chemical and electro-metallurgical industries. Dealing with the opposition to the Bill, Mr. Freeman said the Dublin Corporation, which wished to be absolutely excluded, was protected by the clause under which the company could not supply there without consent, with an appeal to the Board of Trade. The view of the promoters was that the plant of the Dublin Corporation was obsolete, and they had no doubt that in the course of time the Corporation would be only too pleased to come to terms for a supply in bulk. The opposition of the County of Dublin County Council was both unreasonable and unprecedented, for, although it had no powers to supply electricity itself it asked that no supply should be given by the company without consent. The general position taken up by the promoters was that all towns giving a supply of electricity should be asked for its consent before a supply is given, subject to an appeal to the Board of Trade in the event of the consent being unreasonably withheld.

Mr. John Sturgeon, civil and mechanical engineer, of Leeds, who has been connected with the Niagara, Lancashire, Yorkshire, and Belfast power schemes, was then called. With regard to the latter scheme, he stated it had been taken over by Dr. Mond, who was now erecting a generating station at Portadown, which would be driven by gas engines utilising peat in the same way as was proposed by this Bill. The area of the proposed scheme is 1,460 square miles, and included 7,000 acres of bog land. The area also included 121 miles of the Grand Canal. The depth of the bog of which it was proposed to purchase 500 acres was 25 ft., and this would be sufficient for 15,000 h.p. for 50 years at 30 per cent. load factor; whilst the whole of the 7,000 acres of bog would give 35,000 h.p. for 300 years. There was a fall in the bog towards the station of 25 ft., so that it would not be a difficult matter to transport the peat. The equipment of the first portion of the generating station would be 12,000 kw., of which he estimated that 7,000 kw. would be taken up on the spot for electro-chemical and electro-metallurgical works. The generators would be in 500 kw units, this size being fixed as the limit having regard to the efficiency of gas engines at the present time. The promoters were actually in treaty for the erection of a calcium carbide works. He had provided in his estimate for 125 miles of trunk mains in the first instance.

The details of his estimates are as follows:—Costs of Act, stamp duty on capital issue, prospectus and flotation costs £14,000; underwriting on first issue of £200,000 at 7½ per cent., £15,000; interest during construction, 3 per cent. on £100,000, £3,000; purchase of land and bog, drainage, levelling, fencing, and preparing land for buildings, &c., £5,250; buildings and foundations, shedding, &c., £15,000; cost of producers and washing plant for 16,000 h.p., £52,000; gas engines and generators in units of 500 kw., switchgear, &c., £159,600; piping, pumping machinery, and conveying plant, trucks, tools, &c., £20,000; repairing shop with tools, &c., £3,000; wharf crane, travelling cranes, and other lifting tackle, £3,000; sub-stations for 6,000 kw. with static and rotary transformers,, switchgear, &c., £60,000; overhead main lines, 125 miles, 44 poles per mile at £210 per mile, including wayleaves, branches to consumers, accessories and contingencies, &c., £261,260; 125 miles overhead copper wire to transmit 5,000 kw. distributed over four miles, averaging, say, £0·6 per kilowatt per mile with accessories, contingencies, &c., £187,500; wiring to consumers in vicinity of generating station, say, £12,500; engineering, legal, contingencies, and cash balance in bank, £43,890. Total, £600,000.

On Tuesday, in the course of cross-examination, Mr. Sturgeon strongly objected to cutting Dublin out of the area altogether. Owing, he said, to the insertion of such a clause in the Belfast and North East Ireland Power Bill, as regards Belfast, the promoters of that Bill had been unable to place the scheme before the public in the ordinary way, and the carrying out of the undertaking had been considerably delayed thereby. The costs of 0·05d. per unit which he had already given were fuel costs only; the total cost of generation was estimated at 0·12d. per unit. The cost of procuring the peat based upon the prices at present charged by the existing peat cutters was about 5s. per ton. The main success of the scheme would depend very largely upon new industries being commenced in the area, but they also regarded the supply to existing authorities as being a substantial factor. An agreement had been entered into with the Blackrock Urban District Council at a 1½d. per unit, decreasing to 1d. per unit according to the load factor.

Mr. H. Riall Sankey, R.E., said he had been studying the question of the utilisation of peat in connection with gas engines for the past two years, and had visited Germany and Sweden and investigated the methods there used. The estimates of the promoters, with which he agreed, had been based upon using existing methods of dealing with the peat and the cost came out at 4s. 2d. per ton. A new process had been invented by Zeigler, however, which would reduce this to 3s. per ton. He calculated that 2·2 lbs. of peat would produce one unit of electricity. One of the great advantages of utilising peat for the manufacture of gas was that pre-ignition did not occur, there was less sulphur and the products of combustion were much more friable than with ordinary gas. The calorific value was very slightly less than that of Mond gas, which was 148 units per cubic foot. The lowest for peat gas was 128, but he had found it to be as high as 140. It was estimated that the sale of the by-product, sulphate of ammonia, would realise 4s. per ton, and so practically balance the cost of the fuel, whilst the other by-products in the aggregate would probably give the same return per ton, so that there would be actual profits made on the by-products alone.

In cross-examination, it was put to Captain Sankey that if the sale of by-products was to be such a remunerative thing, the question of electricity supply need not enter into their calculations at all, and the extra profit on this might be regarded as so much pocket money. Captain Sankey replied that the scheme was put forward mainly for the purpose of electricity supply, and he only mentioned these figures to show the possibility of the scheme paying. He quite admitted that it would be commercially possible to make the gas and blow it into the air simply for the sake of the by-products if a sufficient quantity would be sold. He did not think, however, it would pay to instal the plant necessary for dealing with the by-products unless 10,000 kw. of electrical energy were sold, which would be equivalent to 26,000,000 units, and the quantity of peat burned would result in 650 tons of sulphate of ammonia. There were several installations in Sweden and Germany using peat for gas engines, but none for giving a public supply of electricity. He mentioned that in connection with the manufacture of nitric acid from the air one important company which was now making experiments in Sweden had expressed its willingness to carry out similar experiments in Ireland if this scheme went through.

The proceedings before the committee will occupy several days.

In this connection reference may be made to the lecture by Mr. A. B. Lennox before the Dublin Local Section of the Institution of Electrical Engineers, in December, on the getting and drying of peat with a view to its use for the generation of electrical energy, in which a special form of grab dredger and drying apparatus was described, together with the complete method of preparing the material for use in gas producers. Estimates were worked out for the cost of preparing peat ready for the producer, which was given as £5 19s. 2d. per 50 tons, and the capital cost of an installation to turn out 50 tons per day was put at £5,000. The Presidential address of Mr. T. Tomlinson, the chairman of the Dublin Local Section, was also devoted to the same subject (Electrical Engineering, Vol. II., pp. 1029 and 859.)

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ECONOMICAL PRESSURES FOR POWER TRANSMISSION BY UNDERGROUND CABLES

By J. B. Sparks

IN the discussion of such an interesting subject as the construction of extra high-tension insulated cables, one is apt to overlook the fact that, although it is quite possible to construct insulated cables for working pressures of 50,000 volts or more, it may be more economical to employ cables of larger copper section and for lower working pressures. For any given transmission scheme, the most economical pressure for the transmission line will depend not only on the cost of the cable, but also on the cost of the transformers and the high-tension switchgear; and having estimated the most economical pressure for the cable line, considering only the cable, we must reduce this somewhat in order to obtain the most economical pressure with regard to the whole plant.

In order to obtain some general idea as to how the cost of the cables is affected by raising or lowering the working pressure of any proposed transmission line, let us take a particular case of the transmission of a certain amount of power over a certain distance under a few assumed, definite, and simple conditions, and work out the actual cost of the cables for different working pressures. A suitable case for such a comparison is the following:—

An annual transmission of 50 million kilowatt-hours over a distance of 31 miles by three-phase alternating-current through two three-core insulated cables laid underground. Power-factor 0·9, and load-factor 0·5. Cost of energy at the generating end of the line, 0·5d. per kilowatt-hour. The average load on the line will thus be:—

$$\frac{50{,}000{,}000}{365 \times 24} = 5{,}700 \text{ kw.}$$

Assuming that the load is equally divided between the two cables, the average load per cable will be 2,850 kw. The load per phase on each cable will be 950 kw.; or with a power-factor of 0·9, some 1,060 kva. Let us estimate the cost of such a cable for four different working pressures, viz., 5,000, 10,000, 20,000, and 40,000 volts between cores. The average kilovolt-amperes per cable per phase are 1,060 kva. in each case, and consequently the average currents per core will be 368, 184, 92, and 46 amperes respectively.

The next step is to decide the section of copper per core in each case. The chief factor determining this, in the case of such a long transmission scheme as that under consideration, is not the heating, but the cost of the energy wasted in transmission. A careful investigation has shown that in the particular case in question the most economical annual efficiency of the line would be from 88 to 98 per cent. The higher the working pressure, the higher is the most economical line efficiency. Thus for a working pressure of 10,000 volts between cores, the most economical efficiency works out at about 89 per cent.; but for 30,000 volts it is found to be about 96 per cent. Were the cost of the energy at the generating end of the line less than 0·5d. per kilowatt-hour, the most economical efficiencies would, of course, be lower than the above.

In order to simplify the present investigation, let us assume an annual loss of 5 per cent. of the energy delivered in all four cases. (This corresponds to an annual line efficiency of 95·2 per cent.) A total loss of 5 per cent. is a loss of 0·161 per cent. per mile of cable for all three phases, or

$$\frac{2{,}850 \times 0{\cdot}161 \times 1{,}000}{100} = 4{,}590 \text{ watts per mile per cable,}$$

or 1,530 watts per mile per core. This loss is really made up of two items: the copper loss and the loss due to hysteresis in the dielectric. We can, however, neglect the latter for the present purpose, especially as its introduction into the investigation would only strengthen the resulting conclusions.

Now, assuming that the copper loss per mile of core is 1,530 watts at 5,000 volts between cores, and therefore 368 amperes per core, the resistance per mile per core will be

$$\frac{1530}{(368)^2} = 0{\cdot}0113 \text{ ohm.}$$

The specific resistance of copper at the temperature at which the cables will work (say 85° F.) is about 0·715 microhm per cubic inch. Therefore,

$$\text{section per core} = \frac{1760 \times 3 \times 12 \times 0{\cdot}715}{0{\cdot}0113 \times 10^6} = 4{\cdot}0 \text{ sq. in.}$$

The necessary sections at the different pressures are tabulated, together with the weight and cost of the copper, in Table I.

Table I.

Volts between cores.	Current per core.	Ohms per mile per core.	Section per core. sq. in.	Tons of copper in 31 miles of one 3-core cable.	Cost of copper in one cable at £100 per ton. £
5,000	368	0·0113	4·0	3,520	352,000
10,000	184	0·045	1·0	880	88,000
20,000	92	0·180	0·25	220	22,000
40,000	46	0·725	0·0625	55	5,500

The maximum practical section per core for a three-core cable is some 0·6 sq. in.; consequently, in the case of the 10,000-volt transmission we should require four three-core cables; and in the case of the 5,000-volt transmission we should require some 12 or 14 cables. However, for the sake of simplicity let us assume that three-core cables having sections per core of 1·0 and 4·0 sq. in. are possible. A sub-division into a number of insulated cables would strengthen the argument here set forth.

Before proceeding further, let us make sure that the cables will not overheat. The current density is greatest in the case of the 40,000-volt cable, where it is 740 amperes per sq. in. If the load-factor of the system were 0·5, then the maximum current density would be 1,480 amperes per sq. in. For such a cable (*i.e.*, 0·0625 sq. in. per core, three-core high-tension cable laid underground) the value of 1,480 amperes per sq. in. will not cause the cable to overheat.

The figure of £100 per ton as the cost of the conductor is taken to include the costs of wire-drawing, stranding, &c. This is rather too high for present market prices, but a lower figure would only strengthen the argument.

The figures of Table I. only illustrate the well-known fact that if we double the pressure and thus halve the current, we require only one-quarter of the weight of copper for equal loss. It will be noticed, however, that whereas by raising the pressure from 5,000 to 10,000 volts we save £264,000 on the copper for each cable, by raising the pressure from 20,000 to 40,000 volts we save on the copper only £16,500 per cable; and it is the purpose of this investigation to show that the saving on the copper in the latter case will be quite offset by the extra cost of the insulation due to the higher pressure employed, and that it is not economical to work at such high pressures.

The effect of the increasing pressure on the total cost

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of the cable is shown by the curves in Fig. 1, which express the ratio of the total works cost of the complete cable to the cost of the contained copper for three-core high-tension lead-covered cables as a function of the pressure in kilovolts between cores, when the cost of the copper (including wire-drawing, stranding, &c.) is £100 per ton. From these curves it is evident that at high pressures and small sections the cost of the copper is such a small fraction of the total cost of the cable that a decrease in section and in cost of the conductor is quite offset by the accompanying increase in quantity, quality, and cost of the insulation necessary to withstand the higher pressure.

The total cost of a cable, as obtained from the curves of Fig. 1 includes the cost of the lead covering, the cost of lead being taken at £20 per ton. The cost of the insulating material, which, except for the very high pressures, would consist entirely of impregnated paper, was taken at from £40 to £60 per ton, increasing with the pressure.

For the particular case under consideration the total

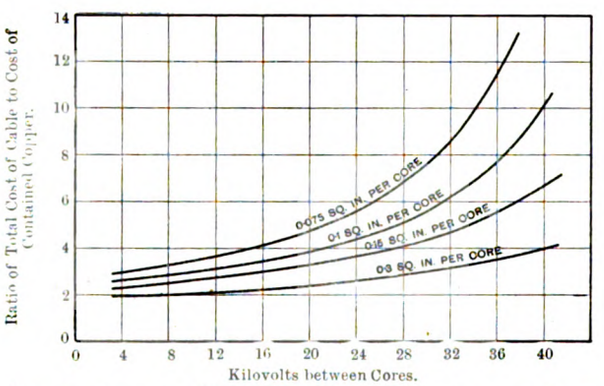


Fig. 1.—Ratio of Total Cost of Cable to Cost of Contained Copper for Three-Core High-Tension Cables, for Various Copper Sections per Core.

costs of the cables have been estimated with the aid of the curves of Fig. 1, and the results are tabulated in Table II.

Table II.

Volts between cores.	Copper section per core, sq. in.	Cost of copper in 31 miles of 3-core cable. £	Ratio of total cost to cost of copper.	Total cost of one 3-core cable (length =31 miles). £	Cost per mile. £
5,000	4·0	352,000	1·3	460,000	14,800
10,000	1·0	88,000	1·5	132,000	4,260
20,000	0·25	22,000	2·75	60,500	1,950
40,000	0·0625	5,500	16·0	88,000	2,840

The values of the cost of cable per mile, given in the last column of Table II., are plotted in Fig. 2 as a function of the pressure in kilovolts between cores.

These cables are for an average load of 2,850 kw. per cable. Curves corresponding to other quantities of power transmitted are given in Fig. 2 for the sake of comparison, and they correspond to cables for 4,500, 1,500, and 300 kw. average load, all capable of transmitting these amounts of power with a loss of 0·161 per cent. per mile. Thus, for example, a cable corresponding to any point on the 1,500 kw. curve would be capable of transmitting 1,500 kw. to a distance of 31 miles with an annual loss of 5 per cent. of the power delivered or an annual line efficiency of 95·2 per cent. We could transmit along this same cable half the power to double the distance at the same efficiency.

Returning to the particular case under consideration, *i.e.*, the transmission of 2,850 kw. per cable to a distance of 31 miles, it will be seen that the most economical pressure, considering only the cost of the cable, is about 25,000 volts between cores. For larger amounts of power transmitted per cable the most economical voltage will be only slightly higher. For smaller amounts of power the most economical voltage will be less.

If the power is cheaper than 0·5d. per kw.-hour at the generating end of the line, then we can afford to

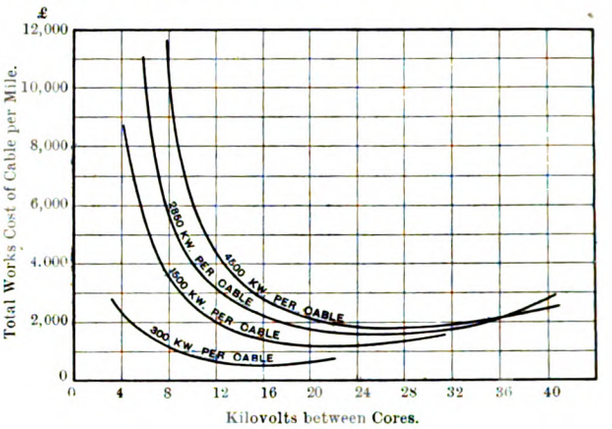


Fig. 2.—Cost of Three-Core Cable for Transmitting Different Amounts of Power per Cable at Different Voltages between Cores and with a Loss of 0·161 per Cent. per Mile.

waste more in transmission, and the most economical efficiency will be lower or the loss per mile more. This means that a smaller section of copper is required, and consequently the most economical voltage will be less than that corresponding to the higher line efficiency.

From these considerations we arrive at the conclusion that it will rarely be economical to employ a higher pressure than 25,000 volts between cores. A higher pressure would be the most economical only in exceptional cases of large amounts of power transmitted per cable to very long distances. In the interests of a reliable supply it is advisable to keep down the amount of power transmitted per cable, and a very long distance underground transmission is rarely practicable, as it involves such an excessive capital cost. In such cases one can only consider an overhead line as the practicable proposition.

The effect of the heavy capital cost of the line on the cost of the energy at the receiving end of the line

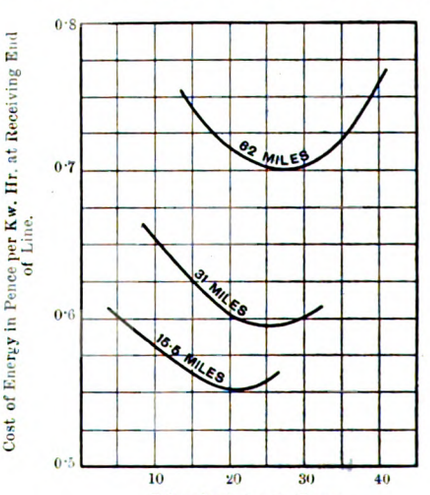


Fig. 3.—Curves showing the Effect of Varying Distance and Voltage on the Cost of Energy at the Receiving End of an Underground Line for Transmitting Fifty Million Kilowatt Hour per Year. Cost of Energy at Generating End of Line 0·5d. per Kilowatt Hour.

is clearly shown in Fig. 3, in which curves are given of the cost per kw.-hour at the receiving end of the line, expressed as a function of the pressure in kilovolts between cores, and for distances of transmission of 15·5, 31, and 62 miles. For the 15·5 mile trans-

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mission, the minimum cost is obtained at a pressure of 20,000 volts, for 31 miles at a pressure of 25,000 volts, and for 62 miles at a pressure of 27,000 volts.

In all cases and at all voltages the cost per kw.-hour, given in Fig. 3, is the minimum obtainable, *i.e.*, that corresponding to the most economical efficiency of the line. The most economical efficiency of the line will, of course, vary with the cost of the energy at the generating end of the line, the distance of transmission, and the pressure employed.

The cost of the energy per kw.-hour at the receiving end was calculated as follows:—

The annual expenditure on the transmitted energy is the sum of the cost of the wasted energy, and the interest, maintenance, and depreciation of the transmission line; this second item (*i.e.*, interest, maintenance, and depreciation) may be taken as 12 per cent. of the capital cost of the line, including cables, conduits, excavation, and filling in, &c. In the case of overhead lines this figure should be taken somewhat higher. Thus the value of 16 per cent. was assumed in the calculations for Fig. 4. This amount, together with the cost of the energy wasted in transmission, must be divided by the total number of kw.-hours delivered, and

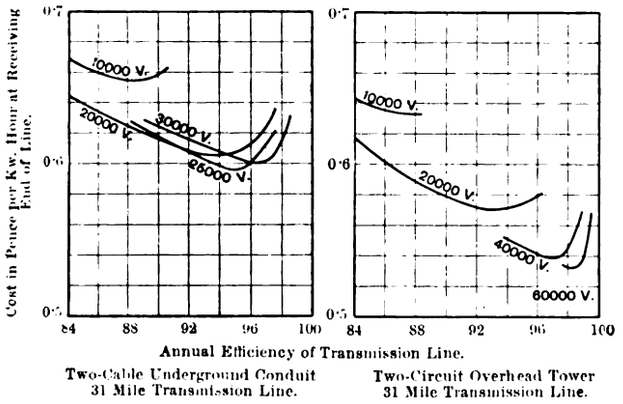


Fig. 4.—Influence of Line Efficiency and Pressure on Cost of Energy at Receiving End of Line.

the quotient (which will be some small fraction of a penny) added to the cost per kw.-hour at the generating end of the line.

Thus, for our specific case of a 31-mile transmission at 25,000 volts, the cost of the energy at the receiving end of the line from Fig. 3 is 0·595d. per kw.-hour, 0·5d. being the cost of generation per kw.-hour, and 0·095d. the cost of transmission per kw.-hour.

The influence of the annual line efficiency on the cost per kw.-hour at the receiving end is shown graphically in the curves of Fig. 4. From these curves we find that the most economical line efficiency for the 31-mile transmission under consideration is about 95 per cent. for a pressure of 25,000 volts. At a lower voltage—for instance, 10,000 volts, which means a heavier capital cost—it is economical to waste more power in transmission, and the efficiency for which the transmission cost is a minimum is about 89 per cent.

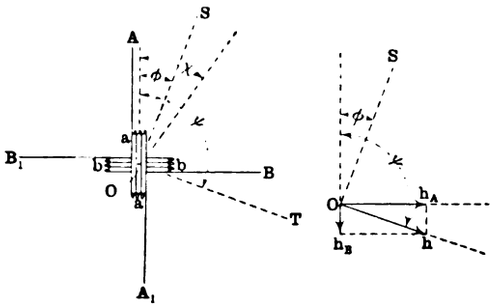
The left-hand curves are for underground lines, the right hand for overhead steel-tower lines. Comparing these curves, we see that whereas the most economical pressure for an underground cable line, in the case considered, is about 25,000 volts, a pressure of 60,000 volts or more will give the most economical results when an overhead steel-tower line is used.

The capital cost in the latter case is also very much less, and the cost of transmission comes out at 0·032d. per kw.-hour at 60,000 volts, against 0·095d. per kw.-hour for the 25,000-volt underground line. In neither case, however, has any allowance been made for the annual wayleaves or compensation charges, and these, of course, would be higher in the case of an overhead line passing through a populous district. The higher percentage charges for maintenance in the latter case were included in the 16 per cent. "interest, maintenance, and depreciation" mentioned above.

There seems, therefore, no necessity for the construction of three-core three-phase cables for higher working pressures than about 25,000 volts, for cases of transmission over long distances by insulated cables. There is, however, a very useful field for extra high-tension cables, whether for continuous or alternating current transmission, in carrying underground the last few miles of a long overhead transmission line, where this line enters or passes through a town or other densely populated district in which the conditions do not allow of an overhead line. Such use has already been made of extra high-tension cables in France, where the last 2·8 miles of a 112-mile overhead transmission line from Moutiers to Lyons is carried underground. Both alternating and continuous current systems are in use, the voltage between cores for the three-phase three-core cables is 26,000 volts, and the continuous-current cables work at 60,000 volts.

In conclusion, the author wishes to state that this investigation has been carried out at the suggestion of Mr. H. M. Hobart and under his direction, and that this article, embodying the main conclusions, has been published at Mr. Hobart's request.

The Bellini & Tosi Directive System of Wireless Telegraphy.—Our attention has been called to slight errors which occurred in the lettering of the angles in the diagrams forming Figs. 1



and 2 of the article entitled "Directive System of Wireless Telegraphy," by Messrs. E. Bellini & A. Tosi, on p. 348 of our issue of March 5th. In order to make the matter quite clear, we give the diagrams in their corrected form herewith.

Forthcoming Mining Exhibition.—A mining exhibition is to be held at Olympia during July. Several electrical firms have already signified their intention of taking space, so that the applications of electrical working to mines should be well represented.

Damage to City Electric Light Standard.—In the King's Bench Division of the High Court, last week, an action was heard by the City of London Electric Lighting Co. against the Vanguard Motor 'Bus Co., for damage done to an electric light standard at the junction of Threadneedle Street and Old Broad Street. The lamp in question was knocked down by a skidding 'bus on two occasions in June last year, and negligent driving was alleged. The City of London Electric Lighting Co., was awarded £43 3s. 4d. damages in respect of the first accident, a stay of execution being granted with a view to an appeal.

State Control of Wireless Telegraphy in America.—A Bill has been introduced into the American legislature, requiring a federal license for foreign and inter-state communication by wireless telegraphy, which is to be put completely under the jurisdiction of the government. The license can be abolished by the President in times of war. The Bill imposes a license on land stations of $100 a year, and a license of $5 a vessel on all equipped with wireless apparatus. The most severe penalty is provided for interference with messages sent or intended for government officials, or the malicious use or operation of wireless instruments under license by the government. Another feature is a provision that makes it compulsory for all licensed wireless operators to act as relays for messages received by them. The act makes it the duty of every person or corporation using or operating wireless installations under a license issued by the United States to answer wireless calls and signals from any other person or corporation so licensed. According to the *Electrical World*, there is considerable opposition to the Bill.

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THE PROPOSED HOME OFFICE REGULATIONS

(Special Report. Strictly Copyright)

THE inquiry before Mr. James Swinburne, F.R.S., into the regulations proposed by the Home Office in connection with the use of electricity in factories and workshops was concluded on Thursday, after a public hearing lasting ten days, in addition to a private conference between the objectors and the Home Office, which also lasted for several days. In our last issue we had reported the proceedings to the eighth day, Tuesday, March 24th.

WEDNESDAY, MARCH 25TH.—NINTH DAY.

Mr. Vesey Knox, continuing his speech on behalf of the Newcastle and other power companies, and the Mersey Docks and Harbour Board, with regard to exemption from prosecution, said his clients were anxious to have it made quite clear that they could only be prosecuted for contravention of the rules if a certificate had been granted by the chief electrical inspector. Unless the amendment he had proposed on the previous day, or something equivalent to it, was inserted, his clients felt that the regulations would be a serious menace to the electrical industry.

Mr. Swinburne asked if the contention was that the Home Office should practically certify that proceedings ought to be started. If so, this really bound the Home Office to commence proceedings, for it would place them in a somewhat illogical position if they certified that the rules were not complied with and then did not prosecute.

Mr. Vesey Knox replied that it would meet his point equally well if the regulations stipulated that unless the electrical inspector had certified that an occupier had, in his opinion, acted in contravention of, or failed to comply with the regulations, no prosecution should take place. He was not arguing so much for the particular words as for the principle, for he attached the utmost importance to the *fiat* of the electrical inspector, as otherwise anybody could put the law in motion against an occupier, and it would be an intolerable nuisance. The statement of law prepared by Lord Robert Cecil on this point, clearly showed that at present absolutely any member of the public could prosecute, and he thought there was no dispute with the Home Office on this point. A way out of the difficulty might be a memorandum calling attention to section 17 of the Factory Act of 1901, which gave the Home Office powers to prosecute for a breach of any regulation. As to the appeal from a decision of a factory inspector, he did not ask for an appeal on every detail, but where, as to past and future work, any requirements under these regulations involved a considerable expenditure of money, there should undoubtedly be an appeal to an independent expert, and his main reason for this was that an electrical inspector might very easily become the prey of inventors. A glaring instance of this occurred in connection with automatic couplings on railways a few years ago, when the Board of Trade was inclined to insist upon these being adopted on all railways. It seemed that an official thought a thing he had seen in America was a very useful invention, and ought to be applied without regard to English conditions, at very great expense. There had to be a Parliamentary agitation to prevent this. Nothing could be more significant on this point than the evidence as to no-voltage releases on three-phase motors. Mr. Garside wanted to have these imposed upon everybody, and if it had been in the power of the electrical inspector only, it was quite clear from Mr. Ram's evidence, they might have been imposed upon everybody. He urged for an appeal to arbitration on the ground that experience showed this was a much less expensive form of appeal than that before magistrates. Generally speaking, the effect of an arbitration clause tended towards agreements without arbitration, and an example of this was that although there was an arbitration clause in the Factory Acts with regard to means of escape from fire in buildings, there had not been more than twenty or thirty arbitrations, and the general effect was that owners had not been put under arbitrary provisions. He therefore proposed that a clause should be inserted stating that where in order to satisfy any requirements of the inspector, an expenditure of more than £100 would be involved, either in an individual case or as applied to a principle, the person required to incur the expense should have the right of arbitration as between the Secretary of State and himself, and that the Arbitration Act of 1889 should apply. The arbitrator's award would be regarded as final.

Mr. Swinburne asked that, if a company had a switchboard, the alteration of which would involve an expenditure of say £90, and also had a large number of other similar switchboards in other parts, did Mr. Knox suggest that one arbitration should cover the lot?

Mr. Vesey Knox replied that he thought in these circumstances, one arbitration could be held as a sort of test case, to which everybody else similarly placed would adhere in the future. As a result of an arbitration, for instance, in connection with no-voltage releases, the Home Office could then issue a statement saying that in particular circumstances no-voltage releases must be fixed.

Mr. Swinburne questioned whether the Home Office could do this, as once the regulations were passed, they would be fixed until there was another inquiry.

Mr. Vesey Knox thought that such a notice would be a rule under the regulations, and would not be made as a new regulation. In this way he thought that a number of persons could combine together for the purposes of an arbitration upon a matter of principle. He felt the absolute necessity for taking such matters before an expert in preference to magistrates. With regard to Exemption 5, he did not regard this as at all satisfactory, as it put the onus on the occupier of proving that there were special conditions which took him out of the regulations, and he thought the addition of the words "as far as is reasonably practicable" was essential.

Mr. Swinburne suggested that Mr. Knox might consider this from the point of view of an occupier, who was putting up new work, and who would naturally wish to know how he stood with regard to the regulations in respect of the design which he was adopting.

Mr. Vesey Knox said he saw no way out of this difficulty except by a system of approval of plans by the Home Office. To have this done, he thought the industry would be brought almost to a standstill, whilst at the same time he thought it would be impracticable to approve every plan throughout the country. For this reason he saw no alternative but to leave this element of risk remaining. At the same time, he regarded it as a strong argument for restricting the scope of the regulations as much as possible. Dealing with the question of voltage, Mr. Vesey Knox stated that so far as the Mersey Docks and Harbour Board were concerned, they would be safe if the limit was raised to 250 volts; if not, then he thought there was a good deal to be said for omitting docks. The law at present with regard to docks was most obscure, and the introduction of the "authorised person," which he had already referred to, involved a problem which he could not solve.

Mr. Gray mentioned that Mr. C. P. Sparks had made some investigations on the question of whether resuscitation by artificial respiration had been successful in any case.

Mr. Sparks stated that he made inquiries and found that two people had received shock and had been restored in this manner. The first shock was from an arc lighting machine at about 2,500 volts pressure (about 15 years ago), and the man was insensible. They had tried to resuscitate him, and sent for a doctor, who after some time said the man was dead, and it was no use going on. The person in question, however, was very well liked, and his fellow comrades, in spite of what the doctor had said, continued to try to resuscitate him. In this they were eventually successful, and the man is alive to-day. This happened twelve years ago. The other case was at 2,000 volts alternating current, and there again artificial respiration was resorted to, and the person was revived.

Mr. H. Faraday Proctor was then called on behalf of the Incorporated Municipal Electrical Association, the Association of Municipal Corporations, and the Bristol Chamber of Commerce, and dealt first of all with the question of voltage. He said he had had experience of all pressures from 2,000 volts downwards for nineteen years, and in no case had he experienced any accident at 250 volts or below. The previous evening he had communicated with a number of the most important cities in Great Britain on this question, including Liverpool, Manchester, Bristol, Leeds, Birmingham, Sheffield, Bradford, Nottingham, Edinburgh, and Glasgow, and in none of these cases had the engineers experienced an accident from electric shock at 250 volts or less which caused loss of life or permanent injury. In one of these places only had there been an accident, to the knowledge of the engineer, on consumer's premises, and in this case he understood that it took place in connection with temporary work. His own view was that there was nothing to be gained by having regulations for these lower pressures. Where there had been accidents such as that mentioned at Fulham Baths and elsewhere, the accident would have occurred notwithstanding any regulations as were now proposed, or any regulations that could possibly be framed. In electricity works where the men employed were all trained and knew of the risks they incurred, he thought a little red paint was a very much better preventative than regulations. With regard to Regulation 30, he thought it would be a great injustice to the electrical industry generally if this "corpse revival" notice was to be put up in all premises where electricity was used at low pressure. If the Home Office would go so far as

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to make similar notices compulsory on all premises where gas was employed, *i.e.*, in every dwelling-house throughout the kingdom, he would not have so much objection to their application on premises where electricity was used, because they would then be treated with that amount of consideration which they deserved. In fact, they would become equivalent to putting a poison label on a medicine bottle, that is, very little notice would be taken of them.

In cross-examination by Mr. Gray, Mr. Faraday Proctor admitted that if the Fulham Baths conduit had been properly earthed there would not have been so much risk, but no regulation could guard against careless work. Generally speaking, he regarded the rules as more or less harmless for the objects they were intended to effect.

Mr. C. Fleetwood Pritchard next spoke on behalf of the Incorporated Municipal Electrical Association and the Association of Municipal Corporations, which he said represented practically every local authority of importance throughout the kingdom, whose combined capital expenditure upon electricity works was about 4½ million pounds. The Home Office had powers under Section 17 of the Factory and Workshops Act to prosecute any occupier whose machinery was not safe for the workpeople, and as they had never put these into force, in regard to generating stations, he asked if it was not fair to assume that in the opinion of the Home Office generating stations as a whole were safe. The only other conclusion to be drawn was that the Home Office had not done its duty, and this he would not suggest. If any regulations at all were to be enforced, they should be of a tentative character, rather than of a fixed nature. The danger from 250 volts or less was not exceptionally great, nor was it greater than in any factory employing steam or any other form of power. On the question of arbitration, he agreed substantially with the arguments of Mr. Vesey Knox, but did not like the form suggested. His clients thought it was just as important to have the right of appeal to arbitration for works constructed after the rules came into force, as it was in connection with works constructed before. Neither did he like the limit of £100, because an important question of principle might arise involving a much less sum. In this same connection he asked for the inclusion of Rule 55 of the Coal Mines Regulations, which he thought would meet the difficulty of Mr. Gray, who, in principle, agreed that in some way existing work should be protected against undue prosecution, by a certificate from the Secretary of State. The regulation in question read as follows:—"Any of the foregoing requirements shall not apply in any case in which exemption is obtained from the Secretary of State, on the ground either of emergency or special circumstances, on such conditions as the Secretary of State may prescribe." On Regulation 29, which deals with the appointment of the "authorised person," Mr. Pritchard argued that it was unnecessary to allow either the contractor or the occupier, or both, to appoint the authorised person, as this might lead to a contractor's man being under the control of the occupier, while the contractor would be responsible for the work that was being done. Subject to these points being made, and adopting the previous arguments on behalf of the objectors, Mr. Pritchard said his clients were quite willing to give the regulations a fair trial, although they did not regard them as perfection.

Mr. Gutteridge, on behalf of the London County Council, said that this body occupied a somewhat peculiar position in relation to this inquiry. The Council had a large tramway generating station and two smaller generating stations, and about twenty tramway sub-stations. With regard to the latter the position appeared to him to be that they were not under the Factory Acts at all, as they did not come within the definition of "electrical stations" in the Factory Acts, but certain workshops connected with the sub-stations might come within the purview of the Acts. The County Council was also affected in that they were, under the Electric Lighting Acts, the inspecting authority in the county of London. He supported the arguments in favour of preventing anybody prosecuting, and, on the question of voltage, felt, on behalf of the ratepayers, that in the case of a small manufacturer, the limits of voltage stipulated in the regulations would press rather hardly. There was no other set of regulations published by the Home Office which were similar to these, either as to length or as to abstruseness.

Mr. C. W. Downing, on behalf of the Barry Railway Co., asked the Commissioner, in considering these regulations in their application to docks, to take into consideration the heavy penalties already inflicted by the Factory Acts, and also the fact that docks are under regulations of the Board of Trade and also other regulations made by the Home Office. He supported the arguments in favour of exempting docks from these regulations altogether, and if in this he was unsuccessful, then he desired to call the attention of the Commissioner to Section 79 of the Factory Act of 1901, which laid it down that regulations must be reasonable, practicable, and deal with the necessities of the case. As an illustration he referred to Regulation 26, dealing with adequate lighting, and in respect of electric lighting stations, urged that it had never been suggested that an accident had occurred through want of lighting. He asked that the evidence should be placed against each regulation, and that if the necessities of the case did not demand it, then that regulation should not be allowed. The regulations should be clear and specific, and there should be no ambiguity.

Mr. W. B. Woodhouse, on behalf of the Yorkshire Electric Power Co., the Leeds Chamber of Commerce, and others, said that so far as the power company which he represented was concerned, he was in a somewhat different position to those represented by Mr. Merz, whose undertakings were more or less established. The Yorkshire Power Co., like many similar companies in the country, were doing pioneer work, and had practically only just started. The difficulty of coming to any real agreement as to any regulations to suit every type of apparatus or switchgear, he thought, was apparent in the informal discussions which had taken place between the Committee of Objectors and the Home Office. The Board of Trade regulations under which they now worked did not prevent the evolution of new types of apparatus, but he contended that the Home Office Regulations would undoubtedly have this effect, and any regulations that were to be imposed should enter into as little detail as possible. He claimed that there were far too many regulations in the proposed code, and as an example suggested that the regulations relating to fencing a portion of a generating station where the switchboard was, might give the impression to the workers that the unfenced portion of the station was not dangerous, whereas it would contain all sorts of apparatus equally, if not more, dangerous than the switchboard. Dealing with the 250-volt limit, he compared the risk of danger under this as being similar to the possibility of drowning in 6 in. of water, and the imposition of regulations in respect of this danger was equivalent to putting a lifebelt at every roadside puddle. The Home Office had not brought to light any danger from electricity which had not been thoroughly realised for years, and there was not sufficient justification for the number of these regulations. If he were selling any other form of power than electricity, he would have taken advantage of the opportunity of securing a copy of the original regulations, if they had passed in that form, and labelled them "33 Reasons Why You Should Not Use Electricity," and this, he thought, would have been one of the finest arguments in favour of any other form of power.

Mr. Sidney Morse, on behalf of the British Electric Federation and others, reminded Mr. Swinburne of the great difficulty under which the electrical industry has laboured since its commencement. He referred to the retarding effect of the Electric Lighting Act of 1882, an effect which had led up to the Act of 1888; to the outcry with regard to uninsulated returns for tramway purposes and to the agitation on the part of gas and water companies on the question of electrolysis. Experience had proved that all these fears had been unfounded, and he ventured to suggest that the fears of the Home Office as to the safety of the workers in electrical stations had, by experience, been proved equally unfounded. There had only been one death in a year in all the factories inspected by the Home Office, and this, in 20 years' experience, he urged, was not sufficient to justify these regulations. He considered that the Home Office had gone unnecessarily out of its way to declare electricity a dangerous trade, for the impossibility of doing away with accidents was commented upon in the report of the Coal Mines Committee, which stated that it was not anticipated the set of regulations drawn up in respect of mines would prevent accidents, and that, indeed, electrical accidents might even increase. Even that committee thought the large number of regulations imposed by them might cause alarm. He agreed with the previous speeches on the question of voltage, and that the dangers of electricity under 250 volts were no more than the ordinary dangers in everyday life. He also agreed that there must be an appeal, to which, so far as he could understand, the only objection was one of expense.

Mr. Gray said that this was not so. The feeling of the Home Office was that the introduction of an appeal would tend to take the control of these matters out of the hands of the Home Office altogether, which was not desirable, and would render the administration of the regulations almost impossible. Up to now there was no power of appeal in respect of any set of regulations issued, except two cases, namely, the earthenware and the china transfer rules, but in these cases the appeal was not in respect of the decision of the Home Office, but in respect of a difference between local authorities and the owner. The appeal in the case of coal mines was not introduced by the committee, but already existed in the original Act.

Mr. Morse said that the question really only came to one of getting the proper staff to carry out the regulations.

Mr. A. M. Sillar, representing a number of factory owners, stated that he agreed with all the arguments put forward by Lord Robert Cecil on behalf of the London Electric Lighting Companies.

Mr. A. B. Cane said that on the question of the *flat*, the Home Office was unable to come to any agreement with the objectors which would effect this object, although both sides were agreed as to the necessity of there being a prosecution only by the Home Office. The matter was therefore left in the hands of the Commissioner, as the Home Office preferred not to take upon themselves the burden of suggesting a way out of the difficulty. With regard to the question of the sub-stations mentioned by Mr. Sparks, in which the size was limited by a previous order, but which would not comply with the proposed regulations, here again the objectors had the sympathy of the Home Office, and the objectors thought that some definite clause might be introduced to exempt them. Rule 56 of the Coal

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Mines Regulations would effect this, with drafting amendments to suit this particular case, and he suggested the following:—"Regulations 25 and 31 to 33 shall not apply to any system of sub-stations or transforming chambers constructed in accordance with plans prescribed or approved by the Board of Trade, or to any extensions of such system of similar construction."

Mr. Gray then commenced his speech on behalf of the Home Office in reply to the objectors. He first acknowledged the fair and frank assistance which the Home Office had received from the objectors in committee, but expressed his disappointment that after the conference in committee there should have been objections raised to the principle of, at any rate, certain of the regulations. Having gone into the details of all the regulations in committee, he had rather been under the impression that the questions of principle raised at the commencement of the proceedings had been abandoned. The great arguments against the rules generally, and also upon the question of voltage in particular, was that there had been no serious accidents arising from the use of electricity; in other words, to justify rules it was necessary that an industry must first pay a heavy toll of human life. The evidence had all been "I know of no accident"; but this was not the proper attitude, in his opinion, for any objector to take in considering the question of whether rules were or were not to be enforced. He claimed that there had been no evidence of any kind, or in any substantial form, of any oppressiveness of these regulations except in quite general terms. The Home Office had had, from the commencement, at heart the interests of the industry, and it was by reason of this that many of the modifications had been made, because it was desired to have the simplest way of properly protecting workmen not only as regards life, but also as regards injury to health or limb. He thought he was right in saying that amendments had been accepted in practically every single regulation as they appeared in the original draft. On the question of voltage, whether there was one or one hundred accidents was not the criteria; it was a question of common sense. The evidence of Mr. Proctor on this point was merely that there had been no fatal accident or accidents involving serious injury, but all the witnesses had admitted the possibility of danger in some degree from a man receiving a shock, which might only be sufficient to startle him, but at the same time involve dangerous consequences from falling off platforms and such like. It was accidental injuries which had to be guarded against. Machinery was not fenced to prevent a man getting into the wheels deliberately, but to prevent him getting there accidentally. Some objections had been raised to the industry being certified a dangerous trade, but it was beyond their province to discuss this, for the Home Secretary had so certified the industry under Section 79 of the Factory Act, and, with all respect, that point did not come within the purview either of the Commissioner or of the objectors. With regard to the degree of danger between alternating current and continuous current, all the evidence was in his favour, for the objectors had brought no evidence on this point, and he thought there was no alternative to the Commissioner but to report that, *qua* limit, alternating current should be lower than continuous current. A good deal had been made of Mr Ram's report for 1906, in which, it was stated, reference was made to only one instance of a fatal accident at less than 250 volts. But this was the voltage of the system, and did not come into the matter at all. The question which was really of importance was the voltage at which the shock was received, and a glance down another column of the table in question showed that there were several deaths from shocks at less than 250 volts, and the point which was in his favour was that in none of these cases could the voltage at which the shock was received have been higher, but it could have been less.

Mr. Sidney Morse pointed out that the exemption related to the voltage of the system, and it was to the exemption that the objection was made.

Mr. Gray, continuing, said that from 1902 to 1906 Mr. Ram's report showed a total of 84 fatal accidents, of which 24 were at pressures within the limit of low pressure under these regulations.

Mr. Swinburne said he had a little difficulty in understanding what was meant in these reports by the expression "probable voltage of shock."

Mr. Ram stated that, for instance, in two-phase systems where the voltage of the system was 280, the probable voltage of the shock would be about 200 volts between one phase and earth. A single alternating-current system of 200 volts would probably give the same.

Mr. Gray said his object was to show that it did not matter in the least what the voltage of the system was. But he even did not rely upon this. The real point was, did these regulations, or any of them, impose an oppressive burden upon the industry? He ventured to say that there was not one tittle of evidence, beyond general statements, put before the Commissioner on this point. His argument in this respect was strengthened by the fact that the inquiry had gone on for the most part by way of Committee, rather than by public inquiry. A great deal also had been made of the 250-volt limit in the Board of Trade rules. These did not apply, however, to workmen at all, but only to the consumer, and were directed practically to a class of consumer using electricity mainly for electric light, in which every part of the installation could be arranged so that there was no danger from shock. Further, the Board of Trade rules did not apply to factories where there were motors and bare conductors, and, also, the rules in question prohibited voltages above 250. Therefore they were not comparable in any way with the proposed regulations of the Home Office. With regard to the objections that 100-volt continuous-current systems went free, if the objectors desired it, the Home Office would make 100-volts continuous current come within the regulations. With regard to whether rules should be retrospective or not, the suggestion that existing works should not be affected by them, was an impossible position. If it was necessary to have regulations for future work, it was essential that they should be also applicable to present work, unless there were special circumstances which would give them an exemption, and a good deal had been done in this latter direction by the modifications which had been accepted by the Home Office. As regards old stations under Rule 17, the dimensions had been dropped out, and slightly modified as regards new work. The suggestion of the objectors that no works should be prosecuted for non-compliance with the rules, until there had been a certificate from the Secretary of State, would make the regulations nearly a dead letter, for it put upon the Home Office the duty of reporting that a particular works did not comply with the regulations before alteration could be compelled to be made. Another point to be noted in connection with the general opposition to the regulations was that all the evidence submitted was from the electric power station point of view, and there had been no evidence from a factory, not being an electrical undertaking. (This remark called forth several protests from gentlemen representing factories, who stated that their evidence was intended to refer to factories as well as to their electric supply undertakings.) Dealing with the question of the appeal from the decision of the factory inspector, Mr. Gray pointed out that in the case of the fire regulations, which had been mentioned so many times, the appeal was between the local authority and the occupier, and did not concern the Home Office. In fact, the general power of appeal to arbitration had been deliberately left out of the Factory Acts, because it was regarded as unwieldy.

THURSDAY, MARCH 26TH.—TENTH DAY.

Mr. Gray, continuing his speech, said that in order to meet the objections to Exemption 5 in connection with which the objectors desired that the whole onus should be put upon the Home Office to show that a works did not comply with the regulations, the Home Office would be willing to add the following words: "And the Secretary of State may, by order, direct that any class of special conditions defined in the order shall be deemed for the purpose of all or any of the requirements of these regulations adequately to prevent danger." This would prevent the Home Office from being placed in the anomalous position of being unable to take any action until it had certified.

Mr. A. B. Cane asked for an assurance that such an order would be granted in the case of the special sub-stations of the County of London Electric Supply Company.

Mr. Gray said that he could give this assurance.

Continuing, Mr. Gray referred to Regulation 34, which had been substituted for Regulation 28. The latter had originally provided for inspections and tests, but to meet the objectors, the Home Office had dropped the "tests" and although, as a matter of fact, he had agreed to abandon the regulation as it now stood, relating only to inspections, he still thought there should be an inspection in the interests of the industry, and in his opinion it was the duty of the Commissioner to consider whether this regulation should not remain.

Mr. Vesey Knox, Mr. Cane, and Mr. Morse all protested on this point, as they said, having been assured that Regulation 34 would be dropped, they had not argued it.

Mr. Swinburne said that the Home Office was practically asking him to reinstate a regulation which the objectors thought had been dropped, and he was really obliged to consider everything.

Mr. Gray next dealt with the question of prosecution for non compliance with the regulations. Whilst agreeing with the principle of this, he said he had some doubt as to whether it would not be *ultra vires* to put in a proviso that nobody but the Home Office should prosecute, because it might be taking away the rights of some other persons or some other department which now existed, to prosecute. The only way out of the difficulty he could suggest was to leave it for the Commissioner to draw attention to the point in his report, and it might be necessary to take the opinion of the law officers of the Crown in respect of it. To meet a point raised by Mr. Pritchard, he agreed to have inserted in the regulations a definition of "public supply." Dealing with Mr. Trotter's evidence, some doubt seemed to exist in the minds of the objectors as to whether the alteration in the Board of Trade regulations which he suggested would be carried out. The Home Office had not yet had any further information from Mr. Trotter, but he had no doubt that as it was the desire of both departments to have no overlapping, they might rest assured on this point.

Mr. Vesey Knox pointed out that there were several Board

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of Trade regulations which should, at any rate be limited; for instance, Rule 6. This dealt with maintenance of insulation, and Rule 9 with transformers, both of which were dealt with in the Home Office regulations. Rule 8, also, which related to circuit breakers for high-pressure mains. The view of his clients, however, was that all these should come under the control of the Board of Trade, so far as they were not on a factory.

Mr. SWINBURNE mentioned that there were cases in which apparently the Board of Trade was overlapping in factories, but was not doing so in reality. The Board of Trade, on behalf of the public, might have to go inside and suggest alterations because of the danger to the public, and not so much from the point of view of the workmen. He would, however, go into this question thoroughly and report as to which regulations he thought ought to be limited.

Mr. GRAY, on Exemption 2, recalled that Mr. Vesey Knox required some provision with regard to docks; in fact, he wanted docks to be exempted. If this was so, he did not know what Exemption 2 would mean, and he thought that if docks were exempted from Regulations 7, 8, 9, and 10, there was no need for any other regulations to be included in this exemption, so far as docks were concerned.

A long discussion here took place between Mr. Gray and Counsel for the objectors on the question of the appeal to arbitration, the point in dispute being as to whether under the Factory Acts the right of appeal to arbitration in individual cases had been substituted by inquiries such as the present one. This was the contention of the Home Office, and the point was finally left to the Commissioner. At the conclusion of the discussion,

Mr. GRAY said he thought that none of the speeches had carried the matter any further, and the fact remained that the objectors were asking the Commissioner to initiate an entirely new practice under the proposed rules, which did not exist under any other rules issued by the Home Office. No suggestion had been made that the present administration with regard to other regulations was in any way different as to make arbitration necessary. He submitted that the suggestion was unworkable and unprecedented. As to the date when these regulations should come into force, he suggested January 1st, 1909, with a provision that a year should be given to enable occupiers to comply with the necessary requirements of the regulations.

In conclusion, he expressed the appreciation of the Home Office at the manner in which Mr. Swinburne had conducted the inquiry, and at his forbearance in listening to a number of elementary matters which had been discussed quite solemnly, but which it had been necessary to do from the nature of the inquiry.

Mr. VESEY KNOX associated himself with the expression of the appreciation on behalf of the objectors.

Mr. SWINBURNE said he thought matters had been simplified and facilitated to a very great extent by the very successful method which had been adopted of discussing the regulations in committee.

The inquiry then terminated.

We give below the complete definitions, exemptions, and regulations as they were left at the conclusion of the inquiry :—

DEFINITIONS.

"*Pressure*" means the difference of electrical potential between any two conductors, or between a conductor and earth, as read by a hot wire or electrostatic voltmeter.

"*Low pressure*" means a pressure normally not exceeding 250 volts.

"*Medium pressure*" means a pressure normally above 250 volts, but not exceeding 650 volts.

"*High pressure*" means a pressure normally above 650 volts, but not exceeding 3,000 volts.

"*Extra-high pressure*" means a pressure normally exceeding 3,000 volts.

"*System*" means an electrical system in which all the conductors and apparatus are electrically connected to a common source of electromotive force.

"*Conductor*" means an electrical conductor arranged to be electrically connected to a system.

"*Apparatus*" means electrical apparatus, and includes all apparatus, machines, and fittings in which conductors are used, or of which they form a part.

[Definition of "Cable" deleted.]

"*Circuit*" means an electrical circuit forming a system or branch of a system.

"*Insulating stand*" means a floor, platform, stand, or mat
"*Insulating screen*" means a screen
"*Insulating boots*" means boots
"*Insulating gloves*" means gloves
} of such size, quality, and construction, according to the circumstances of the use thereof, that a person is thereby adequately protected from danger.

"*Covered with insulating material*" means adequately covered with insulating material of such quality and thickness that there is no danger.

"*Bare*" means not covered with insulating material.

"*Live*" means electrically charged.

"*Dead*" means at, or about, zero potential, and disconnected from any live system.

"*Earthed*" means connected to the general mass of earth in such manner as will ensure at all times an immediate discharge of electrical energy without danger.

"*Sub-station*" means any premises, or that part of any premises, in which electrical energy is transformed or converted, and which are large enough for a person to enter after the apparatus is in position.

"*Switchboard*" means the collection of switches, or fuses, conductors, and other apparatus in connection therewith, used for the purpose of controlling the current or pressure in any system or part of a system.

"*Switchboard passage-way*" means any passage-way or compartment large enough for a person to enter, and used in connection with a switchboard when live.

"*Authorised person*" means a person employed, appointed, or selected by the occupier, or by a contractor or contractors for the time being under contract with the occupier, to carry out certain duties incidental to the generation, transformation, distribution, or use of electrical energy, and competent to carry out those duties.

"*Danger*" means danger to health or danger to life or limb from shock, burn, or other injury to persons employed, or from fire, attendant upon the generation, transformation, distribution, or use of electrical energy.

"*Public Supply*" means the Supply of Electrical Energy by any Local Authority, Company, or Person, authorised by Act of Parliament or Provisional Order confirmed by Parliament or by License or Order of the Board of Trade or otherwise under Board of Trade Regulations, to give a supply of Electrical Energy.

EXEMPTIONS.

1. Nothing in these Regulations shall apply to any system the normal working pressure of which does not exceed 150 volts continuous or 65 volts alternating.

2. Nothing in Regulations 7, 8, 9, and 10 shall apply in electrical stations to any circuit or conductor used for conveying electrical energy for public supply or for traction under license or other statutory powers, or for railway purposes, or for docks constructed under statutory powers.

3. Nothing in Regulation 12 shall apply to any motor of a motor-generator or to any motor forming part of any electrical converter, regulator, or similar apparatus.

4. Nothing in these Regulations shall apply to any service lines or apparatus on the supply side of the consumer's terminals or to any chamber containing such service lines or apparatus where the supply is given from outside under Board of Trade Regulations; provided always that no live metal is exposed so that it may be touched.

5. If the occupier can show with regard to any requirement of these Regulations that the special conditions in his premises are such as adequately to prevent danger, that requirement shall be deemed to be satisfied; and the Secretary of State may by Order direct that any class of special conditions defined in the Order shall be deemed for the purposes of all or any of the requirements of these Regulations adequately to prevent danger.

6. Nothing in these Regulations shall apply to any process or apparatus used exclusively for electro-chemical or electro-thermal or testing or research purposes; provided such process be so worked and such apparatus so constructed and protected and such special precautions taken as may be necessary to prevent danger.

REGULATIONS.

1. All apparatus and conductors shall be sufficient in size and power for the work they are called upon to do, and so constructed, installed, protected, worked, and maintained as to prevent danger so far as is reasonably practicable.

2. All conductors shall either be covered with insulating material, and further efficiently protected where necessary, or they shall be so placed and safeguarded as to prevent danger so far as is reasonably practicable.

3. Every switch, circuit-breaker, and isolating link shall be :—(*a*) so constructed, placed, or protected as to prevent danger, (*b*) so constructed and adjusted as accurately to make and to maintain good contact, (*c*) provided with an efficient handle or other means of working, insulated from the system, and so arranged that the hand cannot inadvertently touch live metal, (*d*) so constructed or arranged that it cannot accidentally fall or move into contact when left out of contact.

4. Every switch intended to be used for breaking a circuit and every circuit-breaker shall be so constructed that it cannot with proper care be left in partial contact. Every switch intended to be used for breaking a circuit and every circuit-breaker shall be so constructed that an arc cannot accidentally be maintained.

5. Every fuse and automatic circuit-breaker used instead thereof shall be so constructed and arranged as effectively to interrupt the current before it so exceeds the working rate as to involve danger. It shall be of such construction or be so guarded or placed as to prevent danger from over-heating, or from arcing or the scattering of hot metal or other substance when it comes into operation. Every fuse shall be either

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of such construction or so protected by a switch that the fusible metal may be readily renewed without danger.

6. Every electrical joint and connection shall be of proper construction as regards conductivity, insulation, mechanical strength, and protection.

7. Efficient means, suitably located, shall be provided for cutting off all pressure from every part of a system as may be necessary to prevent danger.

8. Efficient means suitably located shall be provided for protecting from excess of current every part of a system as may be necessary to prevent danger.

9. Where one of the conductors of a system is connected to earth, no single pole switch other than a link for testing purposes or a switch for use in controlling a generator shall be placed in such conductor or any branch thereof.

10. Where one of the main conductors of a system is bare and uninsulated, such as a bare return of a concentric system, no switch, fuse, or circuit-breaker shall be placed in that conductor, or in any conductor connected thereto, and the said conductor shall be earthed.

11. Every motor, converter, and transformer shall be protected by efficient means suitably placed, and so connected that all pressure may thereby be cut off therefrom and from any apparatus in connection therewith, provided, however, that where one point of the system is connected to earth, there shall be no obligation to disconnect on that side of the system which is connected to earth.

12. Every electrical motor shall be controlled by an efficient switch or switches for starting and stopping, so placed as to be easily worked by the person in charge of the motor. Where necessary to prevent danger through the automatic re-starting of a motor every electrical motor or group of electrical motors shall be protected by a release which will automatically break the circuit if the current is interrupted, such release being suitably placed with regard to the danger to be prevented. Provided that no release shall be required for any motor which has an attendant constantly at the controller of such motor while at work. In every place in which machines are being driven by any electric motor, there shall be means at hand for either switching off the motor or stopping the machines.

13. Every flexible wire for portable apparatus shall be connected to the system either by efficient permanent joints or connections or by a properly constructed connector. Adequate precautions shall be taken against shock due to leakage or other cause in all places where the person handling the portable apparatus is not insulated from earth. In such places and in any place where the pressure exceeds low pressure, the portable apparatus and its flexible wire shall be controlled by efficient means suitably located, and capable of cutting off the pressure.

14. The general arrangement of switchboards shall so far as reasonably practicable be such that :—(*a*) All parts which may have to be adjusted or handled are readily accessible; (*b*) the course of every conductor may where necessary be readily traced; (*c*) conductors not arranged for connection to the same system are kept well apart and can where necessary be readily distinguished; (*d*) all bare conductors are so placed or protected as to prevent danger from accidental short circuit.

15. Every switchboard having bare conductors normally so exposed that they may be touched shall be located in an area or areas set apart for the purposes thereof or where necessary suitably fenced or enclosed. No person except an authorised person, or a person acting under his immediate supervision, shall for the purpose of carrying out his duties have access to any part of such area.

16. All apparatus appertaining to a switchboard and requiring handling shall so far as practicable be so placed or arranged as to be operated from the working platform of the switchboard, and all measuring instruments and indicators connected therewith shall, so far as practicable, be so placed as to be observed from the working platform. If such apparatus be worked or observed from any other place, adequate precautions shall be taken to prevent danger.

17. At the working platform of every switchboard and in every switchboard passage-way, if there be bare conductors exposed or arranged to be exposed when live so that they may be touched, there shall be a clear and unobstructed passage of ample width and height with a firm and even floor. Adequate means of access, free from danger, shall be provided for every switchboard passage-way. The following provisions shall apply to all such switchboard working platforms and passage-ways constructed after the [1st January, 1909] unless the bare conductors, whether overhead or at the sides of the passage-way, are otherwise adequately protected against danger by divisions or screens or other suitable means :—(*a*) Those constructed for low pressure and medium pressure switchboards shall have a clear height of not less than 7 feet, and a clear width measured from bare conductor of not less than 3 feet; (*b*) those constructed for high pressure and extra-high pressure switchboards other than operating desks or panels working solely at low pressure shall have a clear height of not less than 8 feet and a clear width measured from bare conductor of not less than 3 feet 6 inches; (*c*) bare conductor shall not be exposed on both sides of the switchboard passage-way unless either the clear width of the passage is in the case of low pressure and medium pressure not less than 4 feet 6 inches, and in the case of high pressure and extra-high pressure not less than 8 feet, in each case measured between bare conductors, or the conductors on one side are so guarded that they cannot be accidentally touched.

18. In every switchboard for high pressure or extra-high pressure : -(*a*) Every high pressure and extra-high pressure conductor within reach from the working platform or in any switchboard passage-way shall be so placed or protected as to prevent danger; (*b*) the metal cases of all instruments working at high pressure or extra high-pressure shall be either earthed or completely enclosed with insulating covers; (*c*) all metal handles of high pressure and extra-high pressure switches, and, where necessary to prevent danger, all metal gear for working the switches, shall be earthed; (*d*) every switchboard in continuous use shall either (i) be so arranged that the conductors thereof can be made dead in sections, and so separated by permanent or removable divisions or screens from all adjoining sections of which the conductors are live, that work on any section may be carried out without danger; or (ii) otherwise so arranged as to secure that the work may be carried out without danger.

19. All parts of generators, motors, transformers, or other similar apparatus, at high pressure or extra-high pressure, and within reach from any position in which any person employed may require to be, shall be, so far as reasonably practicable, so protected as to prevent danger.

20. Where a high pressure or extra-high pressure supply is transformed for use at a lower pressure, suitable provision shall be made to guard against danger by reason of the lower pressure system becoming accidentally charged above its normal pressure by leakage or contact from the higher pressure system.

21. Where necessary to prevent danger adequate precautions shall be taken either by earthing or by other suitable means to prevent any metal other than the conductors from becoming electrically charged.

22. Adequate precautions shall be taken to prevent any conductor or apparatus from being accidentally or inadvertently electrically charged when persons are working thereon.

23. Where necessary to prevent danger, insulating stands or screens shall be provided and kept permanently in position and shall be maintained in sound condition.

24. Portable insulating stands, screens, boots, gloves, or other suitable means shall be provided and used when necessary to prevent danger, and shall be periodically examined by an authorised person.

25. Adequate working space and means of access, free from danger, shall be provided for all apparatus that has to be worked or attended to by any person.

26. All those parts of premises in which apparatus is placed shall be adequately lighted to prevent danger.

27. All conductors and apparatus exposed to the weather, wet corrosion, inflammable surroundings or explosive atmosphere, or used in any process or for any special purpose other than for lighting or power, shall be so constructed or protected, and such special precautions shall be taken as may be necessary to prevent danger in view of such exposure or use.

[Regulation 28 deleted.]

29. No person except an authorised person, or a person acting under his immediate supervision, shall undertake any work where technical knowledge or experience is required in order to avoid danger. Where a contractor is employed, and the danger to be avoided is under his control, the contractor shall appoint the authorised person, but if the danger to be avoided is under the control of the occupier, the occupier shall appoint the authorised person.

30. Instructions as to the treatment of persons suffering from electric shock shall be affixed in all premises where electrical energy is used, other than for incandescent lighting at low pressure, and in all premises in which electrical energy is generated or transformed.

[Regulation 30 has not been modified, and is left to be dealt with by the Commissioner.]

31. Every sub-station shall be substantially constructed, and shall be so arranged that no person other than an authorised person can obtain access thereto otherwise than by the proper entrance, or can interfere with the apparatus or conductors therein from outside, and shall be provided with efficient means of ventilation and be kept dry.

32. Every sub-station shall be under the control of an authorised person, and none but an authorised person or a person acting under his immediate supervision shall enter any part thereof where there may be danger.

33. Every underground sub-station not otherwise easily and safely accessible shall be provided with adequate means of access by a door or trap-door, with a staircase or ladder securely fixed and so placed that no live part of any switchboard or any bare conductor shall be within reach of a person thereon; provided however that the means of access to such sub-station shall be by a doorway and staircase, (*a*) if any person is regularly employed therein, other than for inspection and cleaning, or (*b*) in any such sub-station not of ample dimensions, either if there is moving machinery therein, other than ventilating fans, or if there is extra-high pressure therein.

[To facilitate reference, the numbering has not been altered, notwithstanding the deletion of No. 28.]

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THE ELECTRICAL EQUIPMENT OF A CORNISH TIN MINE

RECENTLY the Cornish Consolidated Tin Mines, Ltd., recognising the possibilities of Cornish tin-mining worked on modern lines, acquired among other propositions the South Crofty Mines, situated at Carn Brea. This mine has been worked for many years without giving any financial return. On coming under the control of the Cornish Consolidated Co., the whole

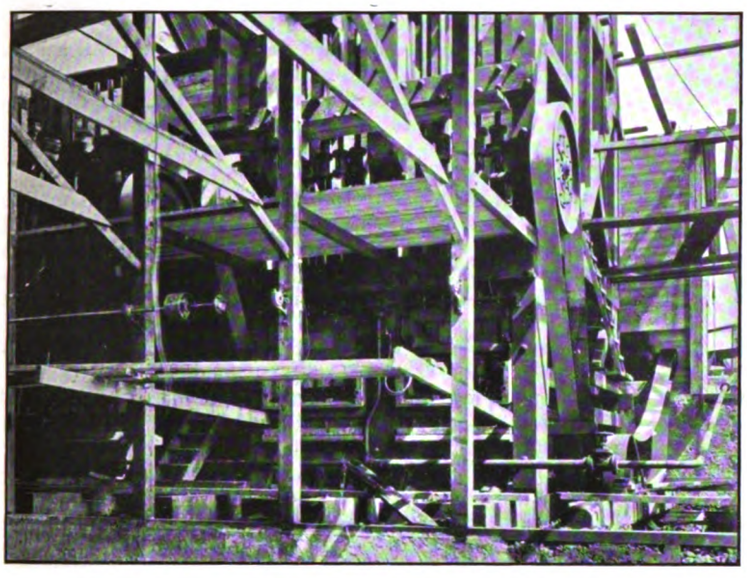


Fig. 1.—Group of Electrically-driven Californian Stamps.

of the underground and surface plant was remodelled, and what had been previously a financial failure will shortly prove to be the most favourable tin mine in Cornwall. The mill and dressing plant was originally operated by a single-cylinder, jet-condensing, balanced beam engine. The cost of operating this plant, neglecting capital cost, which was an unknown quantity, on 15,623 tons of ore treated annually was £1,884, or 2·4s. per ton.

When considering the reconstruction of the milling plant for operating, modern steam plant, suction gas, and electric driving were put forward, and after fully considering the relative costs and advantages, electric driving was decided on, the superior flexibility of motor drive for extensions at the mill and for operating the auxiliary machinery, the low capital cost, and the favourable working cost being the determining factors in favour of motors. Terms were arranged with the Urban Electric Supply Co., whose generating station adjoins the mine, for a supply of power at £6 per kw. of maximum demand, plus 0·45d. per unit, these figures to be rearranged when the maximum demand reaches 1,000 kw. The estimated cost of driving the mill and the auxiliary plant on the above basis being 1·8s. per ton, the actual cost works out at 1·08s. per ton of ore treated.

The ore previously won from the upper levels of this mine contained at least 30 per cent. of wolfram (tungsten), together with tin and arsenic, which could not at that date be satisfactorily separated. These levels were abandoned, and the lower levels which contained a less percentage of wolfram were worked, the wolfram being treated as an impurity, and a low price being accepted for the tin product.

With the advent of the new company, magnetic separation was resorted to, and the previously unsaleable complex ore separated into a tin and wolfram product, the tin commanding a much higher price, and the wolfram finding a ready market. The tin and wolfram product, which contains a heavy percentage of iron, after being calcined to remove the arsenic, is fed on to a 16 in. rubber belt, that travels between the pole-faces of three pairs of magnets, which are spaced apart and supported on a frame; as the belt carrying the product passes under the first pair of magnets, the iron product is drawn up on to a canvas transverse belt that removes the magnetised particles beyond the magnetic field, when the particles drop from the transverse belt into a bin. The product, that now contains tin and wolfram only, which are much less magnetic than the original product, is carried by the main belt under a second pair of magnets, having a stronger field than the first pair, where the wolfram is separated from the tin in a similar manner, the third pair of magnets removing the last trace of iron and wolfram from the tin product, which is now carried by the main belt into a bin and is ready for the smelter. This magnetic separation of minerals is simple and ingenious, and enables what was hitherto a complex, unsaleable product to be put on the market as clean tin and wolfram.

The mill, which at present consists of 40 heads, is arranged for driving in sections of 10 heads, as shown in Fig. 1, each section being driven by a 30 B.H.P. motor, arranged as in Fig. 2, only one section being interrupted should a motor fail or when the heads require attention, a spare armature being in readiness to ensure practically continuous running; whilst for future extensions, which will be commenced at an early

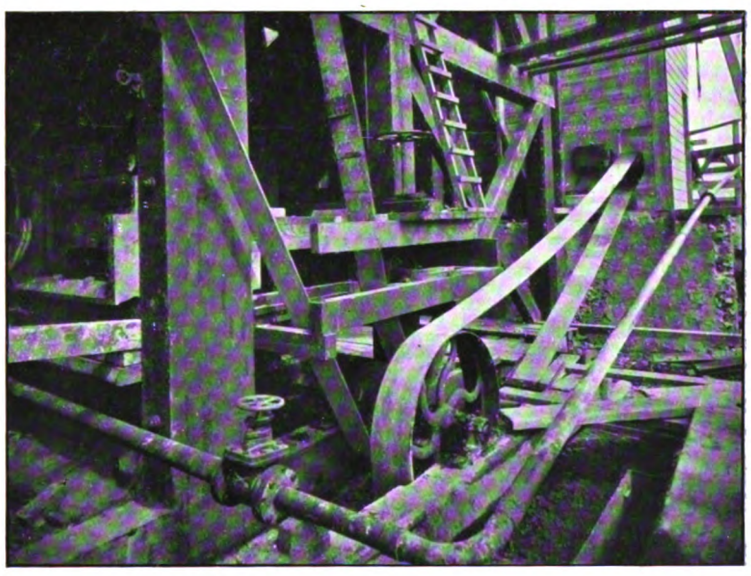


Fig. 2.—Arrangement of Motor Drive to Stamp Battery.

date, extra units can be easily installed. These extensions would have to be considered and arranged for with either of the alternative schemes. With no more ground space and a less number of attendants, the present mill deals with slightly more than twice the quantity treated by the old plant. This shows the advantage which has been obtained by the adoption of electrical working in the way of compactness.

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The present installation of electrical apparatus consists of:—

Four	30 B.H.P	motors for mill drive.
Two	30 ,,	for Blake rock breakers (Fig. 3).
Two	20 ,,	for mill dressing plant.
One	20 ,,	for sorting table and dodge crusher.
One	20 ,,	for vertical pulverisers and calciners.
One	20 ,,	for tube mills.
One	20 ,,	for workshops.
One	17 ,,	for return water pump.
Two	5 ,,	for circulating pumps.
One motor generator		for magnetic separators.

The results obtained from electric driving at this mill are very satisfactory, the present cost being 1·08s. per

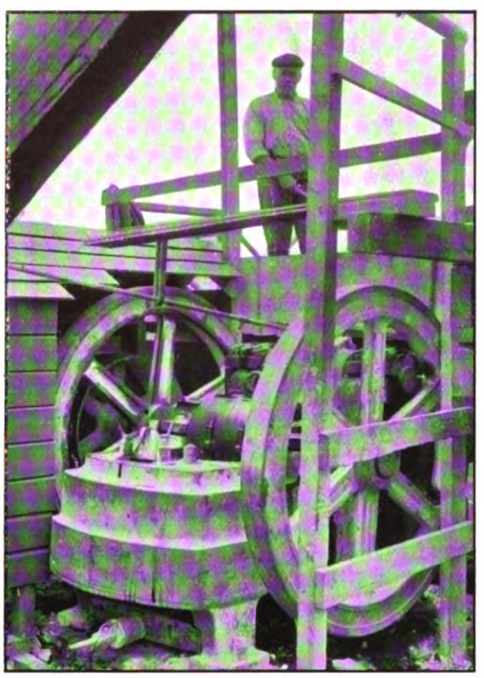


Fig. 3.—Rock Breaker driven by Electric Motor.

ton against 2·4s. per ton by the old method, the extreme flexibility for driving auxiliary plant and for extensions being not the least benefit obtained from the motor drive. All the electrical apparatus for this mine was supplied by the Brush Electrical Engineering Co., and installed by them to the directions of Mr. R. D. Gill, the consulting and resident electrical and mechanical engineer to the Cornish Consolidated Tin Mines.

CORRESPONDENCE

THE INSTITUTION OF CIVIL ENGINEERS.

To the Editor of Electrical Engineering.

Sir,—We have to-day received a communication from the Secretary of the Institution of Civil Engineers notifying us of a special general meeting of corporate members of the Institution to be held on Friday next, April 3rd.

(1) To authorise the Council to enter into an agreement for the sale of the Institution premises to H.M. Government; and

(2) To consider, and, if approved, to adopt the following alteration of the by-laws of the Institution:—

Section V., clause 6, to be altered by the omission of the words in brackets, and the addition of the words printed in italics.

Every new Member *shall, on admission to the Institution, pay a fee of twenty guineas, and every* Associate Member and Associate shall, on admission to the Institution, pay a fee of ten guineas, [but no payment, other than the increased annual subscription, shall be due from an Associate Member on his transfer to Membership,] *and every Associate Member on his transfer to Membership shall pay a fee of ten guineas. All such fees paid on transfer and one-half of the fees paid on election to Full Membership shall be treated as revenue unless otherwise directed by the Council.*

The letter further asked for a reply on a post-card enclosed expressing agreement with or dissent from the proposal before March 31st. We venture to think, Sir, that the proposals deserve more time for consideration and discussion amongst the members than can possibly be given under the circumstances indicated above, and that before members can express their opinions as asked for on the post-card they are entitled to further information.

The existing premises must presumably have been taken over by the Government at a fair price, and one fails at first sight to see the necessity for: (*a*) a special building fund, (*b*) additional revenue derived from transfer and entrance fees. Surely it is putting the cart before the horse to ask for an expression of opinion before the meeting, when, presumably, information will be given.

We venture further to think that the vote on the proposal to alter the by-laws should be taken, not at this meeting called at only a week's notice, but at a further meeting at a later date, when those members who may be prevented from attending on April 3rd have had an opportunity of considering the matter in the light of the printed report of the explanatory meeting.

Many members are disposed to think that the erection of the new buildings provides the opportunity for making the premises of much greater convenience to the general body of the members than has been the case in the past.

It is true that engineers have at the ordinary evening meetings opportunities of meeting brother engineers from the provinces and abroad, but it appears to us that the Institution might in a much greater degree than hitherto constitute a rallying point and meeting place for the members generally, and a place where informal discussions and conversations could be carried on.

The present building, stately as it is, does not contain a single cosy corner where two engineers can talk, much less smoke a friendly cigar together.

This is, however, neither the time nor the place for consideration of such details, and we merely beg the hospitality of your columns to enable us to make an appeal to fellow corporate members who may think with us to ask for further time in which to come to a decision and to communicate their views in writing to the Secretary and to attend the meeting on April 3rd.

We are, Sir, yours truly,

H. W. Handcock,
A. H. Dykes,
(*Associate Members of the Institution of Civil Engineers.*)

1 Victoria Street, S.W.,
March 30th, 1907.

THE FUTURE OF THE TELEPHONE SERVICE.

To the Editor of Electrical Engineering.

Sir,—Mr. A. R. Bennett is mistaken with regard to my relations with the National Telephone Company. My connection with that company is purely advisory, and I do not hold the "distinguished position" referred to, or any position in the company's organisation.

Mr. Bennett lives in a telephone world of his own, and presents the remarkable spectacle of a man who not only does not learn from the experience of others, but apparently does not learn from his own. The Glasgow municipal telephone system, the only one in which the experiment was tried on a serious scale, was run according to Mr. Bennett's theories, and it was such a hopeless failure that the Glasgow Corporation (who do not give up easily) were glad to sell it at a loss after a working life of a little over three years. No more convincing proof of the incorrectness of the theories could be desired.

There could be no surer way of making the telephone service of a large city both inefficient and unprofitable than to adopt a tariff having a low flat rate and a low message rate. Such a tariff positively encourages the users to make the service in-

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efficient, and at the same time prevents the administration from making a profit.

The Imperial German Post Office has tried for years the experiment advocated by Mr. Bennett, has found it a failure, and is reverting to an exclusively measured rate tariff. In Berlin last January the Under-Secretary of State told me that his principal argument for the measured rate was that it would raise the efficiency of the service, which was being ruined by the excessive use of the flat-rate lines.

And that is my argument—more, my absolute conviction. The measured rate tariff, as well as encouraging the development of the telephone, improves the efficiency of the service. To the commercial community the important point is a highly efficient service, and the precise amount of the rate is a minor point. Any man in a large way of business will tell you the same thing—and that is the whole telephone question in a nutshell.

I am, &c.,

Herbert Laws Webb.

35 Old Queen Street, S.W., March 24th, 1908.

NO-VOLT RELEASES FOR POLYPHASE MOTORS.

To the Editor of Electrical Engineering.

Sir,—With regard to the recent controversy which has arisen with respect to the provision of no-volt release adjustments to polyphase motor switches, we desire to state that we have had considerable experience in this direction, especially in connection with high-tension switches, which we have now so far standardised that we can supply, as a thoroughly tested and commercial article, a form of starting gear for two- and three-phase motors fitted with no-volt release. This apparatus we can put forward with our fullest guarantee as to entirely satisfactory operation. You may remember that we sent you in the autumn of last year our large high-tension catalogue No. 67, which includes full details of the apparatus in question.

Yours faithfully,

The Union Electric Co., Ltd.

London, S.E., March 24th, 1908.

COMMERCIAL VEHICLES AT OLYMPIA

THE exhibition opened last Friday at Olympia is the second of the annual series of displays of "commercial" vehicles and motor-boats which the Society of Motor Manufacturers and Traders have organised since it was found necessary to arrange an independent show for these branches of the automobile industry distinct from that of vehicles for private use. Before noticing any particular stands, a few words may be said of the scope of the exhibits generally and the direction in which the different branches of industry represented by them has developed since the last show of its class a twelvemonth ago. The past year, so far as London especially is concerned, has seen not only a vast increase in the use of motor vans of all sizes for commercial purposes, but has witnessed the coming of the now ubiquitous motor-cab, and the putting upon the streets of the much-discussed but apparently successful "Electrobus." With regard to other types of motor-omnibus, strenuous attempts are being made to produce a more suitable design of vehicle than those hitherto in use, and experience has been gained in actual practise with more than one of the petrol-electric systems, which have been put forward as specially suitable for this class of work. The exhibition itself represents all these advances. Quite a large number of new motor-cabs are shown, and before the show is concluded it is hoped that an electric cab of modern design will make its appearance. An "Electrobus" of improved type, as compared with that shown last year, is exhibited, and two complete petrol-electric omnibuses are shown, as well as a finished chassis representing a system now at work in London. A few steam omnibuses appear, but the number of types of geared petrol omnibus exemplified is apparently less than last year. The use of accumulator-driven commercial vehicles other than omnibuses does not seem to be increasing in this country to anything like the same extent as in America, and we only find one stand in the exhibition devoted to the accumulator vehicle pure and simple, although, as we shall see, batteries form an important feature in one of the petrol-electric systems shown.

The stand of the Electric Vehicle Co., of 1 Earl Street, S.W., makes up for the fact of its being the sole representative of battery traction by the variety of its exhibits. Most prominent is the complete double-decked omnibus, built to order of the London Electrobus Co., which is of the improved chain-driven form described in Electrical Engineering, Vol. II., page 903. Five omnibuses of this type have already been delivered, and fifty more are on order. It will be remembered that they are considerably different in design from the first six electric omnibuses put on the road, in that two motors are used instead of one, and the live axle and differential gear formerly used has given place to an independent double reduction chain drive from each motor to one of the rear wheels. The motors are of the six-pole series wound type, each rated at 3·8 h.p., and each drives on to its own countershaft by a Morse silent chain. The controller is arranged for five speeds. In the first and second positions the motors are in series, with and without resistance respectively, and for the third and fourth speeds, parallel connection with and without the resistance is used. On the highest speed, which corresponds to a maximum of 12 miles per hour, the resistance is employed to weaken the fields. There are also three reverse speeds. The capacity of the batteries employed with these vehicles, some particulars of which were given in the article referred to, is sufficient for a mileage range of 45 miles, under service conditions, with the full complement of 34 passengers. We understand that 14 omnibuses of this type have been ordered by the Brighton and Hove Omnibus Co. Other vehicles on the stand include a chain-driven two-ton wagon, with two motors and a controller, giving four speeds forward and two reverse, for a range of 40 miles without changing batteries. A smaller delivery van, with a single motor and cardan shaft drive is also shown, as well as the electric carrier tricycle, which figured at the Agricultural Hall last week, and was referred to on page 464 of our last issue. This machine, which is of German origin, is driven by a single 3 h.p. Siemens-Schuckert motor, and is constructed to carry 3 cwt. The mileage range on one charge is said to be 30 miles, and the maximum speed attainable is ten miles per hour. It should be mentioned that the total weight, complete, but without load, is 7 cwt., of which 3 cwt. is formed by the battery. The battery is contained in a case under the box for the reception of the load, and is easily withdrawn by sliding out from the front. No connections whatever require to be made or broken, and the two metal rails upon which the battery slides are themselves the contacts. It is thought that these little vehicles will be found useful for such work as newspaper delivery, and other work where they can be connected to a charging board during the time when they are necessarily waiting for their load. Another new vehicle shown on the same stand is a two-seated passenger car, intended as an engineer's test and inspection car for tramway and electric supply work, and the example shown is fully equipped with electrical testing instruments. This handy little car weighs, complete, 17 cwt., of which 7½ cwt. is accounted for by the battery, and can travel up to 30 miles per hour, the mileage range is given as 80 to 100 miles. A vehicle which is suitable as an emergency repair wagon for tramway and other work, or for fire brigade purposes is also shown, and it is hoped that an example of the firm's "Electricab" will have crossed the Atlantic in time to be in the exhibition to-day or to-morrow. In order to show the possibility of touring in England on electric cars, a map is shown showing the various towns where charging facilities are available.

Turning to the petrol-electric omnibuses, which form perhaps the most interesting feature of the whole show, we find three systems represented, only one of which figured in last year's exhibition. A complete comparison of the systems which are actually available for omnibus work is not, however, possible, as one or two systems about which a good deal has been heard during the past year are unrepresented. In one of the systems shown batteries are employed, and under some conditions the transmission is mechanical, but in the other two, which represent the more general tendency, the transmission is at all times entirely electrical without batteries. All these are continuous-current systems.

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The three-phase system which some designers uphold so strongly is not exemplified. It is interesting to note that in all three cases the motors drive the road wheels through worm gear.

One of the most interesting vehicles in the exhibition is the omnibus on Stand No. 55 of the DAIMLER MOTOR CO., near the centre of the hall. This vehicle is equipped on what is sometimes known as the "automixte" petrol-electric system, due originally to M. Henri Pieper, of Liège, in which an ordinary petrol engine is coupled to a machine which can act either as a dynamo or a motor according to circumstances, as it is also connected through a clutch and suitable reduction gear to the rear wheels. A small battery of accumulators also forms a feature of the system. When the car is at rest, or when the full power of the engine is not needed for propulsion, the dynamo is employed to charge the battery, but when extra torque is acquired for starting or hill climbing the battery drives the machine as a motor to assist the engine. Mechanical change speed gears are thus avoided, and it is claimed that a smaller engine may be employed, as only the average and not the maximum horse power required has to be considered. The vehicle is driven through an electro-magnetic clutch, and an electro-magnetic brake is also provided. The details of the system have been repeatedly described in the technical press, and a few light cars equipped on this principle are running in this country. The vehicle on the Daimler stand, however, is the first example of the system as applied to omnibus work which has been seen in England, although a similar vehicle is now in actual service in Paris. The equipment, so far as the arrangement of the electrical gear is concerned, is practically the same as that used on smaller cars except that in some of the omnibuses already built the arrangement of solenoid control of the throttle has been omitted in favour of hand regulation of the engine speed according to the indications of a voltmeter, and a positive clutch has been added between the engine and the dynamotor in order to facilitate running the vehicle on the electrical gear only in cases of necessity. Indeed, it was driven into the exhibition in this manner, as the running of petrol engines inside the building is not permitted. In this connection it may be remarked the placard on another stand stating that a certain other omnibus was the only vehicle to enter the hall under its own power is incorrect. Although it has not been exhibited before, this omnibus has been completed for more than a year, and has already been submitted to extensive road trials, so that it may be said to have emerged beyond the experimental stage. It came by road from the works, and will be driven back there at the conclusion of the show. The engine in the particular vehicle exhibited is a 4-cylinder Daimler engine of 120 mm. bore by 130 mm. stroke, with a rating of about 30 h.p., and the dynamotor, which is of the interpole type, was manufactured by Messrs. Dick Kerr & Co. The battery, which is placed under the driver's seat, is of the Tudor pattern, with Planté plates, and weighs 7 cwt., but on account of an absurd insurance regulation it has been removed since the vehicle was driven into the show. The size of engine and battery required naturally depends upon the nature of the service required, and the length and steepness of the hills to be encountered. It may be urged against the system that the battery is liable to run down when ascending a hill longer than that for which it is designed, and that this may prevent the vehicle being able to get up the hill, but all that is necessary in that case is to stop for a few minutes with the engine running and give the battery a short charge. There are several interesting points in the mechanical arrangement of the vehicle. The engine, dynamotor, and clutch are bolted up together and mounted by a three-point suspension in the main frame, which is connected to the front axle by springs in the usual way. The back part of this frame, however, upon which is mounted the gearing by which the back wheels are driven, is entirely unsprung. The body is mounted on an independent frame hinged to the under frame by the dash board, and supported by springs at the back. The under frame is made with as little bracing as possible, and has considerable sideways flexibility. The body, although free to move vertically on its springs, is constrained from lateral motion by horn blocks at the back. The drive from the magnetic clutch to the back wheels is through a longitudinal shaft driving a differential countershaft through a worm gear with a final enclosed spur reduction gear to each wheel.

The 30-33 h.p. petrol-electric chassis on Stand No. 36 of Messrs. J. & E. HALL, of Dartford, is exactly similar to that of the Hallford omnibus with petrol-electric equipment under the S. B. & S. syndicate and Stevens patents, which is now being run in actual service in London by Messrs. T. Tilling, Ltd., and which was fully described in an illustrated article in ELECTRICAL ENGINEERING, January 16th, page 83. The only difference lies in the design of the pressed steel frame. The working of this omnibus was referred to in the Paper read by Messrs. P. Frost Smith and W. A. Stevens recently before the Society of Road Traction Engineers, and reported in ELECTRICAL ENGINEERING, March 26th, page 475. The system falls under the class of petrol-electric systems, in which the transmission is at all times electrical and does not employ batteries. A 30 h.p. 4-cylinder engine drives a shunt-wound interpolar dynamo, which supplies current to two series-wound motors, one of which drives each back wheel through a specially-designed worm-gear. The use of a live back axle and a differential gear are thus entirely avoided. Provision is made for connecting the motor in series or parallel, but it is only in exceptional cases that the series notch is required. The control of the speed of the vehicle is effected almost entirely on the accelerator pedal and the field switch, and under ordinary conditions the main circuit is never broken, even at stopping. Before starting, unless the gradient is very steep, the controller lever is put into the parallel notch with the engine running slowly, and the generator field reduced. In order to start, the brakes are released, and the engine is accelerated by opening the throttle with the pedal, so that the voltage of the dynamo rises, the field switch is gradually moved over to raise the voltages as the vehicle gains speed. The running speed is then controlled by the throttle pedal, and to stop the throttle pedal is released, the dynamo field weakened, and the brake applied. The petrol consumption in actual service has been found to be 5¾ miles to the gallon, which, we are informed, is ¾ mile better than is obtained on the average by Messrs. Tilling for gear-driven omnibuses.

Another petrol-electric omnibus is exhibited by Messrs. GREENWOOD & BATLEY, of Leeds, on Stand No. 26. The actual chassis is the same as that exhibited on this firm's stand last year, but during the interval an engine of improved design has been fitted, and road trials to the extent of over 1,000 miles have been conducted with a three-ton load. The vehicle has been completed by the addition of an omnibus body, but no alteration has been made in the electrical equipment. A description of the chassis as it appeared last year was given in ELECTRICAL ENGINEERING, Vol. I., page 461, but it may be of interest to repeat the main features of the system. As in the last-mentioned system, the transmission is entirely electrical, and does not depend on accumulators. A continuous current compound-wound generator fitted with commutating poles is driven by the engine, which is of 35 h.p. This supplies current through a suitable controller to a specially designed motor provided with two armatures in one field casting. The double motor is mounted on trunnions near the centre of the frame, and is connected to the centre of the back axle by a stout tubular radius rod. Each armature drives its own half of the back axle through its own worm gear through a shaft provided with cardan joints. Thus no differential gear is required. The compounding of the dynamo is so arranged that the voltage shall hold up well till the engine begins to slow down, and it is necessary to perform the operation equivalent to changing gear. This is claimed to give better results than the falling characteristic obtained by the differential constant output employed in some systems in conjunction with series motors. The controller is actuated by a lever on the steering pillar, and is of the drum type with magnetic blow-out. The four forward speeds are by various arrangements of the motor armatures and fields in series and parallel, entirely without resistances. A good deal of the control is effected by variation of the engine speed, and for this purpose the usual throttle and ignition lever are provided above the steering wheel. One great advantage of this is that when speed has been attained on the level the speed of the engine can be reduced. Stopping and restarting are effected by a single foot-pedal, which actuates the main circuit breaker, and at the same time cuts out a large portion of the generator shunt field winding, thereby reducing the voltage. By this means a very smooth start is obtained, as the field has to build up after the pedal is released. The pedal is interlocked with the throttle so that the engine is slowed down when the main circuit is broken. The same pedal actuates, in its most forward position, the brakes on the motor shafts.

The trials on the road have shown a petrol consumption on a fairly hilly country route of six miles to the gallon. This was, however, with a new engine, which will show better economy when thoroughly run in. This figure, however, must not be taken as too much of a guide as to the probable consumption in ordinary service, with frequent starting and stopping. We understand that the result of experience on the road has been to show that a less number of controller notches would have been quite sufficient, as nearly all running can be done on the top speed, and the circuit breaker has been found to be almost unnecessary for ordinary manœuvring, although it is of the utmost use for sudden emergency stops. The ar-

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rangement of not having the circuit breaker interlocked with the controller allows of changing the connections on a hill with much less loss of way than would be otherwise possible.

The motor-boat section contains little of electrical interest, and in the gallery which is devoted to accessories, no striking electrical novelty is shown. Messrs. Lodge Bros. & Co., of Birmingham, have a most effective show of electric igniters on Sir Oliver Lodge's system, of the excellence of which we can speak from personal experience, and exhibit forms both for motor cars and large gas engines. The leading particulars of the system were described in Electrical Engineering, Vol. II., page 798, in connection with the exhibition of private cars. The Bosch Magneto Co. show their latest form of ignition with electro-magnetic plug, as also described and illustrated last November in the article in question. A number of other well-known ignition devices are also represented.

THE CHICAGO DRAINAGE CANAL ELECTRIC POWER PLANT

THE accompanying illustrations give a few details relating to the hydro-electric power plant and equipment on the Chicago drainage canal at Lockport. This power transmission plant, owned and operated by the Sanitary District of Chicago, has a capacity of 16,000 kilowatts for the present development, with extensions provided for a power-station of an output of 32,000 horse-power. The drainage canal and power plant has cost over fifty million dollars. The canal extends a distance of 29 miles from the Chicago River to Lockport, Illinois, where it discharges into the Desplaines River, and the water flows finally through the Illinois River and empties into the Mississippi River, and thence at last into the Gulf of Mexico.

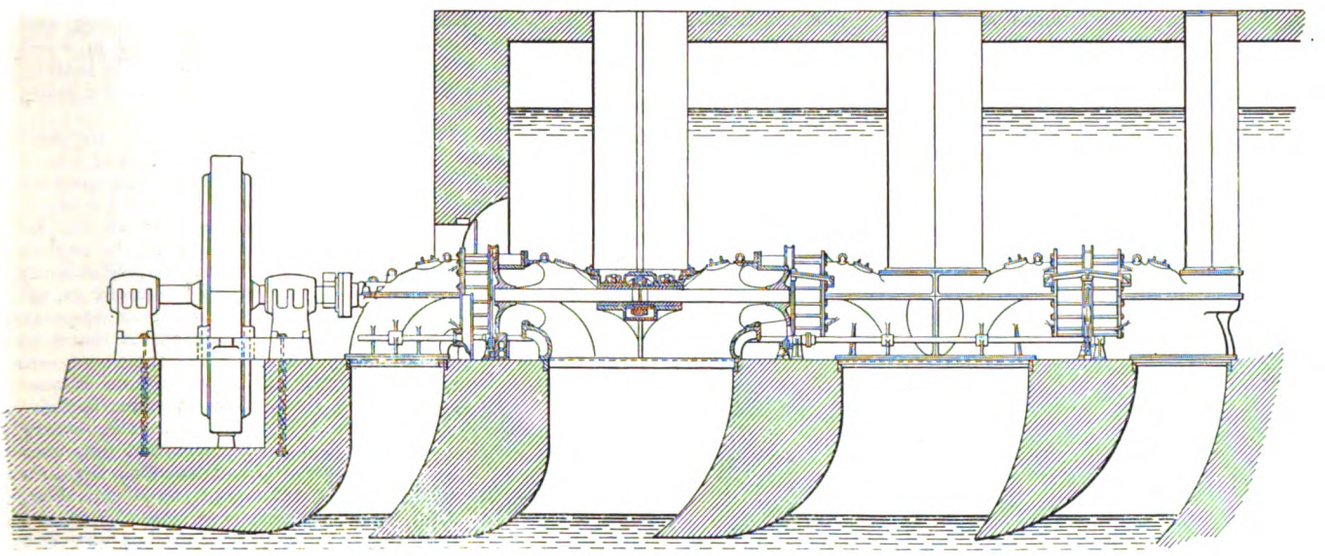


Fig. 1.—Sectional Sketch Showing Arrangement of Water Wheels.

The generating plant is situated at Lockport, about three miles from the city of Jolliet, where there is a regulation flow of more than a quarter of a million cubic feet of water per minute with a fall of twelve feet, the water being regulated by means of a "bear-trap" dam. The power-house is 385 ft. long and 47 ft high, with a width of 70 ft., and is of steel and concrete construction of plain but neat design. By extending the channel to a point about two miles further down from the point above-mentioned, instead of 12 ft. fall there is a fall of 34 ft., and here the power-house was placed, with a retaining wall for the channel 40 ft. high, bringing the water-level on the receiving side near the top of the power-house. The turbines have been installed in chambers at the floor-level, and work under a head of 34 ft. discharging through the chambers to the tailrace. The controlling works or movable-crest dam is on the east joining the power-house, and is designed to regulate the flow of water in the canal. The general arrangement of the plant is shown by the sectional sketch in Fig. 1.

The water-wheels, four in number, have been constructed by the Wellman-Seaver-Morgan Company, and a fifth unit will be installed in the spring. Each of the main turbines drives a three-phase alternator of 4,000 kilowatts capacity. There are two water-wheels of the same construction driving direct-current exciter dynamos, each of a capacity of 350 kilowatts. This plant was designed for eight alternators and turbines of 4,000 kilowatts each, and three exciter sets of 350 kilowatts each. The power-house is provided with a 40-ton electric overhead travelling crane of 35 ft. span, moving over the generator space along the north side of the power-house, which is 385 ft. long. The water-wheel for each unit is in a chamber adjoining, and has a capacity of 6,000 h.p. at a speed of 163 revolutions per

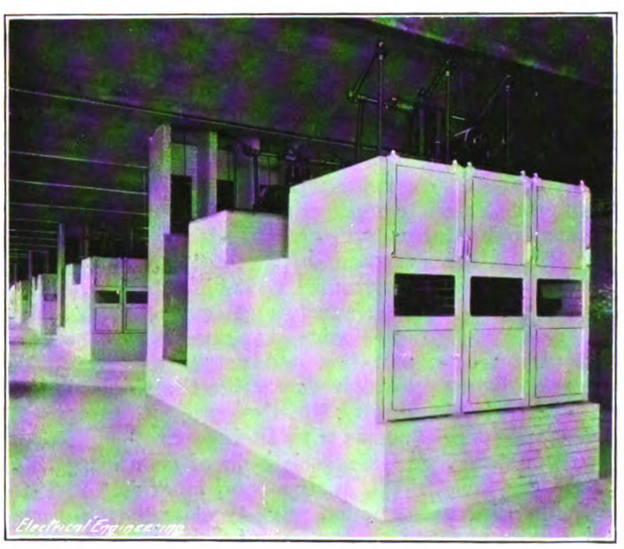


Fig. 2.—High-tension Switch Cells.

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minute. The exciter sets have water-wheels of 600 h.p. each, each of these units being capable of supplying direct current sufficient for exciting the fields of several alternators.

The 4,000-kilowatt three-phase generators are of the Crocker-Wheeler type with revolving fields, and are wound for a pressure of 6,600 volts at 60 cycles.

The switchboards and step-up transformers, as well as the 'bus-bars, oil switches, and circuit-breakers, are on the south side of the power-station, and the transformers are on the main floor, with the 'bus-bars and oil switches on two galleries overhead. The arrangement of the cells containing the main oil switches is shown in Fig. 2, and the choking coils forming part of the protective equipment are shown in Fig. 3.

The transformer installation includes a dozen oil- and water-cooled step-up transformers of the General Electric single-phase type, each having a capacity of 1,333 kilowatts. There is an aluminium transmission line of 44,000 volts pressure, which conducts the current from the hydro-electric plant a distance of nearly 30 miles to a sub-station in Chicago, where the current is transformed down to 12,000 volts for local distribution. This transmission line consists of two circuits of three aluminium wires each mounted on insulators fastened to 60 ft. steel masts, the wires being spaced about 6 ft.

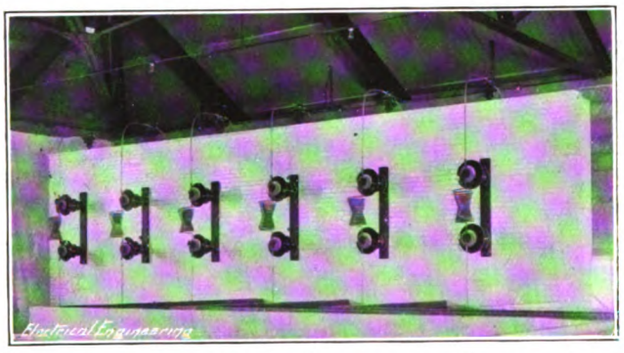


Fig. 3.—Choking Coils for Protection of Outgoing Lines.

apart. The masts or poles weigh about 2 tons each, and are of steel bridge construction, having a square base. Each mast is provided with two cross-arms, the top arm weighing 300 lb. and measuring 12 ft. in length, while the lower arm weighs double this amount and is 18 ft. long.

These steel masts or poles are placed 6 ft. in the ground, the holes being filled with concrete a half a foot above the ground, with rounded tops. The transmission wires on the lower arm are 47 ft. above the ground, mounted on insulators 12 in. high and 14 in. in diameter, tested to more than 100,000 volts. These high-tension insulators are provided with four petticoats or shells, and are mounted on a metal pin, the whole being designed for a horizontal strain of 5,000 lb. The poles are placed 350 ft. apart, and on the top of the poles an iron ground wire is carried the whole length of the line, and this conductor is expected to receive any lightning which may strike the transmission line, the iron poles carrying the discharge to the ground, being excellent conductors with their concrete supports.

The sub-station at Chicago is built of concrete 42 ft. high and 70 ft in width, with a total length of 124 ft. The sub-station is equipped with the usual step-down transformers and switch equipment, with motor-driven centrifugal pump for supplying cooling water to the transformers. The Sanitary District of Chicago has contracted with the municipality of Chicago for the supply of 7,000 kilowatts for the electrical department of the City. The Chicago sub-station will also supply current for the pump of the north channel, where 450 h.p. motors of the slow-speed type are used.

ELECTRIC OMNIBUSES IN PHILADELPHIA

A SERVICE of electric omnibuses was inaugurated last summer in the principal streets of Philadelphia by the Auto Transit Company. Some details of the generating station from which current is obtained for charging the batteries have already been given in Electrical Engineering (Vol. II., page 143). The principal feature of the generating plant is compactness, which is obtained by the use of de Laval turbines. The garage and accumulator charging and repairing shops which adjoin the generating station are described in a recent number of the *Electrical World* (New York), and it is of interest to compare the methods employed with the working of the London "Electrobus" (Electrical Engineering, Vol. II., page 905).

The room devoted to charging and repairing batteries is equipped for handling 80 batteries, and space is provided for 40 additional batteries. These are placed on timber stands and lead-covered cables are run to each stand. The negative leads are brought from the charging board located on the gallery at one end of the room, while the positive leads are all connected to a common busbar built up of copper strips and mounted on porcelain blocks, the whole being encased in wood boxing. The cables are carried along the floor under the battery stands and are thus out of the way when the batteries are being shifted.

The charging board is made up of 10 slate panels. On each panel is an ammeter and 12 three-point switches, each of which connects with a battery stand on the floor below. The operator is thus enabled to connect the battery to any desired busbar. The ammeter is arranged with a portable shunt which can be inserted in the clips of the switches in place of the switch blades used for closing the circuit so that the charging current of the battery may be observed, after which the shunt is removed and the switch closed, thus permitting one ammeter to serve the 12 switches and reducing the wiring on the board to the limit of simplicity. Three voltmeters are mounted on one end of the switchboard. Two methods of charging are in use. In the three-voltage scheme the potential on the three busbars is 90 volts, 100 volts, and 110 volts respectively. The battery is connected first to the 90-volt bus until the current decreases to a specified value, when the battery is switched on the 100-volt bus. The battery is finally connected to the 110-volt bus, where it remains until it is fully charged. In the second scheme, sufficient batteries are connected to one bus and one turbine is run under that load until the batteries are fully charged. Once started, little attention is necessary, and this is the quickest possible way of charging the batteries. In addition, the plan has the advantage of keeping the generators fully loaded, and is conducive to high efficiency.

The battery room is well ventilated, and has practically no exposed iron work. The battery-room floor is of asphalt. The battery trays are handled by a two-ton electric crane. The charged batteries are placed on trucks or cars which are pushed by hand in front of the battery ram. The latter is operated by a $\frac{1}{4}$-h.p. series-wound motor. The field coils of the motor are connected in parallel so as to give the motor sufficient torque. A friction nut is placed in the ram gearing to limit the thrust of the ram and prevent injury to either the ram or the battery. The equipment is capable of handling a battery every two minutes, and cranes, trucks and rams are provided in duplicate to guard against delay in case of breakdown. Distilled water is supplied from the condenser to a cedar tank located over the battery ram and the water is piped to convenient points in the battery room for use in the batteries. The storage batteries used are manufactured by the Electric Storage Battery Company, of Philadelphia. Each tray contains 42 cells of type 21 MV, connected permanently in series. The rated discharge of the battery is 70 amperes for four hours.

The method of handling the omnibuses as they come in is as follows:—The omnibus is run into a driveway until opposite the ram. In front of the ram is a battery truck or car with a fully charged battery. On the other side of the omnibus and directly opposite the ram an empty car is pushed. The battery in the omnibus is disconnected from circuit and an operator closes the switch which sets the ram in operation. In one operation the fully charged battery is pushed into the omnibus and the latter battery in turn pushes the exhausted battery out of the other side of the vehicle onto the car placed there to receive it. The connections to the new battery are quickly made, and in less time than it takes to relate it the omnibus continues on another trip. The batteries are lifted off the trucks by an overhead travelling crane, and taken to the required part of the battery room. In the repairing department there

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is a small electrically-driven compressor for supplying air to the hydrogen blow-pipe used for lead burning.

The omnibuses, of which there are 25 in use, are of the double deck, London type, seating 34 passengers—18 on cross seats on top and 16 on side seats inside. The vehicles were built by the Commercial Truck Company of America, and the chassis is of similar design to that described in Electrical Engineering, Vol. I., p. 689, which was exhibited in one of the London automobile exhibitions, and experimented with the Electrobus Co. in London, although not finally adopted by them. Each wheel is equipped with a series motor of special design rated at 22 amperes, 90 volts, and 1,600 r.p.m. The motor is connected through a 14 to 1 double reduction gear to an internal gear attached to the hub casting of the wheel. The normal speed of the vehicle, fully loaded, is 12 miles an hour on a level street. The four motors are controlled by a revolving-cylinder controller having street-railway type of fingers. The combinations made are as follows: First notch, four motors in series without resistance; second notch, two front motors in series and in series with two rear motors in parallel with no resistance; third notch, motors in series parallel; fourth notch, motors in parallel with resistance; fifth notch, motors in parallel with no resistance. A bus under ordinary conditions and when fully loaded can travel 30 to 33 miles on a charge; but the trips are arranged so as to leave a safe margin to guard against the batteries running down while the bus is in regular service. Under the present arrangement the vehicles make two trips on one charge of battery, travelling a distance of 25 miles.

The vehicles are lighted by four 8-c.p. lamps, and two head and one tail lights of 4 candle-power are used to comply with the requirements of the automobile law. The brakes, which are operated by the foot, consist of hard-wood shoes pressing against a cast-steel surface on the hubs of the rear wheels. In addition, the controllers are designed to permit the motors to act as emergency brakes on the first notch with reversed connections in the event of the failure of the foot-brake. No circuit-breaker is used in the motor connections, but a cartridge fuse is inserted in each motor circuit. This fuse is large enough to permit sufficient current to pass for ordinary service and yet protect the motor.

The garage is designed to accommodate 50 vehicles. The omnibuses, when coming in for battery renewals, pass through the garage and give the attendants an opportunity for making close inspections and quick repairs. After the last trip a fresh battery is installed in the battery compartment under the body of the car, after which the vehicle is returned to the garage, where it is washed, inspected, and put in first-class order before being sent out the next morning. The repair shop is located in the same building with the garage, a room 40 ft. by 128 ft. being provided for that purpose. Particulars are not given as to costs of operation.

TELEPHONE AND TELEGRAPH CABLES

A PAPER was read by Mr. F. Tremain on the above subject at a meeting of the Newcastle Local Section of the Institution of Electrical Engineers on Monday, March 23rd. The Paper dealt exclusively with paper-insulated lead-sheathed cables, as other types have not to any large extent been altered in character for many years. The cost is governed in the case of large multiple cables by the quantity of copper required, although in small cables lead may become the governing factor.

For telegraph purposes pure and simple a single wire insulated with paper and surrounded by a screening tape of copper is in general use, although in cables which may be used interchangeably for telephone or telegraph purposes pairs of wires are used for both purposes, as will be explained later. In each case a copper wire, which varies in diameter from 25 mils for local purposes to 113 mils for trunk purposes, is insulated by means of paper carefully selected and of long fibre. The paper is generally applied longitudinally in a suitable covering machine which is sometimes arranged to supplement the longitudinal wrapping by a helical covering, both being applied without much tension, so as to leave as much air-space as possible between the wire and the individual wrappings of paper. In lieu of the helical wrapping of paper a whipping of thread is used. The paper used varies in thickness from 3 or 4 mils to as much as 10 mils in the case of very heavy conductors. In the case of screened conductors the screening copper tape is about 3 mils in thickness and about $\frac{1}{4}$ to $\frac{3}{8}$ in. in width applied helically with a slight overlap, its object being to screen the conductor from the inductive effect of neighbouring conductors traversed by telegraphic impulses. The screened conductors vary in diameter from 50 mils weighing 40 lb. per mile to 113 mils weighing 200 lb. per mile, and in the smaller sizes the screening tape, although rolled as thin as possible, is practically of the same weight as the conductor itself. Care is taken in stranding the wires into a cable that the screening tape is in contact with the lead sheathing and therefore earthed. The electrostatic capacity of such a conductor measured to earth is 0·097 to 0·133 microfarads per mile.

When the conductors are not screened, two wires insulated in the manner described are twisted together in a twinning machine with a definite length of lay varying in Post Office cables from 4 in. to 13 in., and each length of lay is indicated by the use of a coloured wrapping, which ensures that no two pairs of the same lay are adjacent when the pairs are stranded to make a cable or cable core. The electrostatic capacity varies from 0·04 to 0·07 microfarads per mile, and the self-induction from 0·9 to 1·4 millihenrys per mile. A rough empirical rule for determining the space requisite for any desired wire-to-wire capacity, with the class of paper and method of covering usually employed, is that if the diameter of the completed pair of wires is three times that of one of the conductors, the wire-to-wire capacity measures about 0·07. If the ratio is four to one, the capacity measures 0·055 or thereabouts, whilst if the diameter of the pair of wires is increased to five times that of one of the conductors forming it, the capacity falls to a little over 0·04 microfarads per mile.

It is not impossible, therefore, to obtain in a cable a more efficient loop with conductors weighing 100 lb. to the mile than with 150-lb. conductors; for if the latter are made to have a capacity of, say, 0·07 microfarads per mile and the former 0·045 microfarads, on the basis of k.r. alone the 100-lb. loop would be more efficient, and in addition it would have a higher inductance, say 1·2 millihenrys per mile as against as little as 0·9 millihenrys.

There is room for much ingenuity in the assembly of the pairs of wires to form a cable. The original method was to strand the alternate pairs up layer by layer in a stranding machine, each alternate layer forming a left-handed and right-handed spiral. The number of pairs thus stranded varies from seven pairs in a small distribution cable to as many as 606 pairs in the largest main telephone cable.

Two other methods of stranding the pairs are in general use:—(*a*) The quadruple pair type. (*b*) The multiple twin type, of which more is said below.

The varied requirements which multiple subterranean cables are required to meet may be classified as follows:—(*a*) Trunk-line telephone cables. (*b*) Junction telephone cables. (*c*) Main telephone cables wholly allocated to subscribers' lines from an exchange centre. (*d*) Composite cables providing for any two or three of the above services. (*e*) Composite cables primarily intended for telephonic purposes, but also containing telegraphic wires.

The chief defects in the original type which these special cables were designed to avoid are:—(*a*) Their inefficiency for anything but short-distance communications. (*b*) Their costliness in the provision of spare wires. (*c*) The waste involved in the uncertainty as to the ultimate requirements at the points selected for distribution.

They are also unsuitable for superimposed circuits, in considerable use on aërial lines to which these are often connected, and they generally provide for the short-distance subscriber's circuit the same weight of conductor as for circuits of greater length. As regards the last point it may be noticed that an ideal conductor for subscribers' circuits would be one that tapered gradually, from the longest distance served on a route to the shortest from the exchange, the wire-to-wire capacity per mile being also reduced as the length increased. This also applies to multiple trunk-line cables, in which it is rarely possible to allocate, in the first instance, the whole of the wires for suitable trunk lines. Now it is clearly impossible to secure this ideal equality of treatment in a telephonic network, nor is it possible, when multiple cables are used for trunk circuits, to provide equal efficiency for lines of varying length unless the ultimate appropriation of all the wires can be foreseen. On an aërial line, on the contrary, conductors of suitable gauge can be added from time to time. It is to meet these difficulties that composite cables, containing different gauges of wire, have been

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manufactured, but their utility is limited, and they have the disadvantage that a larger number of conductors of fixed gauge have to be provided for future use. This condition naturally suggests the grouping of wires in a cable to form conductors of larger cross-section, an arrangement which cannot be carried out with any electrical advantage in the case of cables in which the pairs of wires are arranged in layers in the usual manner.

In the two types above mentioned this difficulty is met by stranding pairs in such a way that, (*a*) in addition to the individual pairs being available to form a twisted looped circuit, the wires of two or more pairs may be bunched to provide double conductivity without materially increased capacity; (*b*)

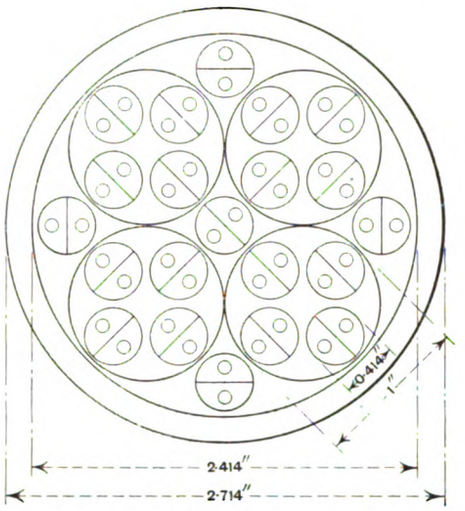


Fig. 1.

by the use of transformers the unit loops can be utilised for a circuit at the same time as those of double conductivity. In quadruple pair cable four pairs of wires are stranded around a centre of yarn, to form quadruple pair cores, and where the conductors are large enough, weighing 100 lb. or more per mile, to worm these four pairs with four pairs of smaller gauge, weighing 10 lb. or more per mile, forming an eight-pair core. These cores are then laid up into a cable of any desired number of pairs. Quadruple pair cores, being large, allow of the helical interstices formed in each layer being utilised for smaller pairs of wires, as may be found necessary.

The quadruple pair formation admits of two diagonal pairs being each bunched to form conductors of double conductivity,

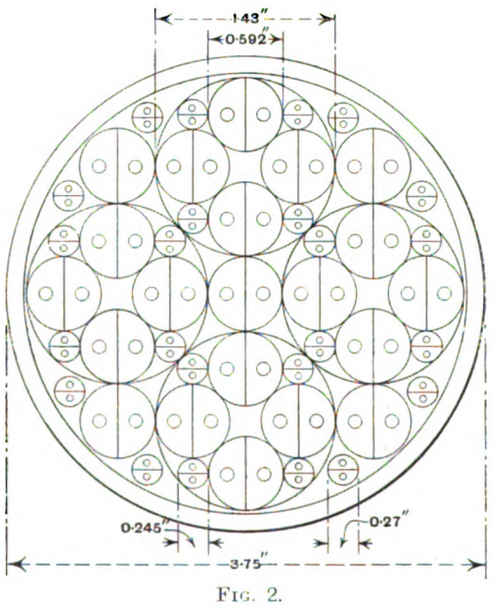


Fig. 2.

the two pairs being used for a metallic telephone circuit. The stranding of the four pairs around a common centre ensures that these loops of double conductivity shall be non-inductive to any similar loops in the same cable. The mutual capacity between these conductors of double conductivity is not materially greater, and may be made actually less than that obtained between the conductors of the unit pairs of which they are made up. An electrical advantage is thus secured, and speech can as a result be carried on over a much greater distance. In the same way all the four wires forming a part of two neighbouring pairs can be grouped together to form a conductor of fourfold conductivity, and can be associated with the other four wires, similarly grouped to form a telephone loop, this loop of fourfold conductivity being non-inductive to other loops in the cable. The capacity of such a loop is necessarily higher than that formed of diagonal pairs, but the arrangement would sometimes prove advantageous. The worming pairs can also be grouped in the same way, and the mutual capacity results obtained with this combination are interesting.

All the remarks as to bunching conductors apply to superimposed circuits, for one of these loops is obtained, in such a system, by bunching the initial conductors through one winding of a transformer. The general result obtained will be best illustrated by reference to a diagram of a 42-wire cable (Fig. 1), excellent electrical tests having been obtained with a cable of this type. It will be seen that the cable is formed of four quadruple pairs laid around a central pair of the same size and wormed with four pairs of equal weight, this being the correct geometrical formation. The wires of the pairs forming each core are laid up with a different lay, to ensure immunity from cross-talk and to ensure the same result when the pairs are bunched as described; the four quadruple cores have also different lengths of lay. The quadruple cores in this cable are about 1 in. in diameter, and the complete cable over the lead sheathing has a diameter of 2·71 in., which is nearly the maximum size permissible for a 3-in. pipe. This may be re-

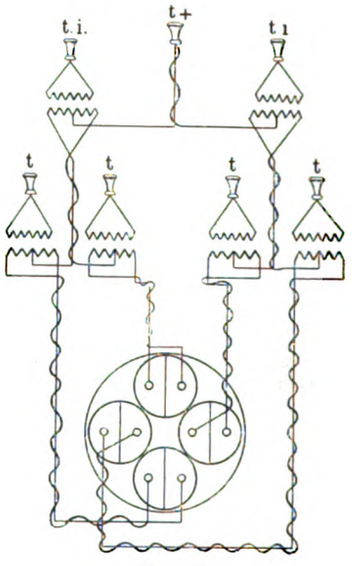


Fig. 3.

garded as typical of trunk-line cables, but for long-distance transmission it would be desirable to provide 200-lb. conductors and a cable 3¾ in. in diameter drawn through 4-in. pipes (Fig. 2). With such a cable telephonic speech between London and Manchester would be practicable. The cost, including pipework, cabling, jointing, and equipment, would be high—exceeding, probably, £300,000—but by the addition of 100-lb. worming pairs as shown in Fig. 2 and the sample on view 24 circuits would be provided, adequate for intermediate distances—a total of 48 metallic circuits. This number could be increased to about 60 by the superimposing scheme illustrated diagrammatically in Fig. 3. No doubt it would be desirable in such a case to provide for loading the cable with inductance coils at every 2 or 2½ miles.

In the multiple twin type the facility for increasing the conductivity without abnormally increasing the capacity of the heavier loop is obtained by a system of successive twinning. Two pairs of wires having been made in the way already described, these are twisted together to form a double pair. These two pairs serve the same purpose as the diagonal pairs of the quadruple core described above. A similar double pair having been prepared, the two double pairs are in turn twisted together to form a pair of fourfold conductivity (see Fig. 4). Eight-wire cores formed in this way are laid up into a cable, and although the fourfold pairs cannot be wormed with smaller conductors as can the quadruple cores, layers of them can be wormed with small groups of pairs or by single pairs as can

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layers of quadruple cores. Two 8-wire cores have been paired in the same way to form 16-wire cores. A multiple twin cable of 10-lb. conductor, containing 1,212 wires, provides facilities for utilising spare wires in the outer zones of a network in the manner referred to later. Quadruple pair and multiple twin cable cores, say 2 in. in diameter, are sometimes surrounded by a layer of ordinary twin conductors or by one or more layers of screened conductors for telegraph purposes, this latter being the method adopted in the case of the former type in connection with the West of England underground system, and in the



Fig. 4.

latter type in connection with the northern underground cables and the cable now being provided between Leeds and Newcastle (Fig. 5).

Cables this completely laid up ready for sheathing are dried in ovens or vacuum chambers to raise the insulation prior to sheathing with lead by passing the core through a lead press in precisely the same way as that adopted for other lead-covered cables. Immediately after sheathing the cable is submerged, and when cool tests for conductivity and insulation are made. As regards the latter test, it is interesting to note that an insulation of from 10,000 to 20,000 megohms per mile is frequently obtained, and that if the insulation of a core is allowed to fall much below 5,000 megohms the electrostatic capacity is raised.

In this country these cables are almost invariably drawn into pipes, the sizes generally used being 3, 3¼, and 4 in., joints being made at every 176 yards, or thereabouts, and sealed by a lead sleeve and carefully-wiped joints. These joints are tested under a pressure of 30 lb. to the square inch, it being essential that the cable throughout its entire length shall be absolutely air-tight. The method of jointing the quadruple pair and multiple twin cables is interesting. Although so far as the mechanical operations of jointing are concerned the ordinary methods are followed, great care is taken that the individual main cores on one side are joined to similarly constructed cores on the other side of the joint, and that individual wires or pairs do not cross from one core to another. As a general rule multiple twin cables are laid up in 8-wire cores, and the construction of the core and method of jointing are illustrated in Fig. 4.

40 or 50 miles. At the end of these sections transformers would be installed, the primaries of which would be connected with telephone exchanges on the line of route along which traffic is probable. The secondary windings of the transformers would be connected across the *A* and *B* of the loop. The central point of the secondary winding being accessible, it would be connected to the central point of the secondary winding of a similar

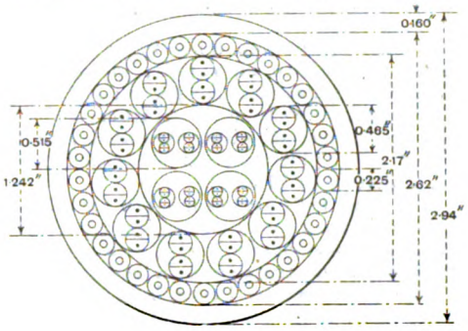


Fig. 5.

transformer connected to the *A* and *B* wires of the forward section of the same loop, this process being followed through the entire length of the cable. The diagonal loop having been similarly equipped at the same points throughout, we shall have available between the extreme ends of the cable a loop of 200-lb. conductors of low mutual capacity. The only disadvantage would be the insertion of non-inductive resistances at three or four places; whilst the great economical advantage will have been secured of having heavy conductors for communication between the termini, which have already been utilised for intermediate communications. The shorter circuits would be subject to the losses common to all inductive circuits; but doubtless transformers could be designed for such a purpose which would reduce these losses to a minimum, although the type in general use would be perfectly efficient for the distances indicated in this case. It is clear that, if four pairs forming a quadruple pair be symmetrically stranded around their common centre of yarn, the companion diagonal loops could be similarly utilised. Exhaustive experimental trials have been made on circuits 11, 33, 55, and 77 miles long in quadruple pair cables with complete success; and in addition super-superimposing has been successfully obtained by the insertion of transformers in the 200-lb. circuits and using as the *A* wire of an additional circuit two diagonal pairs of wires (400 lb. per mile), and as the *B* wire the companion diagonal pairs of wires in the same quadruple core, thus obtaining seven circuits with four pairs of

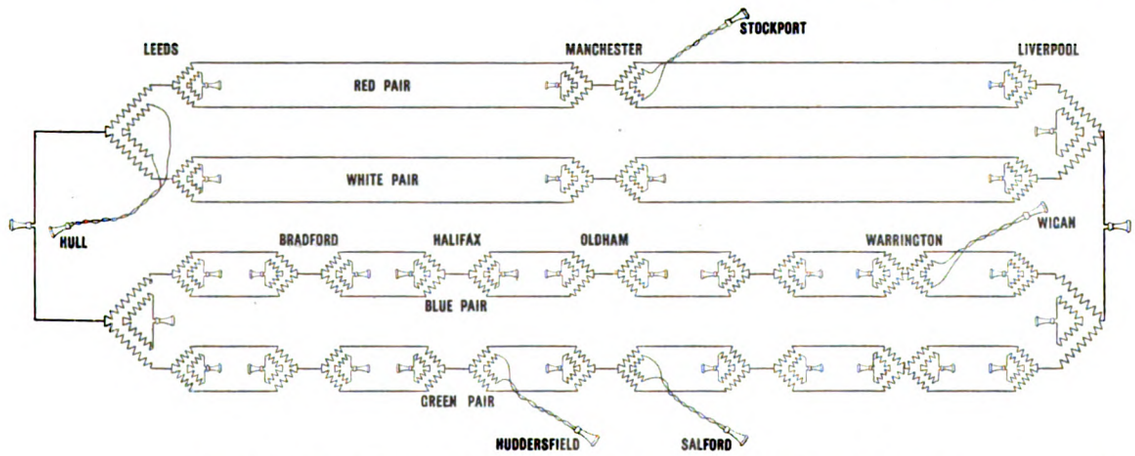


Fig. 6.—Diagram Illustrating Superimposition and Super-Superimposition.

As each of the differently coloured pairs of wires is laid up with a distinctive lay, it is necessary to follow a definite plan in jointing the pairs together, in order that the greatest immunity from inductive disturbance may be secured. Care is therefore taken in jointing these cables that (1) in any quadruple pair core similarly coloured pairs are not jointed together, and that (2) the diagonal positions of the pairs are maintained.

Superimposing.—An economical method of using such cables is illustrated in Fig. 3 by means of a quadruple pair core, but similar results are to be obtained with the multiple twin type. In the first quadruple cable cited, Fig. 1, the unit conductors, weighing 100 lb. per mile, would be used for distances up to

wire as shown in Fig. 3. There was a complete absence of cross-talk or inductive interference throughout the system.

As illustrating their utility, if cables of this type were used between Liverpool and Leeds, communication could be established between the following towns on the line of route by means of inductive circuits as described above:—Liverpool and Warrington, Warrington and Manchester, Liverpool and Manchester, Manchester and Oldham, Halifax and Bradford, Oldham and Halifax, Manchester and Halifax, Manchester and Leeds, Halifax and Leeds, Bradford and Leeds. Also by spur lines off the line of route connected to the transformers, between other places (see Fig. 6).

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In this way all the unit conductors will be utilised for short-distance communications between large towns having a community of interests, and therefore likely to provide an adequate traffic. At the same time conductors of double conductivity metallic circuit would be available for traffic between Liverpool and Leeds, with extensions by means of aërial lines to, say, Hull, Goole, Grimsby, York, and other places within about 100 miles of Leeds as a centre, and similarly with Liverpool as a centre.

Considerable lengths of two other types of quadruple pair cable have been manufactured, namely, (*a*) one containing 56 conductors, each weighing 100 lb. per mile, 15 miles having been laid between Liverpool and Warrington; and (*b*) one containing the same number of wires, associated with 26 screened conductors for telegraphic purposes between Manchester and Warrington, a distance of 19 miles.

The planning of an underground network for a local telephone system on economic lines presents a fascinating problem.

Certain transmission standards having been agreed to for local and trunk purposes, and the equivalent lengths of various conductors in cable and open lines having been determined in terms of a standard cable, it is made evident that whilst conductors weighing 10 lb. to the mile are necessary for many subscribers to an exchange system, there are a large number—probably the majority—of those connected to a well-placed exchange who could be efficiently served by a conductor of, say, 5 lb. to the mile. It is doubtful, however, if so small a conductor could be safely provided in a cable of the ordinary construction, as the pairs of wires would require to take the strain of the large stranding machine used for building up the entire cable. In quadruple pair and multiple twin cables, on the contrary, pairs are first assembled in small machines into suitable cores, and these 8-wire cores so manufactured would be quite capable of taking the strain involved in the final stranding of the cable.

These two types therefore bring within practical limits much smaller conductors than are now used, with the advantage that whenever necessary they can be bunched to form 10lb. or 20lb. conductor circuits.

There is one other method of increasing the efficiency of the line, and securing approximate equality of treatment in connection with a telephonic network, viz., the economy of filling the pipe or duct, within certain limits, without regard to the number of conductors. It should be regarded as an axiom of telephone engineering that, a given duct space having been provided at a heavy cost, a main cable should as nearly as possible fill it, and a low mutual capacity be secured where the wires in the outer zone are few. Thus, if circumstances should demand that a 2½-in. cable should only have a hundred conductors, these wires should not only be heavier if necessary than those near the exchange, but widely separated, so as to have a low capacity. It is conceivable that by this means a subscriber at a distance of more than two miles from the exchange may be able to speak over a long trans-continental trunk circuit with the same efficiency as one situated only a quarter of a mile from the exchange.

It will perhaps be well to emphasise the fact that notwithstanding the great success which has been obtained by the use of telephone cables, even for considerable distances, it by no means follows that aërial lines cease to be necessary. Not only are aërial lines a vital necessity if long-distance telephonic communication is to be secured, but the enormous growth of this long-distance traffic makes it difficult to find room on the highways for all the wires required for that purpose. Moreover, the short-distance trunk circuits, largely placed in the underground cables, are not suitable for long-distance communication.

The author then referred to the method of utilising these cables for telegraphic purposes, of which Sir John Gavey, in his Presidential Address, gave some particulars. The method consists of working a telegraph circuit in a loop, and superimposing thereon an earth circuit. Hughes instruments have been very successfully employed between London and Glasgow, without a repeater, both by means of the superimposed circuit and also by the use of screened conductors. These screened conductors have also been used for long-distance undulator circuits without a repeater.

A striking illustration of the efficiency of screened conductors is the 200-lb. wire used in the West of England underground. It is probable that before the end of the next financial year conductors of this type will be available between London and Land's End, the landing-point of various Atlantic and other cables. The length of this circuit will be about 310 miles, and it is interesting to note how it compares with an Atlantic telegraph cable, and what results would follow the extension of an Atlantic cable by means of it, if such an arrangement be possible, in order that direct communication might be accomplished between London and the American stations, without retransmission at the cable stations. The length of cable from this point to Nova Scotia is 2,531 knots. Assuming that one mile of the screened conductor cable equals one mile of submarine, the 200-lb. screened conductor between this point and London would represent about 310 miles of the Atlantic cable, increasing its length to 2,800 knots. In the same way the cables landing on the west coast of Ireland could be extended to London if a screened conductor cable were provided across Ireland, South Wales, and the Bristol Channel, to replace the open wires at present used for the Transatlantic traffic by this route in conjunction with a submarine cable—57 nautical miles in length across the St. George's Channel. If a cable of Atlantic type replaced this it would increase the length of Atlantic cable landed at Valentia from 1,847½ nautical miles to 1,904, and the screened conductor cable in England, Wales, and Ireland would be about 480 miles in length, thus making the circuit equivalent to 2,321 knots of Atlantic cable. The fact that one mile of the 200-lb. screened conductor in question is roughly equivalent to one mile of Atlantic submarine cable—although the conductivity of the latter is about 2¾ times that of the former—is due to the capacity of the Atlantic cable being 0·42 microfarads per knot (0·364 per mile) compared with 0·135 per mile for the screened conductor. It, of course, remains to be seen if the screening which is effective for ordinary telegraphy would be adequate if the conductors were joined to long submarine cable wires, but whether underground cable wires be stranded in pairs for use interchangeably for telegraphic or telephonic purposes, or provided with a screening tape for the prevention of inductive interference, they are a complete success for inland telegraphic purposes.

DISCUSSION.

Mr. A. L. E DRUMMOND (District Manager National Telephone Co.) regretted that it had been impossible for members to examine the Paper before its reading, as its character was such that any discussion on the spur of the moment would do justice neither to the author nor the questioner. He thought that in reference to superimposed circuits Mr. Tremain showed even more confidence than telephone experience in the past had given encouragement for, in expecting such a high degree of safety. He thought the effect of the transformers had been rather disregarded, as these instruments were not always faultless. He thought that the tendency nowadays was towards decentralisation in telephone systems. Ten years ago the cry was "centralise"; now the opposite fashion has set in. The true policy was therefore to make a careful study of the distribution and to put up smaller exchanges, and more of them than in the past. The necessity of approximating to the ideal equality of treatment of subscribers would be met in this way rather than in finding equivalents for the ideal tapering conductor described. With regard to the methods of jointing cables, there appeared to be some chance of complication. As the results of experiments conducted some time ago by his company, they fought shy of the use of coloured covering papers, as they found that the dyes affected the wires. With reference to multiple twin wires, he would point out in passing that such cables as delivered from manufacturers would sometimes come to hand with extra pairs of wires inserted as a margin for breakages; for example, a nominal 606 pair cable might really have 608 or 610 pairs of wires.

Dr. W. N. THORNTON (Armstrong College, Newcastle) pointed out the three electrical effects playing their part in a telephone cable:—Firstly, capacity, which retarded messages by means of the surface dissipation of the electrical impulse; secondly, the inductive effect, which in a telephone cable was an advantage in wiping out the effects of capacity; and thirdly, resistance, which acted simply as an absorber of energy. In Fig. 2 the capacity of circuits at opposite ends of a diameter 45° to the vertical would be the same as that of any single pair. This was probably due to the fact that the electrostatic lines go round the sheath and not straight across the core. Analogous results had been obtained in stream-line experiments. Of course, inductance would be greater in these diagonal groups, which would be an advantage. He would like to know whether better speech was obtained in super-super-imposed circuits. This might be possible, as there was more copper in circuit.

Mr. TREMAIN (interposing to reply) said that there was not much difference either way. The super-superimposed circuits did not benefit by the greater conductivity on account of the greater capacity introduced. For short circuits having small wires the performance on superimposed circuits was better, but not for long, heavy circuits. Moreover, the effect could again be varied by the way the lines were loaded, as each electrical impulse had its own electrostatic effect.

Mr. T. B. JOHNSON (Assistant Superintending Engineer Post Office) pointed out the great influence that lead-covered cable had had on modern telephone progress. The limits of speech with the use of indiarubber and guttapercha covered cables was easily reached, and Mr. Tremain had had much to do with the development of the lead-covered cable. It is not always possible entirely to foresee the extent of service, so that it is a

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wise course to provide many small wires and bunch a certain number to supply subscribers living far away from an exchange. For this purpose multiple twin and quadruple cables are useful. As a matter of fact, this course is at the present day in common use, two 20-lb. cables being, for example, bunched to make up a 40-lb. cable. He thought Mr. Tremain too sanguine with regard to super-superimposing, not so much with regard to underground cables, although the K.R. law was interfered with by the transformers, which, though non-inductive, reduced the efficiency on circuits containing them, but chiefly in cases where aërial wires were joined in. Owing to faults it is impossible to maintain these so well as to shut out slight disturbances, which, although almost negligible in ordinary practice, would be noticed in telephones where the speaking efficiency was near the point of exhaustion. He would like to know what Mr. Tremain thought of the idea of fixing copper tapes on alternate conductors only, instead of on every conductor. The copper tape would be earthed by its contact with the lead sheath. Intermediate conductors would be screened sufficiently by the presence of the copper sheath round neighbouring conductors, and much expense would be saved. It might be advisable to sheath all the inner conductors, which were very important, but was the cost of screening all the outer conductors justifiable? He asked whether it had been found that tinfoil was unsuitable for a screening material. Its cost would be much less than copper, but possibly there might be mechanical difficulties in the way of its use.

Mr. F. W. Gaskins (National Telephone Co.) pointed out that Mr. Tremain had referred to a 606-pair cable as the largest main telephone cable. He believed that in the system formally belonging to the Glasgow Corporation, and now to the Post Office, there was an 808-pair trunk. With reference to the insulation and conductivity tests mentioned as being necessary after sheathing, he assumed that the capacity tests were made at the same time. Referring to the example of trunk-service to towns mentioned, he thought that using Liverpool as a centre for the towns named was unnecessary. Was it not better to run wires direct from Leeds rather than to come back over the same ground?

Mr. Tremain, in reply, said that Mr. Johnson's doubts as to the question of using aërial lines as superimposed circuits were justified, and, as a matter of fact, branch extensions were often carried underground. As regards underground cable, however, there was no trouble to fear. It is always fine weather in a cable. In his experience with such cables, he could say that not a fault had occurred in two years. It was necessary to pump air very rarely indeed. Once lead cables were laid, they were practically sound. Only in such districts as Nantwich, where subsidence was likely to occur, was there any cause for anxiety. He agreed it was not worth while superimposing on small local circuits. The point as to the principle of decentralisation was one he was not going to attempt to settle that evening. But if a cable is provided capable of giving satisfactory service to the person furthest from the exchange over the longest distance commanded, too much copper is used. A cable may easily require 5 to 6 tons of copper per mile. In one system he came across 300 tons of copper lying spare, which he used in by bunching up. He thought that junction systems were most complicated, and considered that it was still debatable whether central systems having 10,000 or 15,000 subscribers were not the thing. Dr. Thornton's idea regarding the influence of the sheath on the capacity of diagonal conductors was new and acceptable to him. He had always put it down to cascade effect due to intervening conductors. He thought that the big drop in insulation of paper cables if the slightest trace of moisture was present might be due to the fact that continued heating made the paper more dense, and there were less points touching the wire. A point with regard to aërial wires coming down was that even if these were earthed there was no effect on other circuits in the superimposed system, as the earth virtually existed across two equal arms of a Wheatstone bridge, which balanced each other. With reference to screening, where there are two layers the screening of alternate conductors in the outer layer would be very satisfactory, though not, so far as he was aware, tried at present. Tinfoil was not strong enough mechanically, nor had it a sufficiently high conductivity to fritter down eddy currents. Copper tape could be made very thin by rolling, and manipulated in a rapidly revolving covering machine. Aluminium and also iron were now being used experimentally for this purpose, with what results he did not know. Mr. Gaskins was correct in saying that Glasgow had the largest trunk telephone cable. It had 1,616 wires.

ARTIFICIAL LOAD FOR TESTING ELECTRIC GENERATORS

SOME further contributions to the discussion on Messrs. Morcom and Morris' Paper, read on March 11th, before the Birmingham Local Section of the Institution of Electrical Engineers, and reported in Electrical Engineering, March 19th, p. 427, have been received.

Mr. Oswald T. Davis (Newcastle) wrote, referring to the author's conclusion that a successful water resistance required water with a large percentage of mineral matter in solution, that he had used the hot-well for a water resistance on one occasion for a 150-kw. 230-volt machine, sufficient current being obtained with a fairly small battery of resistance plates by reason of the high temperature of the water (about 150° F.). As a general rule, however, the circulating water discharge from a surface-condensing plant was more suitable. For a permanent resistance he favoured a brick-built cement-lined tank. For a low voltage resistance the plates (which may be of $\frac{1}{8}$ in. sheet iron for lightness) should be fixed in frames a certain distance apart, and the load controlled by raising or dropping the whole frame into the water. If the groups of plates are controlled by switches, the load may be prepared by lowering the resistance frame into the water, switching on a certain number of groups of plates, and finally securing fine adjustment by further raising or lowering, or preferably by manipulating a weir on the outlet.

He did not consider iron-wire resistances immersed in water permanent enough for standard use, but they were useful in exceptional cases. They were best arranged in a box, and should be well swept with water flowing through. If run at a density of about 10,000 amps. per square inch, their life was fairly long. For extra high voltage work it was necessary to well insulate the source of the entering water, and the writer had found a small erection resembling a cooling tower useful for breaking up the water into drops. As regards the use of choking coils, it must be remembered that ordinary commercial work only calls for power factors of 0·75 and above, and this point should be considered when designing chokers. Generally speaking, the use of choking coils on machines under test is limited to determination of the increase of excitation or voltage drop. For this reason, the period during which they are in use can be kept small, and artificial cooling may be dispensed with. On the other hand, most engineers desired to see their plant tested under a load as closely as possible approximating to that which they will be called upon to take up in everyday practice, and therefore it was best to design the chokers to enable their use on long temperature and steam consumption runs. A point often lost sight of by engineers in charge of the latter class of tests was the reduced efficiency and consequent increased steam consumption of machines when under inductive load. The extra losses (*i.e.*, increased armature and excitation copper losses) often amounted to 2 per cent. of the output, and hence will make an appreciable difference to the steam consumption.

Mr. R. K. Keer (Manchester) wrote describing a liquid resistance in one of the electrical laboratories of the Municipal School of Technology, Manchester, intended to form a load for a 25-h.p., 500-volt, traction motor when driven as a generator by another similar machine. Being of a permanent nature, the tank was built of glazed Staffordshire blue bricks, in cement, the walls being $9\frac{1}{2}$ in. thick. A $\frac{1}{2}$-in. layer of mastic asphalt was put between the two thicknesses to make it watertight. The internal dimensions of the tank are 6 ft. 9 in. by 2 ft. 6 in. by 2 ft. It is placed in a pit, the bottom of which is 4 ft. 4 in. below the level of the floor. This pit is partly roofed over with steel girders, to which machines can be bolted for testing. The space between the girders is fitted with trap-doors. The electrolyte used is a 2 per cent. solution of aluminium sulphate, the electrodes being lead plates. This makes a very clean arrangement, as there is practically no sediment or fumes formed. The arrangement of the plates is as follows. At one end of the tank are four fixed plates, each 12 in. square and $\frac{1}{8}$ in. thick. They are placed parallel to the length of the tank and at a distance of $7\frac{1}{2}$ in. from each other. The movable electrode consists of three plates, each 1 sq. ft. in area, but all shaped at the bottom. These are fixed to a simple carriage, fitted with wheels, which runs on two lengths of gas pipe placed on an incline, sloping down towards the fixed plates. When the movable plates are at this end they are completely immersed and fit in between the other plates. This gives an area of 6 sq. ft., the distance between the plates being $3\frac{3}{4}$ in. As the plates are moved away they rise up the incline, and thus rise up out of the liquid at the same time. The plates are moved from above by means of a handwheel actuating a winch through bevel gearing. A brake is provided to prevent the plates running back. The whole arrangement is well coated with anti-sulphuric paint. Connections are made to the movable plates by means of flexible cables.

This arrangement of the plates gives a very large variation of resistance. Thus, with a 1 per cent. solution, which was tried at first, the resistance could be varied from about 50 ohms, with the plates just touching the liquid, to about 0·75 ohm when they were completely immersed. The lowest resist-

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ance required was less than this, so the amount of aluminium sulphate was doubled, bringing the resistance down to about 0·5 ohm. The resistance varies considerably with current density, as the following figures show. With the 2 per cent. solution and with the plates completely immersed, the resistance with 10 amps. was 0·8 ohm., with 20 amps., 0·65 ohms., gradually becoming less until with 100 amps. it was only 0·48 ohm. The "resistance" measured includes, of course, a certain amount of back E.M.F., which is constant, and, therefore, most apparent with the large currents, and helps to account for the variations obtained. Apart from this, the variation is not due entirely to temperature rise, for the readings were taken quickly before there was time for much rise in temperature to occur. To test the temperature rise of the tank, it was loaded with 25 kw. (50 amps., 500 volts) for one hour. The temperature rise at the end of the hour was 27½° C. (from 14½° to 42°). While at this temperature the resistance with plates completely immersed, and with 100 amps. was 0·335 ohm. as compared with 0·48 ohm. when nearly cold. The movable plates are connected to three separate terminals, so that higher resistances can be obtained by using only one plate. By using the middle plate as the common connection, the tank can be used for a balanced two-phase load, but will not, of course, give a balanced three-phase load.

STANDARDISATION.

TWO afternoon lectures on this subject were delivered by Dr. R. T. Glazebrook (Director of the National Physical Laboratory), on Thursdays, March 19th and 26th respectively, at the Royal Institution. The first lecture dealt with standardisation in mechanical engineering, the second with standardisation in electrical engineering.

Dr. Glazebrook commenced the first lecture by giving a brief history of the evolution of the units of measurement and weight. The earliest English standards were set up by King Edgar at Winchester; the unit of length was the yard. The lecturer had on view the original bronze yard of Henry VII., made standard in 1496, and also the standard weights of 1601. In 1670, Mouton proposed a metric system, but it was not until 1795 that the present metric system was defined and made standard in France. Although the metric system was supposed to be founded on a natural length, it was found that the measurement was not accurate enough, and now the metre is defined as the length between two marks on a metal bar at Sievre in the same way as the English standard yard is the distance between two marks on a bar of metal kept at Westminster. The present standards are thus material standards. As a natural standard of length, Clerk Maxwell proposed the wave-length of light of a definite colour. The wave-length corresponding to the red line in the spectrum of cadmium has been suggested as a suitable unit. There are, however, 1,553,163 such units to the metre. In order that the metal standards of length should not vary with temperature, they are made of an alloy called invar, which consists of one part of nickel to two parts of steel. Such a bar has a constant length at all temperatures, but takes over two years to settle down to a constant length after being annealed. Such bars are made with an **H** section, and the marks are put on the neutral plane, so that the length between the marks shall be independent of the method of support. The lengths of standard metres have been compared to within one-tenth of one-thousandth of a millimetre. When comparing end-measures by means of screw calipers or other similar instruments, it is very difficult to ensure that the same amount of contact is obtained in each case. Sir Joseph Whitworth, whose measuring machine, with which he measured to one-millionth of an inch, the lecturer had on view, used a "feeler," or a polished cylinder of metal, which is placed between the rod to be measured and the end of the screw, and the screw turned until the feeler only just passes through. Other workers used an electrical contact method. The lecturer then described the Hartmann automatic comparator, which compared standards of length automatically. In order that manufacturers can be sure that the work turned out shall be interchangeable, a system of limit-gauging is in use, that is, the dimensions of any piece of work must lie within certain limits: for instance, it might be specified that a 2-in. cylinder should not be three-thousandths of an inch out either way. Such limits for cylindrical work have been settled by the Engineering Standards Committee, and published in their reports. Screws are much more difficult to standardise, as there are several dimensions to be determined, but the same principle of limit-gauging is applied.

In the second lecture Dr. Glazebrook gave a *résumé* of the history of standardisation as applied to electrical engineering, mentioning in particular the efforts made by Lord Kelvin and the British Association Committee in 1862. In those days an accuracy of one per cent. was considered good, whereas an accuracy of one in one hundred thousand was now attained to. The lecturer described the various forms of Weber's spinning coil for the absolute measurement of resistance and the latest form of the Lorenz apparatus. Descriptions were also given of the standard electro-dynamometers and the standard cells. Comparisons and measurements are still being made with the Clark and Weston cells, and the lecturer showed how most of the differences in the values obtained by different observers have been explained, and how values have been fixed and universally accepted. With regard to the standardisation of electrical machinery, the Engineering Standards Committee have drawn up some rules for the rating of machinery, but this work is not yet quite complete. As a basis for the rules, several series of experiments have been carried out by Mr. Rayner at the National Physical Laboratory, and Dr. Glazebrook gave a brief summary of the results obtained. One series of experiments consisted in determining the distribution of temperature in the interior of dynamo-coils. It was found that the maximum temperature, as determined by thermo-couples in the interior of the coils, was some 10 to 20 degrees Centigrade higher than the average temperature as determined by the resistance method. Tests on insulating materials showed that the mechanical and electrical properties of most insulators were not adversely affected if subjected to temperatures up to about 125° C., and consequently the Engineering Standards Committee have decided that ordinary stationary coils should be allowed to rise in temperature 60 degrees Centigrade above an assumed room temperature of 25° C. This rise must be determined by the resistance method, which gives the average temperature of the coil. Coils of insulated wire, impregnated with a heat-carrying enamel or varnish, are not included in this rule, as, owing to the more favourable distribution of temperature, a higher average temperature can be allowed. The lecturer then described the standard lamps used for comparing and measuring the candle-power of electric lamps, and showed some curves obtained by Mr. C. C. Paterson for the falling off in the candle-power of lamps with time (see ELECTRICAL ENGINEERING, Vol. I., p. 193). In general a lamp drops some 20 per cent. in candle-power after 500 hours' working. The Engineering Standards Committee have already issued a standard specification for carbon-filament lamps, in which efficiency, length of life, and uniformity of candle-power are some of the factors considered. The International Electrical Commission, a meeting of the Council of which will be held in the autumn of this year, originated in the work of the Engineering Standards Committee. Amongst the subjects down for consideration by this Commission are the standardisation of nomenclature and symbols, and the classification of electrical machinery and apparatus.

Portable Engine Tests.—We understand from Messrs. R. Wolf, who, as is well known, make a speciality of self-contained portable and semi-portable engines complete with a special form of combined boiler and superheater, that some exceptionally good results have been obtained in a series of tests of a new 100 B.H.P. semi-portable set of their manufacture, conducted by Prof. M. F. Gutermuth, of Darmstadt. The figures attained were 1·045 lbs. of coal per B.H.P. hour, and 8·661 lbs. of steam per B.H.P. hour. Particulars of the degree of superheat and steam pressure are not given.

Electrical Engineers and the New Army Scheme.—The Birmingham Local Section of the Institution of Electrical Engineers has issued a circular letter stating that the County Association of Warwick has authorised Mr. J. F. Lister to raise in the Birmingham district three telegraph companies for the Territorial Army, and the assistance of the Institution of Electrical Engineers, through its Local Sections, has been solicited in the matter. The companies will consist of:—One Wireless Telegraph Company, consisting of 3 officers and 66 men; one Cable Telegraph Company, consisting of 6 officers and 150 men; and one Airline Telegraph Company, consisting of 7 officers and 282 men. The training will consist of about 20 drills and at least 8 days' annual training, which will probably take place at such a time as to include August Bank Holiday week. All officers and a good proportion of non-commissioned officers and men are mounted. The County Association provides the mounts. The minimum period of service is four years. The necessary outfit for an officer will cost about £40. If an officer wishes to purchase a complete outfit, including full dress, &c., the cost will probably be £60 or £70. Part of this expense is met by a Government grant of £20 on appointment. In addition, officers and men during training in camp will receive pay at army rates. For officers this rate would be from 10s. per day according to rank. The County Association will provide necessary uniform, equipment, &c., for non-commissioned officers and men.

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ELECTROCHEMISTRY AND ELECTROMETALLURGY

ATTENTION is often drawn to the fact of the enormous quantities of aluminium minerals which are found in nature, and one always regrets that, so far, it has not been found possible to employ most of these compounds for the manufacture of the metal.

As is well-known, bauxite and cryolite are practically the only sources from which, up to the present, it has been found possible to manufacture aluminium. E. Viel, in the French patent 380.087, of September, 1907, now suggests a method for the employment of aluminium silicate. He reduces in the electric furnace a mixture of the silicate, carbon, oxide of iron and chalk, and presumes that the following reaction takes place :—

$$Al_2O_3(SiO_2)_2 + FeO + CaO + 2C = 2Al + FeSiO_3{\cdot}CaSiO_3 + 2CO + O.$$

The aluminium so obtained contains from 3 per cent. to 5 per cent. of silicon, which, of course, would spoil it for commercial purposes. He, however, removes the silicon by melting down the aluminium with a small quantity of ferrous oxide or copper oxide, according to the equation

$$Si + 2FeO = SiO_2 + 2Fe.$$

It will be noted that in the equation metallic iron is liberated. This iron is said to sink to the bottom of the aluminium bath, and finally metallic aluminium is obtained of 99 per cent. purity.

If it is possible to work such a process, it should go far to cheapen the manufacture of aluminium, because aluminium silicates are obtained in enormous quantities. According to the author, oxygen gas is liberated, as shown in the first equation. This seems very unlikely to take place, because it would be certain to unite with the molten aluminium. However, by the addition of another atom of carbon to the equation, this oxygen could be removed. But, of course, there might then be a tendency for the formation of aluminium carbide.

In the electrolytic preparation of chlorates and perchlorates of the alkali metals, it is by no means easy to obtain good current yields, one of the reasons being the reducing action which takes place at the cathode; and it is always found disadvantageous for free alkali or hypochlorite to be formed. The formation of the latter at the temperature of the bath often causes evolution of oxygen, and this means low current efficiency. In order to get over the danger of reduction, small quantities of alkali chromate are generally added to the bath. The action is presumed to be due to the momentary formation of a protective coating of hydroxide upon the cathode. To prevent the bath becoming alkaline, M. Couleru, in the German patent 195.639, recommends the addition to the electrolyte of metallic chlorides, which form, in the presence of alkali, insoluble oxides or hydroxides, and finds that the addition of magnesium chloride or lead chloride works satisfactorily.

In the first case, magnesium hydroxide is inclined to settle upon the cathode, and this also helps to prevent reduction. In the second case, lead chloride, after it has been converted into hydroxide, will react with any hypochlorite which may be present, and become converted into lead peroxide, which can be afterwards filtered off, and forms a valuable by-product.

It is claimed that the current yield is 90 per cent. for potassium chlorate, and 85 per cent. for sodium chlorate.

In the *Chemiker Zeitung* of the 25th, A. Lottermoser contributes an article upon "The Preparation of Metallic Filaments for Electrical Glow-lamps, especially from Colloidal Metals," in which the ordinary methods of wire drawing and squirting as employed in the tantalum and tungsten filaments respectively are referred to, and the well-known work of Dr. Kuzel, of Vienna, on colloids is described. For some years past it has been well known that metals can readily be converted into the colloidal state by electrical means, such as causing a high potential electrical discharge to pass between two poles in water or by various chemical means. Dr. Kuzel, in 1905, patented a method for preparing colloidal tungsten, molybdenum, silicon, titanium, thorium, &c. The metals cannot be reduced to the colloidal condition by ordinary mechanical means, but Kuzel converts them into the colloidal or hydrosol condition by first grinding them or producing them in a very fine powder, and then treating them with acid and alkaline fluids and in-between washing out with distilled water. As alkaline and acid fluids, mainly acids and bases in aqueous solution, are employed, and it is remarkable what a large quantity of a metal can be converted into the hydrosol. The fluid hydrosols are not in a condition to be directly employed for making incandescent filaments, as it is necessary first to get them into a condition in which they will be plastic. The hydrosol is in general treated with an electrolyte, which causes the hydrosol to be converted into a precipitate of a more or less pasty or plastic consistency. It appears to make a great difference in the plasticity of the precipitate what electrolyte is employed. Some electrolytes give great plasticity, and the precipitate can be forced through fine openings and form long filaments which do not break off. On the other hand, other electrolytes do not have this property, and the parts of the filament have no adhesion. For example, silver hydrosol prepared in weak alkaline solution with a complex ferrous solution is quite plastic. But if prepared with pure ferrous sulphate, it is non-adherent and non-plastic. According to Kuzel's method, then, the metallic hydrosol is precipitated by means of a suitable electrolyte. The paste so obtained is pressed through fine orifices, and the filament ignited, either in a reducing atmosphere—to reduce any oxide produced—or in an inert atmosphere. The filaments so produced are of pure metal, and contain no carbon.

ELECTRICAL SCIENCE

British and American

Terrestrial Magnetism.—The annual Report of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington has just reached us. A large part of the Report deals with the third cruise (1907) of the magnetic survey yacht *Galilee* in the Pacific Ocean. This cruise has already extended over some 22,000 nautical miles, and a complete record of the magnetic declination, magnetic inclination, and intensity of magnetic force has been secured at distances averaging 200 or 250 miles along the entire route. Along some of the well-traversed routes of the Pacific there were found declination errors amounting to 3°. These are errors of serious importance to navigators. Among the land observations of the Department, the most interesting are those made in Alaska. At Treadwell Point is an anomalous local magnetic pole. Here a source of local attraction exists which affects the mariners' compasses about 8° at a distance of a mile. Its concentration is so intense that a movement of a few inches in a horizontal or vertical direction shows considerable changes in the magnetic elements. For example, a compass carried 2 or 3 feet horizontally at a height of 5 ft. above the earth's surface changed its direction by nearly 180°. The Report states also that the magnetic and electric observations made during the solar eclipse of 1905 are nearly ready for publication, and they show that there is an observable magnetic fluctuation in connection with a total solar eclipse.

Electric Discharges through Gases.—At the Royal Institution, on Saturday last, Prof. J. J. Thomson delivered the fourth of the course of lectures on this subject. The lecturer commenced by showing an experiment illustrating how a volume of gas could be maintained in a conducting state although the ionising agent had been removed. A discharge was started, by means of an induction oil, between two metal electrodes about two inches apart in an exhausted tube containing a small amount of helium. The discharge was continued with only 200 volts, and at 270 to 300 volts the luminosity of the tube was, the lecturer added, intense enough to be of practical use if the absorption of the helium by the electrodes could be overcome. This continued conductivity was explained by the fact that the negative particles, in their passage to the positive electrode, collided with the molecules of the gas and broke off other negative particles and, of course, corresponding positive particles. The presence of these secondary ions was then shown by the following experiment :—A lime spot on the cathode of a Wehnelt exhausted tube, raised to a high temperature, emitted a bright pencil of rays, which was a stream of negative particles. This pencil of rays was surrounded by a haze, consisting of the secondary negative particles. This haze disappeared in the neighbourhood of a negatively charged plate, showing that it consisted of negative particles. In a gas at a pressure of 1 mm., each negative particle would produce another by collision in every half millimetre of its path, so that after a length of n millimetres, one negative particle would have given rise to 2^{2n} particles. With increased pressure there would be more collisions, but a stronger electric field would be required to give the particle the necessary velocity, the length of the path between collisions being reduced. Prof. Townsend, of Oxford, had found that the maximum effect was obtained when the E.M.F. in volts per centimetre divided by the pressure in millimetres was equal to 800. Prof. Thomson then described another experiment, showing that negative particles were produced by the impact of positive particles on a plate negatively charged. In the case of a

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continuous discharge, the supply of negative particles to carry the current to the anode was, he said, dependent on the impact of the positive particles on the cathode. The lecturer then showed Hittorf's experiment, illustrating that an electric discharge prefers a long path to a short path at low pressures, and explained it by the statement that the positive particles could not accumulate a sufficient amount of kinetic energy, in the space of the short gap, to produce negative particles at the cathode. The number of negative particles produced was proportional to the energy with which the positive particles reached the cathode. At normal pressures, a large number of particles reached the cathode with a small amount of energy each, but as long as the total amount was large enough, a discharge could pass. A spark could not be produced, Prof. Thomson said, with a potential difference of less than 340 volts unless the length of the gap was so small as to be comparable with the wave-length of yellow light.

Continental

Magnetic Properties of Electrolytic Iron.—The behaviour of electrolytic iron offers many magnetic anomalies which can hardly be said to be cleared up satisfactorily. A valuable contribution towards this end is made by K. Schild in No. 3 of the *Annalen der Physik*. He used an anode of platinum, a cathode of copper, and an electrolyte of ferrous ammonium oxalate. As regards magnetic permeability, the electrolytic iron obtained was found to behave like cobalt in weak fields not exceeding 15 gauss. In stronger fields it behaved like soft wrought iron, approaching saturation at some point above 120 gauss. In the matter of hysteresis, however, electrolytic iron behaves, not like soft wrought iron, but like hard steel. Near saturation, the hysteresis per cycle and per c.cm. was as high as 56,900 ergs. Another remarkable property of electrolytic iron is its high coercive force. In soft iron, magnetisation may be cancelled by an opposite field of 1 to 3 gauss. Electrolytic iron requires 5 to 15 gauss. In order to shed some light on the molecular theory of magnetism, the author obtained the deposit in magnetic fields of various strengths. He found that the magnetisation so obtained is two or three times as intense as that obtained by subsequent magnetisation. The difference represents the molecular resistance to magnetisation in the solid state.

Photoelectric Cells.—Selenium cells are more convenient as reagents for photoelectric effects than sodium cells, since they require no vacuum or protection from oxidation. But there is no reason why sodium cells should not be improved and made available for photo-transmission. In the *Physikalische Zeitschrift* for March 15th, H. Dember begins by studying the gradual loss of sensitiveness in these cells, which may be called Hallwachs cells on account of their being based upon the Hallwachs effect (discharge by illumination). Like Elster and Geitel, the author used a liquid alloy of sodium and potassium enclosed in a bulb containing hydrogen, and illuminated the liquid surface with ultra-violet or other light passing through a quartz cover-glass. He claims to have eliminated any possible "fatigue" due to oxidation, the formation of ozone, or the influence of the cement used for the joints. Nor could any fatigue be observed on repeated illumination—a valuable point as regards practical applications. The maximum effect is obtained when the hydrogen has a pressure of 0·33 mm. In 87 days the sensitiveness to light decreased 25 per cent. In 30 days it decreased 7·6 per cent. This may be due to the occlusion of some of the gas, and the reduction of the pressure below that required for maximum sensitiveness, but the author makes no decisive statement.

Duration of Cathode Emission.—The duration of emission of cathode rays in vacuum tube discharge has hitherto only been observed indirectly by measuring the duration of emission of Roentgen rays. But it is quite conceivable that the latter only become perceptible after they have acquired a certain intensity, and this may take some appreciable time. A direct determination has now been made by P. Doglio, who communicates his results to the *Physikalische Zeitschrift* for March 15th. He finds the cathode flash to last 0·0002 to 0·0003 sec., according to the capacity contained in the circuit. This is slightly less than the very uncertain value deduced by Broca from the mean current, but a good deal greater than the values obtained by Brunhes and Colardeau from Roentgen-ray observations. The author used a Braun fluorescence tube, and gave the cathode spot a circular motion by means of two coils with fields at right angles and a difference of phase of 90°. The current was interrupted 10,000 times per second, and only the break current was sent through the tube. The rotation was accelerated until the circular arcs of light coalesced into a complete circle. Instead of a circle, an ellipse can also be obtained by using a single coil with copper core, and axis making an acute angle with the vacuum tube.

Wehnelt and Simon Interrupters.—In a Paper "On the So-called Electrolytic Interrupters," contributed to No. 3 of the *Annalen der Physik*, P. Ludewig combats the idea that the interrupting action at the active point of Wehnelt's interrupter is purely thermal. That a genuine electrolytic action intervenes may be proved by calculation. In one actual case the platinum point had a surface of 7 sq. mm. The current was 3·45 amperes, and the period of interruption 0·01922 sec. During that period 3·542 c.mm. of oxygen must have been evolved, which would alone produce a layer of gas ½ mm. thick on the anode. For Simon's hole-interrupter, on the other hand, a thermal theory suffices, and the author extends it to cover a wide range of pressures and temperatures. Klupathy's idea that the interruption in Wehnelt's instrument is due to Peltier heat is untenable. That Wehnelt's interrupter only works with the point as anode, not as cathode, is best explained by the hypothesis due to Stark and Cassuto, according to which an arc forms between a point cathode and the liquid. The hole-interrupter is to be preferred for X-ray work on account of its lower "make" inductance. The author reproduces some interesting current curves obtained by means of the oscillograph.

AUTOMATIC SIGNALLING IN THE HUDSON RIVER TUNNEL

THE *Electrical World* contains an account of the block-signalling, interlocking and automatic train stopping equipment of the recently opened tunnels of the Hudson and Manhattan Railroad under the Hudson River, which were described in Electrical Engineering, March 12th, page 395.

The signals are placed on an average of 367 ft. apart. The minimum distance where speed is low is 115 ft., and the maximum is 1,620 ft.

The signals give three indications: "proceed," indicated by green light; "proceed with caution," yellow light; "stop," red light. As the consequences of a train passing a signal in the "stop" position may be disastrous, a device for automatically stopping such train is used at each signal. This consists of two movable short arms or trips placed alongside each rail. When the signal is in the "stop" position these arms are raised to engage with the trigger of a valve in the air-brake pipe of the train, releasing the air and setting the brakes. Each car is equipped with two of these valves—one on each end and on opposite sides of the car. When the signal moves again to the "proceed" position, the electric motor moves these train-stop arms out of "stop" position, thus permitting the train to pass without setting the brakes, the arms being returned to stop position by gravity after the train has entered the block. This automatic method of train control is in successful use on the Boston Elevated Railroad and on the New York Subway express tracks. On these lines, however, only one automatic stop is used to protect a train. In the Hudson tunnels, two stops are used, thus insuring a greater measure of protection.

An important feature of the system is that both rails of each track are used for the train propulsion current and also for the signal current. This arrangement permits of broken rail protection—that is, a broken track rail will interrupt the circuit and so cause the display of a "stop" or red signal, and the operation of the automatic stop if the "stop" signal be displayed.

All of the switches are under the control of the interlocking devices, consisting of seven plants—one at the Hoboken Terminal (the largest), two at Caisson No. 1, two at Caisson No. 2, one at Greenwich Avenue, and one at Nineteenth Street, of which there are seven installations. The interlocking is by the all-electric system—the switches being operated by electric motors at each switch. The signals are of the same type as used in the block system, and are controlled from the machines, the levers of which are so interlocked that it is possible to make only such movements as have been previously arranged for; conflicting movements are in this manner absolutely guarded against.

An interesting feature of this plant is use of the illuminated track diagram similar to that employed on the London Underground Railways. This is a diagram or chart of each track lay-out painted on glass, and placed in front of each machine for the information of the operator. Each line of track has a row of small electric lamps placed back of the glass; these lamps are controlled from the different track sections; when the tracks are unoccupied the lamps show a bright green light; as soon as a train enters the limits of the interlocking, the light controlled by the track on which the train is running is extinguished, so that movement of a train along the track can be followed by observing the corresponding movement of the dark space along the track on the diagram.

New Telephone Charges.—At a meeting of the Council of the Bradford Chamber of Commerce on Wednesday last week, a fund was started for the purpose of carrying on the agitation against new telephone charges. The president of the Council, Mr. H. A. Foster, has given £100, and the Chamber recommends each member and each telephone user in Bradford and district to make a contribution of at least one guinea.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published March 26th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

4,709, R. A. Fessenden. For receiving messages by wireless telegraphy, the use of three tuned receiving circuits, one tuned to the period at which it is desired to receive, one tuned to a higher period and one to a lower period. The higher and lower period circuits neutralise the effect of disturbing impulses produced on the receiver by the properly tuned circuit. The higher and lower period circuits should be damped by eddy-current or resistance losses to a higher degree than the middle one. By using a receiver tuned to group frequencies as well as to wave frequencies, the selectivity is still more pronounced. Multiplex telegraphy may be accomplished by arranging the circuits in groups of three or more, each group being arranged to respond only to a single frequency. Eleven claims, thirteen figures.

4,710, R. A. Fessenden. In signalling by electromagnetic waves, the electrostatic component of the waves has hitherto been utilised, the receiving or transmitting device consisting of a long vertical antenna as an upper capacity, and a horizontal wire or network as a lower capacity. If, however, the magnetic component of the waves is utilised, a horizontal wire only is necessary. According to the present invention, this can consist of a single iron wire or a bundle of iron wires of such a length as to be in tune with the waves which it is desired to generate or receive. This wire or bundle of wires is supported on insulators at a height of about two feet above the ground. The wire should be capable of rotation in a horizontal plane, as it is not responsive to waves reaching it in the direction of its axis. The wire is surrounded at its centre with a coil of wire in series with condensers and spark-gap in the case of a transmitter or with some form of detector in the case of a receiver. This specification also describes a method of inductively insulating the steel mast or metallic guy-ropes of antennæ (for signalling by means of the electrostatic component of electromagnetic waves). The lower part of the mast as well as the guy-ropes are surrounded by coils of fine iron wire, and their impedance thus increased. This prevents the mast or guy-ropes from carrying off the energy sent out or received by the antennæ. Thirteen claims, six figures.

5,671, British Thomson-Houston Co. and B. Hopps. An improvement in the system of control of electrically propelled vehicles of the type, fully described in Electrical Engineering, Vol. I., page 463. In this system the generator field is weakened when it is desired to change the connections of the driving motors. The resistance in the generator field circuit, according to the present invention, is controlled only by the foot-pedal, but the main controller and the foot-pedal are interlocked so that the generator excitation is reduced when the controller is in the off position or when changing from one running position to another. The foot-pedal is also connected to the governor or throttle valve of the engine, so that when the generator voltage is reduced the supply of motive fluid to the engine is also reduced. Four claims, one figure.

5,741. British Thomson-Houston Co. (*General Electric Co.*). Ring-like flanges of non-magnetic material, such as brass, cast on the pole-pieces of the commutating poles of electrical machinery. Transverse ribs, which fit into recesses in the pole-face, are provided. These break up the pole-face into a number of portions each surrounded by a closed circuit, which acts as a damper to prevent sudden magnetic fluctuations. The brass flange also forms a support for the exciting winding. A flange at the other end of the pole may be cast in one piece with the core. Three claims, three figures.

5,749. Griffiths and Bedell. An improved cable for use with the G.B. surface-contact system of electric traction (see Electrical Engineering, January 2nd, 1908, p. 7). The cable, which consists of a layer of copper strands over a jute core, and then a layer of galvanised iron strands, is further provided with a series of short iron sleeves. The smooth cylindrical contact surface obtained gives a better contact and decreased wear of the carbon surface of the switch. The short sleeves are butted together, but are not connected together. One claim, two figures.

14,203, British Thomson-Houston Co. (*General Electric Co.*). Wedges for closing magnetically and mechanically the slots of alternators or induction motors, and composed of a bundle of iron or steel wires suitably insulated from one another, or a rolled-up strip of woven iron or steel wire fabric. In each case the magnetic wedge is surrounded with an insulating cover. The iron or steel wire fabric should be well japanned to insulate the layers from one another. Three claims, three figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1907 Patents

5,339. Leitner. Quick acting "make and break" switches.
5,508. Lamme. Alternating current commutator motors.
5,522, James Hawley, Ltd., & Jones. Electro-magnetic separator drum for grain conveyors.
5,564A, Mershon. Control of alternating current motors.
5,652, Fynn. Alternate current motors.
5,853, Skinacker & Plisnier. Wireless telephony.
6,064, Brecknell, Munro, & Rogers, Ltd., & Munro. Bow trolleys or collectors.
6,083, Morris & Lister. Electromagnets.
6,224, Handcock, Dykes, & Smith. Fuses.
6,279. Kitsee. Electric telegraphy.
6,288, Metcalfe. Electric trembler coils.
6,409, Sir W. G. Armstrong, Whitworth, & Co. & Honner. Electric lighting of railway vehicles.
6,417, Torrens. Electrical ignition apparatus.
6,847, Johnson-Lundell Electric Traction Co. (*Lundell*). Dynamo-electric machines.
6,869, Burnup & Kirk. Time controller for electric signs.
7,953. Archibald. Electric transmission of power from a prime mover for automobiles.
8,764, British Thomson-Houston Co. (*General Electric Co.*). Controlling devices for electric motors.
9,652. Watson. Electric switches.
9,683. Storer. Voltage regulators.
9,962, British Thomson-Houston Co. (*General Electric Co.*). Electrically-operated signals.
10,440, Browne. Microphones for telephones.
11,594, Allgemeine Elektricitäts Ges. Rolling-mill motors.
12,529. Maiche. Inductive telegraphy and telephony.
12,559. Carpentier. Sparking plugs.
15,656, Daley & Daley. Automatically-operated station indicators for electric railways.
17,690. Stone. Space telegraphy.
19,274. Eisenstein. Receivers for wireless telegraphy.
21,173, Siemens Bros. Dynamo Works, Ltd. (*Siemens Schuckertwerke Ges.*) Automatic switches.
23,037. Conrad. Alternating-current motors.
23,098. Schott & Carl-Zeiss-Stiftung. Incandescent lamps.
23,225. Timar & Von Dreger. Arc lamps.
26,081. Meyerling. Meter for direct current.
27,232. Meyerling. Ampere-hour meter.
28,425. Allgemeine Elektricitäts-Ges. Measuring instruments.
28,542. Hiorth. Electrical induction furnace.

1908 Patent

660. Allgemeine Elektricitäts-Ges. Multiple-rate meters.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patent

12,634, Galletti. Methods of producing electric oscillations.

1908 Patent

4,432, Maschinenfabrik Oerlikon. Single-phase commutator machines.

Applications for Amendment

Further particulars and instructions as to procedure in opposition to amendment will be found in the Official Journal of the Patent Office of March 25th.

2,260 of 1900. The British Westinghouse Electric & Manufacturing Co., Ltd., seek leave to amend the specification numbered as above, granted to Hugo Bremer, for "improvements in electric arc lamps." The proposed amendment consists in eliminating portions of the specification, including the first six claims and figures 1 to 4 and 7, on the ground of doubtful validity.

Expiring Patents

The following patents expire during the current week, after a life of fourteen years:—

6,888, of April 6th, 1894. J. Imray (*La Société Anonyme pour la Transmission de la Force par l'Electricité*). Telegraphic or telephonic transmitting and receiving apparatus for transmitting undulations of various periods along a single line simultaneously.

7,050, of April 9th, 1894. G. C. Fricker. Electrically illuminated signs in which the lamps are switched on or off progressively by the action of a rotating commutator.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. 1906	Dividend Paid. 1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ltd.	10	7	5/-*	10⅜—11¾	-½
Do. 4½% Cum. Pref.	10	4½	4½%	10—11	
Do. 6% Cum. Second Pref.	10	6	6%	10—10¾	
Do. 4½% Debenture, Red.	Stock	4½	4½%	100—103	
Bromley (Kent) E. L. & Power Co., Ltd.	5	5½	2/-*	4⅜—5½	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	96—99	
Brompton & Kensington E. S. Co., Ltd.	5	10	10%	7¼—8¼	-¼
Do. 7% Cum. Pref.	5	7	7%	6¾—7¼	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	98—101	
Ch. Cross, W. E. & City E. S. Co.	5	5	5%	3¼—4¼	-¼
Do. 4½% Cum. Pref.	5	4½	2½%	4¼—4¾	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	4⅛—4⅜	
Chelsea Electric Supply Co., Ltd.	5	4½	4½%	3⅛—3⅜	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9⅜—10⅜ xd	-¾
Do. 6% Cum. Pref.	10	6	6%	11½—12¼ xd	-¼
Do. 5% Deb. Red	Stock	5	5%	122—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	101—104	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	3—3⅜	
Do. 6% Cum. Pref.	5	3½	—	¼—1¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	58—63	-2
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4½—5 xd	-⅛
Do. 5% Cum. Pref.	5	5	5%	4½—5⅜ xd	-⅛
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½%	6⅝—6¾ xd	-¼
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E. L. Co.	5	10	10%	7¾—8¾	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N'ting Hill E. L. Cos. Db. Rd.	Stock	4	4%	97—101 xd	-2
London Electric Supply Corporation	3	4	4%	1⅛—1⅜	
Do. 6% Pref.	5	6	6%	4½—5	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6¼%	5—5½	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. Db.	100 & 500	4½	4½%	97—100	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	9¼—10¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	10¼%	5¾—6¼	-¼
Do. £2 Pm.	5	8	10½%	5⅞—6⅛	
Do. 5% Pref. (fully paid)	5	5	5%	5⅛—5⅜	
Do. 10/- Pm.	5	5	5%	5⅛—5⅜	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7%	5⅜—6⅛	
Do. 4% Deb. Red.	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7½—8½	
Do. 7% Non-Cum. Pref.	5	7	7%	6¾—7	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—1⅛	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2⅝—3⅛	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅜—⅝	
Do. 7% Cum. Pref.	1	7	7%	1¼—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102 xd	-2
Urban Elec. Supply Co., Ltd.	5	5	5%	1⅜—2¼ xd	-⅛
Do. 5% Cum. Pref.	5	5	5%	1⅞—2⅜ xd	-⅛
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90 xd	-2
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¼—8	-½
Do. 4½% Cum. Pref.	5	4½	4½%	5—5½	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	89—92	
Central London	Stock	4	3%	71—74	+6
Do. 4% Preferred	Stock	4	4%	82—84	
Do. Deferred	Stock	4	2%	52—55	+10
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Enst. & Hamp. Pp. Db.	Stock	4	4%	81—84	
City and South London Cons.	Stock	2½	4¼%	39—41	+2
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	-1
Do. 5% Perp. Pref. 1895	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11½d.	1—1⅛	
Gt. Northern, Piccadilly & Brompton	10	4	4%	5½—6½	
Do. 4% Perp. Deb.	Stock	4	4%	87—90	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	¼%	41—42	+5
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½%	71—74	
Metropolitan District	Stock	nil	—	10½—11½	+1
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Deb.	Stock	4	4%	70—75	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co of London 5% Profit Shg. Sec. Notes	Various	5	5%	40—44	
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	½—¾	
Do. 5% Cum. Pref.	1	5	5%	⅛—⅜	
Do. 4½% Deb. Red.	Stock	4½	4½%	89—94 xd	-2
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93 96	
British Electric Traction Co., Ltd.	10	—	—	1⅛—1⅜	-⅛
Do. 6% Cum. Pref.	10	6	6%*	4—4½	-⅛
Do. 5% Perp. Deb.	Stock	5	5%	94½—97½ xd	-2½
Do. 4½% 2nd Deb.	Stock	4½	4½%	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4⅜—4⅝	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	98—101	

NAME.	Amount of Share.	Dividend Paid. 1906	Dividend Paid. 1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%			
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	95—98 xd	-2
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	¾—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	⅞—1 xd	-⅛
London United Trs., Ld., Cm. Pf.	10	5	5%	5⅞—6⅜	-1⅛
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	85—90 xd	-2
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	¾—⅞	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	97—99	
National Elec. Construction Co. Ltd.	1	10	2/-	⅞—1⅛	-1/16
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅛—1	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅛—⅜	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9½d*	¼—⅜	
Do. 5% Cum. Pref.	1	5	5%	⅞—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3⅜	4%	4⅜—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	1/1½	¾—1⅜	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1½	
Do. 6% Cum. Pref.	5	nil	—	3—3½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	3½%	55—58	+1
Do. 6% Pref. Ord.	Stock	6	6%	98—100	+1
Do. Def. Ord.	Stock	1¾	1%	13⅜—14½	+⅛
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	86—89 xd	-1
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3¼—3½ xd	
Do. 10% Cum. Pref.	5	10	10%	8½—9½ xd	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4¼	4⅜%	13⅝—14⅝	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	98—101	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12⅞—13⅜	+⅛
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5⅜	5%	130—135	
Do. 3½% Pref.	Stock	3½	3½%	84—87	+1
Do. 4% Mort. Deb.	Stock	4	4%	100—103	
G. N. Tel. Co. (Copenhagen)	10	20	5%*	31—33	
Indo-European Telegraph Co. Ltd.	25	18	65/-	54—57	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅞—⅝	
National Telephone Co., Ltd., Pref.	Stock	6	6%	106½—108½	
Do. Deferred	Stock	5¼	6%	108—110	
Do. 6% Cum. 1st Pref.	10	6	6%	10—12	
Do. 6% Cum. 2nd Pref.	10	6	6%	10—12	
Do. 5% 3rd Pref.	5	5	5%	5⅜—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	97½—99½	+½
Do. 4% Deb. Red.	Stock	4	4%	101—103	
West African Telegraph Co. Ltd.	10	4	4/-	10—10½	
Western Telegraph Co., Ltd.	10	7	6%	13½—13⅝ xd	+⅛
Do. 4% Deb.	Stock	4	4%	99—102	+½
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅝—¾	
Do. 6% Cum. Pref.	1	6	7½d	¾—⅞	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅜—3⅝	+⅛
Do. 6% Pref.	1	6	7½d.	1⅛—1⅜	
British Insulated & Helsby Cables, Ltd.	5	10	4/-*	6½—6⅝	-⅛
Do. 6% Cum. Pref.	5	6	6%	5⅝—6½	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	+1
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	88—92	+1
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—¾	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—½	
Do. 6% Pref.	2	nil	—	⅛—⅜	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	77—80	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10⅜—11⅜	
Do. 5% Cum. Pref.	5	5	5%	5⅛—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106—108	
Consolidated Electrical Co., Ltd.	1	3	8¾d*	⅞—1	
Crompton & Co., Ltd.	3	5	5%	11½—11⅞	-⅛
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	2/-*	1⅜—1⅝	
Do. 6% Cum. Pref.	1	6	6%	1—1¼ xd	-⅛
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
Edison & Swan United "A," £3 paid	5	4½	2/6	¾—1	
Do. do. (fully paid)	5	4½	4/2	1⅜—2⅛	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87 xd	-2
Electric Construction Co., Ltd.	2	—	—	¼—⅜	
Do. 7% Cum. Pref.	2	7	—	1¼—1⅜	
Do. 4% 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8⅛	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90 xd	-2
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10¼—11¼	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15¾—16¼	
Do. 4% Deb. Red.	100	4	4%	98—100 xd	-1
Tel. Const. & Maintenance Co.	12	15	5%*	31—33	
Do. 4% Deb. Bds. Red	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	1/-	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3⅜—4	+¼
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

ALTRINCHAM: *Purchase of Electric Supply Co.*—A valuation is being made of the Altrincham electric supply undertaking with a view to purchase.

ARGENTINE: *Buenos Aires.*—It is stated in the *Review of the River Plate* that the Cia. Alemana Transatlantica de Electricidad is about to increase its capital so as to give greater impulse to its business in Buenos Aires, Montevideo, and Chile. A new issue of bonds to the extent of 25 million marks is to be made, half of which will shortly be offered to the public. In 1906 the capital of this company was increased from 36 to 72 million marks, the 15 million marks in debentures, which was the original issue, was increased to 30 million in 1906, so that with the new issue the debentures will amount to 55 million marks, and the total capital of the company in shares and bonds will be 127 million marks.

Rosario.—The Rosario Electric Lighting Company, owing to increasing demands, is increasing the capacity of its generating station by the installation of two 2,000 kw. generating sets. A new chimney has been built, and a Green economiser is being put in. Extensions are also being made to the distributing system.

La Plata.—Mr. Otto Franke, concessionaire for a high-speed electric railway between La Plata and the Federal capital, has deposited the $50,000 guarantee stipulated in the contract.

ASHTON: *Guardians' Electricity Scheme.*—The Board of Guardians have been informed that their application to the Local Government Board for permission to borrow £2,000 for an electric lighting installation for the new hospital and workhouse has been refused. The reason is given that it would be possible to purchase electrical energy from the local authority at a cheaper rate than the Guardians could themselves generate.

AUSTRALIA: *Kalgoorlie.*—According to the *Australian Mining Standard*, extensions to the power plant of the Kalgoorlie (W. A.) Electric Power Corporation have been made to the extent of 1,600 h.p. The new machinery was purchased recently in England during a visit by Mr. E. C. Crocker, the company's General Manager. The tramway system now open in Kalgoorlie has a total length of 20½ miles, and the gross receipts for the year 1907 amounted to £47,822.

Claremont.—Having successfully floated a loan of £4,000 at 4½ per cent., the Municipal Council has recently installed a battery booster at the power station. The report for 1907 shows that 102,487 units were generated, compared with 90,099 for the year 1906, whilst the number of consumers increased from 205 to 284. There are 237 street lamps, the length of streets lighted electrically being 16¾ miles. For the year 1907, the undertaking, which was opened in February, 1905, showed a surplus of £1,004 over working costs.

Melbourne.—Two 750-kw. Westinghouse-Parsons' turbo-generating sets, supplied by the British Westinghouse Electric & Manufacturing Co. through their local agents, Messrs. Noyes Bros., have recently been put into operation. These machines are to supply power under the new system which is being installed by the City Engineer, Mr. Harper, for the outer network of distribution.

BELFAST: *Car Cleaners' Wages.*—A report has been presented by Mr. A. Nance, General Manager of the tramway system, on the question of the wages of car cleaners. He comments strongly upon the discontent which appears to be rife, and points out that if he were given a free hand he would at once discharge all the present cleaners and take on new ones, for he is confident that he could get 20 men for every one of them at 24 hours' notice, and for 5s. per week less wages if desired.

Police Tramway Facilities.—Mr. Nance has also reported upon an application by the City Police Commissioner that all members of the police force should be allowed to travel upon the cars by a free pass in return for an annual payment of £500. Mr. Nance points out that for the 350 Post Office officials to travel "free" upon the trams the sum of £1,250 per annum is paid. In the case of the police force there were 1,040, and it was reasonable to suppose that they would take more rides during the year than the Post Office officials. He therefore does not recommend the acceptance of the proposal of the Police Commissioner as it stands.

Electricity Works.—Mr. A. B. Wilson has been asked by Messrs. Coombe, Barber & Coombe to act as arbitrators between them and the Corporation with regard to the engines which they have supplied, as sub-contractors to Messrs. J. G. White & Co., in connection with the tramways.

BISHOP AUCKLAND: *Electrical Sewage Pumping.*—The Local Government Board have approved of a scheme of main sewerage and sewage disposal for the Denebeck Valley. The work consists in the laying of several miles of main outfall sewers, the sewage from which will gravitate to the disposal works situate at South Church, with the exception of the sewage from South Church, which is proposed to be pumped by electrically-driven centrifugal pumps to the disposal works. The engineers of the scheme are Messrs. D. Balfour & Son, of London and Newcastle-on-Tyne.

BOURNEMOUTH: *East Cliff Electric Lift.*—It is stated that the new electric lift which has been erected on the East Cliff will be ready for use at Easter. A second lift on the West Cliff is in course of construction.

BRIGHTON: *Lecture on Electricity Undertaking.*—Mr. J. Christie, the Engineer and Manager of the electricity undertaking, gave a lecture at the Free Library on Thursday upon the origin and progress of the municipal electric lighting undertaking. He recalled that Brighton was one of the first towns in the United Kingdom to have a public electric supply system, and mentioned that the original Hammond Co., in 1882, had total costs from 1s. 4d. to 2s. per unit. Having traced the various stages of development, the lecturer gave the following figures showing the progress of the undertaking during the last fourteen years. In 1892 the consumers connected were 215, with an equivalent lamp connection in 8 c.p. lamps of 11,229, whilst the units sold were 156,110. The capital expenditure upon the undertaking was £55,1[illegible], and the total revenue for the year was £4,687. At the end of the 1907 financial year there were 4,500 consumers connected, the connections being the equivalent of 307,604 8 c.p. lamps, whilst the units sold were 7,849,194. The capital expenditure upon the undertaking was £758,297, and the total revenue £81,415.

The Action re Vibration.—At the last meeting of the Corporation, a special vote of thanks was passed to the Town Clerk, Mr. H. Talbot, for his successful conduct of the recent action in regard to vibration at the North Road sub-station.

DENTON: *Runaway Tramcar.*—A car belonging to the Oldham, Ashton, and Hyde Electric Tramway Co., whilst going down a steep incline in the direction of Hyde known as Broomstair Brow, got out of control on Wednesday last week, and leaving the rails dashed into a boundary wall at the bottom. Several passengers were injured, but none seriously. It is stated that the snapping of the brake chain was the cause of the accident.

FINCHLEY: *Bulk Supply.*—The Electricity Committee has had several interviews with representatives of the North Metropolitan Electric Power Supply Co. with reference to a bulk supply, but the Council has endorsed the opinion of its committee that no satisfactory basis can at present be arrived at.

FREEMANTLE: *Electricity Charges.*—A new schedule of charges has been adopted, ranging from 7d. per unit for a consumption not exceeding 75 units per month, to 4½d. per unit for 500 units and over per month.

GLASGOW: *Tramway Extensions.*—The Corporation Tramways Committee has had under consideration the question of extending the tramways to Burnside, Rutherglen, and Rouken Glen. It has been decided to defer consideration of the subject until the general policy with regard to tramways extensions is defined.

GLOUCESTER: *Charge for Tramway Energy.*—A special report of the Electricity Supply Committee deals with the question of the charge for current to the light railway undertaking. The report states that the present charge of 1d. per unit is a reasonable and fair one, but one member of the Committee thought it should be somewhat higher. A recommendation was made by eight votes to three, recommending that the present charge of 1d. per unit be continued. At a subsequent Council meeting an amendment was passed referring the matter to Mr. R. A. Chattock, the City Electrical Engineer of Birmingham, for settlement.

HANWELL: *Bulk Supply.*—Negotiations are proceeding between the Ealing Urban District Council and the Hanwell Council with regard to a supply of electricity in bulk.

Transfer of Lighting Order.—The Council's consulting engineer recommends that arrangements be made with the Metropolitan Electric Supply Co. for the taking over of the Council's Electric Lighting Order.

LANARKSHIRE: *Tramway Extensions.*—The Lanarkshire Tramway Company has begun laying their new route to Uddingstone, *viâ* Bothwell, from Hamilton.

LEEDS: *Engineer Volunteers.*—Information has been received by the commanding officers of the 2nd West Yorkshire Royal Engineers (Volunteers) that the Army Council have allotted to Leeds an air-line cable company and a wireless telegraph company, which will consist in the aggregate of 18 officers and 500 men.

Tramway Receipts.—The total receipts upon the municipal tramway system for the 51 weeks to March 21st were £328,475, an increase of £12,782 over the figures for the corresponding period of the previous financial year.

LIVERPOOL: *Tramway Report.*—The annual report of the Tramways Manager has been issued, and shows that the number of passengers carried during 1907 amounted to 124,043,239, the receipts to £572,822, and the mileage to 12,231,799. The average earnings per car-mile were 11·24d., an increase of 0·07d. over the earnings of 1906. The traffic receipts and car-mile earnings, together with the number of passengers carried, are the highest recorded in connection with the Liverpool tramways undertaking.

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LONDON: *London County Council.*—At the meeting on Tuesday the London County Council sanctioned the borrowing by Marylebone Borough Council of £31,306 for electric lighting purposes.

On a report of the Finance Committee submitting the annual estimates, a discussion took place as to the amount allowed for tramway work, viz., one and a quarter millions. Various amendments to increase the amount of the estimates were defeated, and the proposals of the Finance Committee were agreed to.

The report of the Parliamentary Committee, recommending the Council to continue its opposition to the London and District Electricity Supply Bill, the London Electric Supply Bill, and the London (Westminster and Kensington) Electric Supply Companies Bill, was adopted.

Hampstead: Street Boxes.—At the last meeting, the Borough Council agreed to support Islington in their appeal to the L.C.C. to obtain powers to exempt electric lighting service boxes from the provisions of Section 145 of the London Building Act, 1894, the effect of which Section is to entitle the District Surveyor to fees in respect of their construction.

Marylebone.—At the last meeting of the Borough Council, it was stated that the receipts of the electrical undertaking during the past year had fallen short of the estimates by £4,520. This result was attributed to reductions in the price, increased price of coal, &c.

MANCHESTER: *Tramway Sick Fund.*—The Tramways Committee have decided that they cannot comply with the tramway workers' request for help from the public funds towards their sick and benefit society, the Committee having adopted the following resolution :—"That having fully considered the General Manager's reports as to the formation of a sick and benefit society for the employees of this department, we are unable to adopt the suggestions contained in such report as to the subsidising of the finances of such a society from the fund of the tramways department," point out that the thritt fund, which is open to all Corporation servants receiving more than 30s. per week, is supported by the funds of the Corporation.

MARLBOROUGH: *Electric Lighting Order Revoked.*—The Board of Trade has revoked the Electric Lighting Order granted in 1905.

MIDDLESEX: *Tramway Finances.*—The recommendations of the Light Railways and Tramways Committee regarding the accounts of the Metropolitan Electric Tramways, Ltd., which were adjourned by the County Council at its February meeting (ELECTRICAL ENGINEERING, March 5th, p. 368), were again considered on March 26th. It was agreed to pay to the company £422 2s. 9d., being interest for 1905, at 4 per cent., upon the company's expenditure on light railway depôt sites; that the £500 a year proposed to be charged by the County Council as regards light railways in respect of rent, rates, cleaning, lighting, warming, salaries (clerks' department), and office expenses, for 1906 and 1907 be charged against the Council's capital expenditure, upon which the company pay interest, and that for 1908 and onwards £500 a year be paid to the Council by the company and charged to revenue; and that a joint reserve fund be created out of revenue for the purpose of the reconstruction and renewal of the light railways and tramways tracks in the future, subject to the fund being invested in the joint names of the County Council and the company, without earmarking it as between tramways and light railways, and that the fund only be drawn on for reconstruction and renewal of tracks with the consent of the County Council. The Council also agreed that the stock now representing the £20,000 deposited by the company, in accordance with agreement, and any amounts representing the invested dividends on the stock, be released, and that this amount, together with £3,471, representing £3,993 of consolidated stock, to be paid over by the company and invested in the joint names, be made to form the nucleus of the reserve fund, to be added to out of revenue, but that the amount of stock referred to above be primarily held as security for the performance by the company of their obligations under agreement of November, 1900, up to the grant of the lease of all the light railways. Any part of the reserve fund not expended at the end of the lease is to be divided in agreed proportions of 45 per cent. to the County Council, and 55 per cent. to the lessee company, and the dividends received in respect of the reserve fund are to be invested from time to time in the joint names, and be added to the reserve fund.

MINSTER-ON-SEA: *Tramways.*—A committee has been formed to arrange for an application to the Light Railways Commissioners for an extension of the Sheerness tramways to Minster-on-Sea.

NEWCASTLE: *Tramway Extensions.*—A deputation from the Newburn Urban District Council recently waited upon the Tramways Committee of the Newcastle Corporation with the request that the Newcastle tramway system should be extended to Newburn.

Street Lighting.—The Tramways Manager and the Lamps Inspector have issued a report dealing with the lighting of Jesmond Road, North Road, and Osborne Road with alternate lamps, together with the cost of removing the lamps which are to be dispensed with. The difference in the cost of lighting by flame arc lamps in Westage Road was also dealt with. There are 100 centre pole lamps and 50 side pole lamps in the streets mentioned, and the cost of removing 50 centre pole lamps and 25 side pole lamps and fixing them elsewhere is estimated at £721. In discussing this proposition, the officials point out that as all the lamps left will be on one circuit, there will be a greater risk of the streets being left in total darkness, a circumstance which cannot take place at present. The report goes on to state that the experiments in Westgate Road have clearly demonstrated that the original Brockie-Pell arc lamps are inferior to flame arc lamps as a lighting medium for public streets. If flame arcs are adopted, the annual cost will be £12 each, and the total cost for lighting Westgate Road with 20 lamps will be £240, as against £180 for enclosed arc lamps. The report anticipates that before long makers of flame arc lamps will be able to place upon the market a carbon which will materially reduce the annual cost.

PERTH: *Tramway Employees' Social.*—The annual social and dance of the employees of the tramway department was held in the Masonic Hall, Perth, last week, the Governor of the Tramways Committee presiding. During the course of the proceedings the Convener made an appreciative reference to the manager of the tramways, Mr. Lambert, who, he said, had not only invented a folding step, but also a magnetic brake.

PORT GLASGOW: *Electricity Supply.*—Negotiations have been carried on between the Greenock Corporation and the Port Glasgow Town Council, with regard to a supply of electricity. The Greenock Corporation proposes to lay the necessary high-tension transmission cables, and establish a low-tension supply, the whole expenditure to be borne by Greenock, except in special cases of large demands, when the supply shall be the subject of a special agreement. The option is given to the Port Glasgow Council to purchase the whole undertaking at the end of 28 years. The recommendation of the Electricity Committee that the Council should approve generally of the above agreement has been confirmed by the Corporation, subject to the following additions :—(1) the charge to be the same as to Greenock consumers; (2) any deficit to be met by Greenock; (3) that the Greenock Corporation have no power to assess in Port Glasgow for any deficit.

POTTERIES DISTRICT: *Tramway Ambulance Corps.*—The fourth annual dinner of the Potteries Electric Traction Company's division of the North Staffordshire Corps of the St. John's Ambulance Brigade was held at Stoke last week.

RAWMARSH: *Dolter Surface Contact System.*—As a result of a conference between the Mexborough, Swinton, and Rawmarsh Urban District Council, referred to in our last issue, it is stated that the Manager of the tramways company can give no undertaking that the Dolter system can be run more satisfactorily than it is at present. The conference was favourably inclined to accept a proposition that the overhead system should be substituted, the two courses offered by the company being to improve the present system at a cost of £3,000, or to substitute the trolley system at a cost of between £6,000 and £8,000. A resolution was passed that in the event of the tramway company installing the overhead system, it would be desirable to allow the company to defer the payment of rents for the first three years, provided the whole of the rent be paid up within the stipulated period of seven years.

SUNDERLAND: *Supply to Sir James Laing & Sons.*—Satisfactory arrangements have now been made between Sir J. Laing & Sons and the Corporation, by which the supply of electrical energy to the firm's works has been resumed. It will be remembered that a short while ago, in consequence of the voluntary liquidation of Sir J. Laing & Sons, and the fact that the Corporation were not allowed to rank as preferential creditors, the supply was cut off.

SOUTH SHIELDS: *Tramway Manager.*—At an adjourned meeting of the Town Council last week, a recommendation of the Tramways Committee to give the tramway manager a three months' notice to terminate his engagement in the event of his not tendering his resignation was passed. A new manager is to be advertised for at a salary of £250 per annum.

SHANGHAI: *Opening of Tramways.*—The Shanghai Electric Tramways Co. inaugurated its service on March 5th.

TASMANIA: *Electric Winding.*—The Mount Lyell Mining & Railway Co. is installing an Ilgner electric winding plant at the North Lyell Mine.

TUNIS: *Electric Lighting.*—A company under the title of La Compagnie Electrique de Bizerte has been formed to carry out an electric lighting scheme at Bizerta.

WALSALL: *Workhouse Lighting.*—The Building Committee recommend that no action be taken with regard to the proposed electrical installation in the workhouse, on the ground that the cost would be excessive.

WREXHAM: *Electricity Undertaking.*—At the last meeting of the Corporation, when the rates for the ensuing year were fixed, it was stated that for the first time in its history the electric light undertaking called for no aid from the rates, whilst it was estimated that next year would see a credit balance equal to a penny rate.

YARDLEY: *Tramways.*—Arrangements in connection with the agreement between the Council and the British Electric Traction Co., for working the tramways, are nearly completed

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TENDERS INVITED AND PROSPECTIVE BUSINESS

DERBY.—The Electric Lighting Committee estimate that £7,500 will be required for capital expenditure during the coming financial year, and recommend that application be made to the Local Government Board for sanction to borrow this sum.

IRELAND.—At the present time five towns—Fermoy, Enniscorthy, Newcastle, County Down, Templemore, and Warrenpoint—are interested in electric lighting schemes, the matter being in the hands of the local authorities of each place.

LIMERICK.—Tenders are invited for a supply during the year ending March 31st, 1909, of accumulator accessories, cable, electrical stores, engine-room stores, mains accessories, meters, &c. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by April 10th.

LONDON: *Poplar.*—The Electricity Committee invite tenders for the erection of a sub-station building at Millwall in brick, ferro-concrete, or corrugated iron. Full particulars from the Borough Electrical Engineer, fee 5s., not returnable, and tenders to the Town Clerk by April 29th.

METROPOLITAN ASYLUM BOARD.—Tenders are invited for the installation of electric lighting at the South Western Hospital and Ambulance Station, Landor Road, Stockwell, S.W. Full particulars from Mr. W. H. Hatch, Engineer-in-Chief to the Board (fee £2 2s. returnable), and tenders to the Clerk by April 15th.

NETHERLANDS.—The *Bulletin Commercial* (Brussels) of March 7th reports announcements in the Dutch press to the effect that the Communal Council of Gouda have granted a provisional concession to Mr. J. H. Müller, of The Hague, for the construction and working of tramway lines between Gouda and Schoonhoven, Gouda and Oudenwater, and Gouda and Rotterdam; and that the Communal Council of Kampen offers a subsidy, without interest, of 495,000 florins (about £41,250) for the construction of a tramway between Hatten and Kampen

RHYL.—Tenders are invited for the wiring, &c., for electric lighting of the new promenade gardens. Full particulars from the Engineer, Electricity Works, Rhyl, and tenders to the Town Clerk by April 9th.

SPAIN.—The *Gaceta de Madrid* of March 15th announces a public competition for the establishment of inter-urban telephonic communication between Las Palmas and Arucas, in the island of Gran Canaria. Sealed tenders must be presented, within 30 days from the date of publication in the *Gaceta*, either at the Civil Administration of the Canaries, or at the Registry of the Dirección General de Telégrafos, Calle de Carretas 10, Madrid. The *Gaceta*, containing the conditions of contract and model form of tender, may be consulted by British firms on application at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall Street, London, E.C. The same *Gaceta* notifies that the Compañia Elétrica Madrileña de Tracción has applied for a concession for an electric tramway in Madrid, and that a period of one month has been appointed for the presentation at the Dirección General de Obras Públicas, Madrid, of propositions in terms more favourable to the Government.

WALLASEY.—Tenders are invited for the supply of automatic overload and reverse current single-pole circuit-breakers. Particulars from the Engineer and Manager, and tenders to the Town Clerk by April 15th. The Council also invite tenders for the supply of stores during the ensuing twelve months, including switches and cut-outs, meters, cable, and junction boxes, and arc lamp carbons.

WATFORD.—A report by the Electricity Sub-Committee recommends that, subject to sanction by the Local Government Board, tenders should be invited for a high-speed engine, 150 kw. alternator, exciter, and accessories. The question of installing an additional 500 kw. turbo-generator, it is suggested, should be deferred until January next year.

WIMBLEDON.—A Local Government Board inquiry was held last week into the application by the Corporation to borrow £17,600 for additional machinery at the generating station, and £3,600 for a switchboard. There was a good deal of opposition.

TENDERS RECEIVED AND ACCEPTED

ASTON MANOR.—About twenty tenders have been received for the extensions of buildings at the generating station, ranging from £4,737 to £5,600.

AUSTRALIA: *Queensland.*—The tender of Messrs. W. T. Henley's Telegraph Co., Ltd., has been accepted for the supply and delivery at Brisbane of the following:—880 yards 208 cable pair, 12½ lb. conductor, £630; 2,860 yards 104 cable pair, 12½ lb. conductor, £360; 320 yards 78 cable pair, 20 lb. conductor, £380; 3,941 yards 52 cable pair, 20 lb. conductor, £285; 440 yards 39 cable pair, 20 lb. conductor, £245; 880 yards 26 cable pair, 20 lb. conductor, £180; 440 yards 13 cable pair, 20 lb. conductor, £115; 880 yards 2 cable pair, 20 lb. conductor, £25.

FINCHLEY.—The District Council has accepted the tender of Messrs. Browett, Lindley & Co., Manchester, at £4,528, to supply a 700-kw. engine and dynamo, and carry out the necessary work of installation.

FRANCO-BRITISH EXHIBITION.—It is stated that a Southampton firm has obtained the contract for an electric lighting installation in the great Stadium.

LONDON: *London County Council.*—In connection with the reconstruction of the tramways from Brixton to Camberwell, the Highways Committee recommend the acceptance of the tender of Mr. W. Manders, of Leyton, for the roadwork, &c., at £19,276 8s. Permission will be granted for sub-letting the supply bonds to the Lahmeyer Electrical Company, Limited, Hadfield's Steel Foundry Company, Limited, the supply of the drain-boxes; and to Bayliss, Jones and Bayliss, Limited, the supply of the tiebars, bolts, &c.

The following tenders have been received for the supply of cables in connection with the tramway works to be undertaken during 1908-9:—(1) Tenders for high-tension electric cables, &c.: The British Insulated and Helsby Cables, Ltd., £32,000 3s. 11d.; Siemens Brothers & Co., Ltd., £32,487 4s. 10d.; The Western Electric Company, £32,580 14s. 8d.; Callender's Cable and Construction Company, Ltd., £32,918 16s. 2d.; W. T. Henley's Telegraph Works Company, Ltd., £33,292 13s.; W. T. Glover & Co., Ltd., £33,648 15s. 7d.; Johnson & Phillips, Ltd., £33,922 10s. 8d. (2) Tenders for low-tension electric cables and telephone cables, &c.: W. T. Henley's Telegraph Works Company, Ltd., £35,101 4s. 7d.; The Union Cable Company, Ltd., £36,085 2s. 2d.; The British Insulated and Helsby Cables, Ltd., £36,349 9s. 10d.; Siemens Brothers & Co., Ltd., £36,918 11s 1d.; Johnson & Phillips, Ltd., £36,955 11s. 8d.; The Western Electric Company, Ltd., £37,050; W. T. Glover & Co. Ltd., £38,546 13s. 6d.; Callender's Cable & Construction Company, Ltd., £38,745 11s. 3d.

The tender of the British Insulated & Helsby Cables, Ltd., has been accepted for the high-tension cables, and that of W. T. Henley's Telegraph Works Co., Ltd., for the low-tension cables.

The tender of Messrs. John Spencer, Ltd., has been accepted for the supply of steam, exhaust, feed, drain and condenser piping and valves, water tanks, &c., required for the second portion of the Greenwich generating station at £10,910 13s. 10d.

The tenders of the Frodingham Iron & Steel Co., Ltd., for the supply of slot and conductor rails, and of Hadfield's Steel Foundry Co., Ltd., for the supply of special trackwork, were extended to include £2,633 0s. 10d. for slot rails, and £5,283 for special work in connection with electrification of the tramways in Queen's-road, Battersea.

For the installation of electric lighting at the Hackney Downs Secondary School the tender of W. G. Cannon & Sons, Ltd., at £249 10s. was accepted.

Hampstead.—The Borough Council has accepted the following tenders for supplies to the Electricity Department:—Dynamo and Belliss crank chamber oil, A. Duckham and Co., three years' supply; cylinder oil for superheated steam, Vacuum Oil Co., Ltd., three years; crank-chamber oil for Willans engines, Bowring Petroleum Co., Ltd., one year.

Hammersmith.—The Borough Council has accepted the following annual tenders:—Supply of meters: Messrs. Ferranti, Ltd., 110 volts, 3 amp., £1 12s. 6d.; 5 amp., £1 12s. 6d.; 10 amp., £1 12s. 6d.; 25 amp., £1 15s. 6d.; 50 amp., £2 4s.; 75 amp., £2 11s. 6d.; 100 amp., £2 19s.; 250 amp., £5 15s.; 500 amp., £7 2s.; 2½ per cent. discount; 220 volts, 3 amp., £1 12s. 6d.; 3 amp., £1 12s. 6d.; 10 amp., £1 12s. 6d.; 25 amp., £1 15s. 6d.; 50 amp., £2 4s.; 75 amp., £2 11s. 6d.; 100 amp., £2 19s.; 250 amp., £5 15s.; 500 amp., £7 2s.; 2½ per cent. discount; 3,500 yards 0·1 E.H.T. cable, Western Electric Co., £690; 700 yards, 0·05 H.T. cable, do., £35; 750 yards 0·023 H.T. cable, do., £50 4s.; 500 yards 7/18 twin, do., £43 16s. 3d.; 500 yards 0·25 E.H.T. cable, do., £180 13s. 6d.; motors, dynamos, &c., for Messrs. Gwynnes, Ltd., British Thomson-Houston Co., Ltd., £1,638 10s.

Woolwich.—The Borough Council has placed an order with the

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Patent Enamel Co. for 50 enamelled advertisement plates, at £29 7s. 6d., for use in advertising the electricity supply.

METROPOLITAN ASYLUMS BOARD.—The Board has accepted, at £23 11s. 6d., the tender of Veritys, Ltd., for fittings to prevent unauthorised interchange of electric lamps.

WATFORD.—A tender by Messrs. Ferranti, Ltd., for the supply of two high-tension fuse-boards at £52 15s. each has been referred to a Sub-Committee.

Annual Convention of the American Institute of Electrical Engineers.—It has been decided that the Annual Convention of the American Institute of Electrical Engineers will be held at Atlantic City, from June 29th to July 2nd.

Accident in a Mine.—A miner, who was putting corrugated iron sheeting over a wooden casing which contained a 500-volt electric cable in the underground workings of the Francis Pit, Dysart, Fife, drove a nail into the cable and received a fatal shock.

The North-west London Tube.—A private meeting of property owners and agents, representing land and houses to the value of several millions sterling, was held at Kilburn on Thursday last, and a committee was appointed to direct a movement for the presentation of a petition from the residents of the district to the promoters of the North-west London Railway, who hold statutory powers for the construction of a tube railway from Victoria to Cricklewood, via Marble Arch. The intention of the committee is to arouse public interest, in order that the commencement of the line shall not be further delayed.

Electrical Power in Ontario.—In the Ontario Legislature, Toronto, last month, Premier Whitney, in answer to questions addressed to the Government, stated that the Government had been approached with regard to the purchase of the plant and transmission lines of the Electrical Development Company, but that in consideration of the practically accepted contract with the Ontario Power Company, they had declined to consider the proposition. The purchase would also have involved a liability of upwards of five million pounds sterling, which was too great.

Creosoted Wood for Tramway Tracks.—In the Court of Appeal on Friday last, the Lord Chief Justice, Sir Gorell Barnes, and Lord Justice Farwell had before them the case of West *v.* The Bristol Tramways Co., on the appeal of the defendants from the judgment of the Divisional Court (see ELECTRICAL ENGINEERING, February 6th, 1908, p. 220). The Lord Chief Justice, in delivering judgment, said that although there was an obligation on the defendants to use wood pavement, there was no obligation to use wood pavement which was dangerous to property, and the jury had found that the injury to the plaintiff's plants was caused by the creosoted wood paving. He came to the conclusion that the contention that the plaintiff had no common law right of action failed, and that the contention that the special Act authorised what the defendants had done also failed. The appeal was therefore dismissed.

North Metropolitan Tramways Co. v. Leyton Urban District Council.—In the Appeal Court last week, the North Metropolitan Tramways Co. appealed against the decision of Mr. Justice Phillimore and Mr. Justice Walton, last October, with regard to the acquisition by the Leyton Urban District Council of so much of the company's undertaking as was within its area. Mr. Graham Harris awarded the Company compensation for the whole of their undertaking in Leyton, but held that a car-repairing factory and land comprising a total area of 77,000 square feet were not suitable or used for the purposes of tramways within the area of the Council, being a factory where the Company repaired and constructed cars for the whole of their system. He accordingly declined to make any allowance in his award for the works and land in question. The Company appealed against this decision, and sought to have the award set aside. The Court held that the local authority were not compelled to take the car factory. The Lord Chief Justice now stated he was satisfied that substantial justice had been done by the award of Mr. Harris, and the appeal was dismissed.

Proposed Alterations in the American National Electric Code.—Some alterations in the American National electric code have been suggested by a committee of the Underwriters' National Electric Association, and are under consideration. According to the *Electrical World* (New York), the recommendations of the committee on rheostats do not cover construction and installation of automatic apparatus, but consist in amendments to rules dealing with the construction of rheostats. The amended rules, if adopted, will call for resistances so constructed that if the conductor be fused, the arc or attendant flame shall be confined within the rheostat. The committee on transformers has recommended the adoption of new rules covering the installation of transformers on low potential systems. A complete set of rules is proposed covering the wiring of electric cranes, and also a set of rules governing the construction and testing of circuit breakers. In order that there may be no dispute regarding the wiring of varying speed alternating-current motors, motors of this type will be required to be marked with the maximum current which they can safely carry for thirty minutes, starting cold. The report of the committee on switches and cut-outs has to do chiefly with rules governing the construction of panel boards and cabinets.

MISCELLANEOUS CITY NOTES

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO.—Applications are invited before the 8th inst. for an issue of £250,000 six per cent. prior lien debentures in £100 shares, redeemable by means of an annual sinking fund of 2 per cent. (with power for the company to increase the same at any time) to be applied annually in purchasing debentures in the market at not exceeding par (exclusive of accrued interest), or in redeeming debentures to be selected by drawings, the first redemption being on January 1st, 1909. Any debentures not previously redeemed will be repayable at par on January 1st, 1933, or on the security constituted by the trust deed becoming enforceable.

MEXICO ELECTRIC TRAMWAYS.—An application was made in the Chancery Division on Wednesday last week for the appointment of a receiver to this company. It appears that a lease has been granted of the company's undertaking to the Mexican Consolidated Electric Co., which certain shareholders regard as a device for depriving them of certain dividends upon their shares. An action is pending as to the legality of the lease in question, and after hearing evidence and arguments, the parties in the present action agreed that pending the action yet to be heard, there should be no completion of the lease.

ROBEY & CO.—Mr. William Embleton-Fox, of Northorpe Hall, Lincoln, has joined the board.

SOUTH METROPOLITAN ELECTRIC LIGHT & POWER CO.—The warrants for payment of interest due on April 1st on the 4½ per cent. first mortgage debenture stock of this company have been posted.

UNITED RIVER PLATE TELEPHONE CO.—In a circular issued by the directors, it is stated that an issue of 20,000 ordinary shares of £5 each is to be offered to present shareholders. The extra capital is required for the general development of the company's undertaking, especially in connection with placing the company's lines in the city of Buenos Ayres underground. Sir J. Gavey last year visited Argentina with a view to making an examination of the company's affairs, and his report is entirely favourable to the proposed issue.

Electrical Engineers Volunteers (London Division).—Mr. F. M. Masters has been given a second lieutenancy.

Serious Accident in Germany.—A large dynamo, which was being tested in the presence of several engineers and a number of workmen in the Siemens-Schuckert Works at Charlottenburg, suddenly flew to pieces. The building in which the machine was being tested was completely wrecked. Three men were killed and fifteen seriously injured.

Excessive Speed of an "Electrobus."—The driver of an electric omnibus was summoned at Marylebone last week for exceeding the speed limit in the High Road, Kilburn. It was stated that the omnibus was timed over a measured furlong, and covered this distance at a speed of over 16 miles an hour. The traffic manager to the Electrobus Company, however, stated that the company had eleven omnibuses running, and informed the magistrate that the 'buses were unable to travel at a speed exceeding 12 miles an hour unless running free-wheel, and he was prepared to call expert evidence to prove this if an adjournment could be granted. Mr. Paul Taylor did not think this worth while, and fined the driver 10s. and 2s. costs.

Telegraph Traffic.—The Alexandra-Larnaca cable is still down, as are also the cables between Paramaribo and Cayenne, and between Guadeloupe, Antigua, and Dominica. Neither have we yet been advised of the repair of the cable between Guantanamo (Cuba) and Mole St. Nicholas (Hayti). Interruptions have again occurred to the routes via Hanekin and Fao, which were speedily put right. The question of a system of Imperial cables has again been taken up by the daily Press, and the Ottawa Board of Trade have issued a pamphlet on the subject. Not only will the scheme voiced provide duplicate routes to all the chief Colonial possessions, but also means of communication at a cheap rate.

Disclosure of a Secret Process.—In the King's Bench Division of the High Court, on Thursday last, the case of the London Electron Works Co., Ltd., *v.* Wagner was heard by Mr. Justice Ridley and a special jury. The company sought an injunction to restrain the defendant, who had been in their employ, from committing a breach of an agreement by which he had undertaken not to enter into a similar business in England and not to disclose any knowledge he should obtain of their secret process. The process in question was an electrical method of recovering the tin from old tinned iron articles. The company, which had a capital of £40,000, dealt with about 15,000 tons of tinned metal each year, out of which about 2 per cent. of pure tin was obtained. In November, 1905, the defendant entered into the employ of the company, but in 1907 the company gave the defendant one month's notice to terminate the agreement, as they were suspicious of his intentions. In April, 1907, a description of the process appeared in a German electrotechnical journal, and the company contend that the information was supplied by the defendant. The defendant denied any breach of the agreement, but gave the undertaking asked for. Each party paid their own costs.

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MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night, was £61 10s. to £62 per ton (last week, £61 5s. to £61 15s. per ton).

AGENCY.—Mr. P. F. Brittain, of 110 Cannon Street, has been appointed sole selling agent in England, Wales, and Ireland for the Universal Electric Manufacturing Co., whose works are at Peckham, for the sale of their switchboards, fuse-carriers, cable sockets, iron-clad switches, fuse-boxes, feeder pillars, fuse-clips, resistances, choking coils, street-lighting brackets, street boxes, fuse-boards, heavy-duty switch fuses, regulating switches, &c.

LIQUIDATIONS, BANKRUPTCIES, &c.—A general meeting of the London & Continental Electric Carriage Co. will be held at South Sea House, Threadneedle Street, London, E.C., on April 23rd, at 12 noon, for the purpose of hearing the liquidator's account of the winding up.

It has been decided to voluntarily wind up the Standard Wire Co., of Sowerby Bridge, Yorkshire. Mr. W. H. Armitage, Halifax, has been appointed liquidator.

Creditors of the York Electric Co., Ltd., are requested to send in particulars of their debts or claims, together with the names and addresses of their solicitors, to the liquidator, Mr. C. A. Rymer, Bank Chambers, Nessgate, York, by April 11th.

A meeting will be held at the offices of the liquidator on April 29th at 2 p.m. to hear the liquidator's account of the winding up.

The trustee in the bankruptcy of Mr. K. C. Moran, electrical engineer, 80A Teddesley Street, Walsall, has been released.

The trustee in the bankruptcy of C. W. Stafford, Electrical Engineer, 59 Toll End Road, Ocker Hill, Tipton, Staffs, has been released.

Notice is given in the *London Gazette* of a meeting of Messrs. Ferranti, Ltd., at the offices of Mr. J. M. Henderson, the liquidator, 2 Moorgate Street Buildings, London, on April 27th, at 12 noon. This, of course, refers to the old firm, before the reconstruction in 1901.

A meeting of the Chatham, Rochester & District Electric Lighting Co., Ltd. will be held at 22 High Street, Chatham, on May 1st at 4 p.m. to hear the liquidator's account of the winding up.

A meeting of the Britannia Electric Lamp Co. will be held at the offices of Messrs. James Worley & Son, 37 Lime Street, London, on April 29th at 2 p.m. to receive the liquidator's account of the winding up.

A meeting of the creditors of Messrs. Bruce Peebles & Co. was held in London on Thursday, when Mr. Tait stated that if there was a forced liquidation, he calculated that the unsecured creditors would only receive 6s. 6d. in the £, and that this would not be distributed for a considerable time. A committee of creditors was appointed to consider a scheme put forward by the directors as follows: That the debentures should be extended for ten years, that the interest should remain, as at present, at 5 per cent., with a sinking fund of 2 per cent. per annum; that the trade creditors should accept 7s. 6d. in the pound in a debenture which would be redeemed by the proceeds of the sale of securities and the collection of contract balances, and this 7s. 6d., he considered, should be paid in a short time. The other 12s. 6d. would be given the creditors in the shape of a cumulative 6 per cent. preference share in the new undertaking. Altogether 120,000 cumulative preference shares would be issued, of which 30,000 would be offered at par to the shareholders for subscription, and that would provide £30,000 for working capital and for redeeming debentures. The deficiency has been estimated at £163,086.

The Removal of Snow from Tramway Tracks.—An action has been brought by the Acton Urban District Council against the London United Tramways Co. to recover £20, the cost of removing snow from the margin of the main road, cast there by the action of the tramway company's snow plough. They also claimed damages under the Tramways and Public Health Acts for a nuisance and obstruction. The tramway company stated in defence that they were only obliged to keep the track in proper repair, and were not obliged to remove snow. At Brentford County Court, Judge Howland Roberts said that the tramway company was not obliged to remove snow, but that an obstruction had been caused, and judgment was given for the plaintiffs for the amount of £25 damages and costs.

Damages against the Gt. Northern, Piccadilly, & Brompton Railway Co.—At Clerkenwell last week an engineer's assistant named W. W. Johnson, and his wife, sued the Gt. Northern, Piccadilly & Brompton Railway Company for damages for alleged negligence on the part of the company's employees. As the train in which the plaintiffs were travelling ran into Gillespie Road Station, it was said to have been pulled up with a sudden and violent jerk, with the result that the plaintiffs, who were standing up, were thrown to the floor of the car, and Mrs Johnson was rendered unconscious. The jury awarded £20 damages.

PARLIAMENTARY INTELLIGENCE

DUBLIN AND CENTRAL IRELAND ELECTRIC POWER BILL.—Our report of the proceedings in connection with this Bill before a House of Commons Committee is given on p. 503.

FINCHLEY URBAN DISTRICT COUNCIL BILL.—This Bill, which provides for a small extension of the boundaries to which electric supply will be extended, was read a third time in the House of Commons on Monday, having been passed by a Committee last week.

KING'S COLLEGE, LONDON (TRANSFER), BILL.—This Bill was sent forward for third reading by the Unopposed Committee of the House of Lords last week. The object of the Bill is to transfer to the University of London the powers and duties of King's College, London, in relation to instruction of a university standard in subjects comprised within the faculties of the University other than the faculty of theology.

LONDON AND WINDSOR MOTOR ROADS BILL.—It is announced that the London and Windsor Motor Roads, Tramroads and Tramways Bill, will not be further proceeded with this session.

METROPOLITAN ELECTRIC TRAMWAYS BILL.—A Committee of the House of Lords, presided over by Lord Wenlock, considered this Bill on Wednesday last week. The object of the Bill is to revive the capital powers which the company obtained in 1901 in connection with the Harrow Road and Paddington tramways, and also in connection with the extensions of the line to Edgware Road. The Willesden Urban District Council opposed the Bill in an endeavour to secure halfpenny half-mile stages, which the company said was commercially impossible. There was also an objection by a jobmaster on the route, who asked that the whole of his property should be taken, and not a portion. The preamble of the Bill was declared passed, and both oppositions were unsuccessful.

MOTHERWELL CORPORATION BILL.—This Bill, which was before a Committee of the House of Commons last week, was reported for a third reading on Friday. Particulars were given in our last issue.

PROGRESS OF ELECTRICAL BILLS.—In the House of Commons last week, the London County Council Tramways and Improvements Bill was read a third time.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION BILL.—The House of Lords Committee presided over by Lord Wenlock, decided, on Wednesday last week, to allow this Bill to proceed, subject to one or two adjustments on the question of the area to be supplied by the Freforest Electrical Consumers Co. We gave full particulars of the Bill and the opposition to it in our last issue.

TRAMWAYS ORDER CONFIRMATION (No. 1) BILL.—This Bill, which was read a third time in the House of Lords last week, relates to a Provisional Order granted by the Board of Trade under the Tramways Acts to the Manchester Corporation for three short lengths of tramway in the Moss Side district. There are two pieces of double-track, respectively 8·89 chains and 0·67 chains, and a connecting link of single track 0·55 chains long.

WISHAW ELECTRICITY BILL.—This Bill was reported for third reading by the Unopposed Committee of the House of Commons on Thursday. It provides for the expenditure of money in supplying electrical fittings, &c., and makes provision with regard to stand-by supply and discounts.

WOLVERHAMPTON CORPORATION BILL.—The Police and Sanitary Committee of the House of Commons, presided over by Mr. Corrie Grant, had this Bill under consideration last week, when it was ordered to be reported for third reading. Mr. Ram, K.C., and Mr. Jeeves appeared for the Bill, to which there was no opposition. Amongst the proposals in the Bill was one relating to tramways, extending the time granted by the Act of 1904 for the reconstruction and improvement of Rookery Bridge and for the construction of tramways in connection therewith for three years. The proposed new tramways will join up with the busiest part of Wolverhampton, negotiations for the acquisition of the necessary property having just been concluded. At the other end of the line there is a rapid development going on which has justified the Corporation in reviving the powers in question.

APPOINTMENTS AND PERSONAL NOTES

Mr. C. C. Butler, the first assistant in the Willesden Electricity Department, has been promoted from the second to first-class division at a salary of £160, rising by annual increments of £10 to a maximum of £200, and the salary of Mr. L. T. Bickell, Mains Superintendent, has been increased from £104 to £111 10s., rising by annual increments of £7 10s. per annum to a maximum of £134.

The Stoke Newington Borough Council has increased the salary of the Electrical Superintendent, Mr. S. Hann, from £150 to £175 per year, and the salaries of Messrs. L. Andrew and H. Large, assistants, have been advanced respectively from £91 to £104 a year, and from £65 to £78 a year.

The Stepney Borough Council has raised the maximum salary of Mr. E. E. Dorking, senior analyst and prime cost clerk to the electricity supply department, from £135 to £140 per annum.

According to the *Review of the River Plate*, Mr. J. T.

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Cornish, Chief Engineer to the six associated tramway companies of the Grand National group, has been appointed Chief Engineer to the City of Santos Improvements Co., Ltd. (electrical traction, lighting, and gas and water service). Mr. Cornish will pay a visit to England before taking up his new appointment.

Mr. W. P. Beatty, Chief Electrical Engineer of the Pacific Railway, has left for England in connection with the tenders for the new power house to be erected at Bahia Blanca. The total cost of the work amounts to about £250,000.

Mr. Morton Beales is severing his connection with Messrs. Bruce Peebles & Co., Ltd., and is entering into partnership with Mr. M. M. Gillespie. The new firm will be styled Gillespie & Beales, and will have offices at Amberley House, Norfolk Street, Strand, and will carry on business as buying and selling engineers, exporters, and contractors.

COMPANIES' MEETINGS AND REPORTS

ANGLO-ARGENTINE TRAMWAYS.—The report for the year ended December 31st, 1907, shows a net revenue, including £10,081 brought forward and including profits of the six months' working of the Buenos Aires and Belgrano tramway system, and allowing £65,000 for depreciation renewal fund, of £335,573. After transferring £4,200 to a sinking fund for the redemption of the preference shares and £4,030 to the investment depreciation account, a dividend of 8 per cent. is recommended on the ordinary shares, carrying forward £16,734.

BASTIAN METER.—During the six months ending December 31st, 1907, there was a net profit of £552 earned. This sum, added to the balance of profit remaining from the half-year ending June 30th, 1907, of £534, makes a total of £1,086. The directors propose the payment of 2½ years' 6 per cent. cumulative preference dividend to December 31st, 1907, and a dividend of 2½ per cent. on the ordinary shares, carrying forward £536. At the meeting recently the report was adopted.

BRITISH ELECTRIC TRANSFORMER CO.—The report for the year 1907 shows that the net trading profit has improved to the extent of about £1,800, as compared with the year 1906. For the purposes of making this comparison, allowance has been made for the sales of patents included in the 1906 account, and also for the fact that this year's account provides considerable sums for writing down stock, &c., not dealt with in the previous year. A block of £15,010 preference shares has been obtained in settlement of the debt, amounting to £10,011, the whole of which was written off last year. These preference shares the directors believe may ultimately prove of value. After writing down certain items of stock, &c., referred to above, and paying all manufacturing costs, and the expenses of administration, there remains a net trading profit of £6,248, *less* loss brought forward from last year, £3,998, making available a balance of £2,249. The Board recommend that this be allocated as follows:—To depreciation reserve, £1,300; to payment of 6 per cent. preference dividend for the six months ended December 31st, 1906, carrying forward £34. Mr. E. Phillips, who acted for several years as chairman of the company, resigned his seat on the Board on November 20th, 1907, and Mr. J. F. Albright was appointed chairman of the company. After full consideration of the various matters referred to them, a report was recently issued by the committee of shareholders approving the policy adopted by the majority of the Board. The directors are in full agreement with the further conclusions arrived at in the committee's report. The meeting will be held on the 7th inst.

BROMLEY (KENT) ELECTRIC LIGHT AND POWER.—The report for 1907 states that the lamp connections have increased from 71,222 to 77,802. The revenue from sale of current increased from £13,997 to £15,237. During the year considerable extensions have been made to the generating plant to meet the increased demand, and an additional sub-station is being erected at Elmstead. The result of the year's trading, including £313 brought forward, shows a profit of £12,386, and after payment of debenture interest and trustee's fees, amounting to £3,202, and £250 for depreciation of stock, there is a balance of £8,933. An interim dividend at the rate of 4 per cent. per annum was paid for the half-year in October, and the directors now recommend the payment of a further dividend at the rate of 7 per cent. per annum, making a total dividend of 5½ per cent. for the year, and that £4,500 be placed to reserve account, leaving a balance of £308 to be carried forward. The meeting is on April 6th.

BROWETT, LINDLEY.—The report for the year ended December 31st, 1907, shows an increased profit of £9,859. Deducting bank, debenture, and loan interest (£2,190), depreciation upon buildings, machinery, and investments (£3,859), and allocating £2,505 for upkeep of patterns, there remains a net profit of £1,318, compared with a loss for 1906. At the meeting last week the report and accounts were adopted.

CAMMELL LAIRD.—The report for 1907 states that for the first time in its history the earnings of the company do not permit of a final dividend for the year. The net profits for the year, after charging depreciation and bank and loan interest, but without interest on debenture and debenture stock, is £139,358, to which is to be added £45,952 brought forward from last year. The interest on debentures and debenture stock, the instalment of 2½ per cent. on account of dividends on paid up capital which was paid in October, and the ascertained loss on the ore and coke contracts, exceed the balance available by £14,987.

CROMER GAS.—At the ordinary general meeting of the Cromer Gas Company last week, Mr. J. Lovelace, the chairman, had some remarks to make with regard to the competition of the Corporation electric light undertaking, which, he said, was likely to be even more serious in the future than it had been in the past. To the company as ratepayers the fact that the electric lighting undertaking was not paying its way was a serious matter. This competition was extremely unfair, but he had no doubt as to the result if the company was only able to compete on fair terms.

EDWARDS AIR PUMP SYNDICATE.—The report for 1907 recommends a final dividend of 15 per cent. per annum, making 20 per cent. for the year. A further sum of £2,500 is to be placed to reserve fund for redemption of patents, bringing this fund up to £15,000, which equals the amount originally paid for patents. The reserve for dividend equalisation stands at £1,000, and the investments reserve account at £565. Of the 1,203 pumps sold during the year, 737 were for land installations, including electric lighting works, and the report further adds that the Edwards pump has now been fitted in more than 400 of the principal electric lighting and traction stations. The gross revenue for the year was £11,555, and the working expenses £4,262, leaving a gross profit of £7,293, to which is added £63 brought forward. After meeting dividends and the other amounts mentioned above, the sum of £578 is carried forward.

THE ELECTRIC LIGHTING AND TRACTION COMPANY OF AUSTRALIA.—The report for the year ended August 31st, 1907, shows that there has been capital expenditure in Australia on buildings, plant and mains incurred as follows:—On the Melbourne undertaking of £11,657, and on the Geelong undertaking of £2,526. The profit and loss account shows that the gross profit derived during the year from the two undertakings was £16,354. Adding the dividend received on the company's holding of Ordinary Shares in the Adelaide Electric Supply Company, together with interest, discounts, transfer fees, &c., the total gross profit for the year amounted to £19,741, which compares with £16,202 for the previous year. Management and general expenses at the London head office absorbed £1,971, and interest on debenture stock and sundry loans amounted to £13,361. After payment of these charges, there remains a balance to the credit of profit and loss account of £4,408, to which must be added the amount of £1,185 brought forward from the previous year, making a total credit balance of £5,593. Of this sum the directors have transferred £4,000 to reserve account, leaving £1,593 15s. 3d. to be carried forward. On August 31st, 1907, there were connected to the mains in Melbourne the equivalent of 125,974 eight c.p. lamp, whilst the total number of units sold were 1,820,879. Similar figures relating to Geelong were 44,582 and 344,501 respectively. The Adelaide Electric Supply Company, in which the company holds £127,500 ordinary shares, has continued to make satisfactory progress during the year; and a dividend of 2½ per cent. per annum on the ordinary shares was declared in December last, credit for which has been taken in this company's profit and loss account. A contract has been entered into by the Adelaide Company for the temporary supply of power to the Adelaide Municipal Tramways Trust, which is expected to prove an important source of additional revenue. The provision of the additional capital required to cope with the continued expansion of the Melbourne and Geelong undertakings is receiving the careful consideration of the directors, and they hope to be in a position to place before the shareholders at an early date a comprehensive scheme for effectually dealing with this question. The meeting will be held on the 6th inst.

FOLKESTONE ELECTRICITY SUPPLY.—The report for the year ended December 31st, 1907, states that whereas at December 31st, 1906, the equivalent of 86,871 8-c.p. lamps was being supplied, on December 31st, 1907, the equivalent of 96,500 8-c.p. lamps was being supplied. The accounts show that, including the receipts from hired installations, the profit on the revenue accounts for the three undertakings at Folkestone, Hythe, and Sandgate amounted to £12,872. This amount, with

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the sum of £306 brought forward from last year's accounts, and after allowing for interest on debenture stock, dividend on preference shares, and bank charges &c., and also for the interim dividend at the rate of 4 per cent., per annum, paid on the ordinary shares, shows a balance of £5,513. Out of this the directors have carried the sum of £3,080 to the depreciation fund allocated to the various districts as follows, viz. :—Folkestone, £2,530; Hythe, £400; and Sandgate, £100; and also the sum of £350 to the reserve fund, making this fund now £2,350; and they recommend the payment of a dividend at the rate of 7 per cent. (less income tax) for the half-year (making 5½ per cent. for the year), leaving a balance of £333 to carry forward. The directors much regret the loss the company has sustained through the death of the late Mr. Alderman Baker, who was one of the pioneers of electric lighting in Folkestone, and had been associated with the company since its incorporation, and Mr. Councillor Wampach has been appointed by the directors to fill the vacant seat on the board. At the meeting last week, the report and accounts were adopted.

GATESHEAD & DISTRICT TRAMWAYS.—The report for the year 1907 shows a total revenue of £54,309, compared with £52,622 for the year 1906. Deducting working expenditure, including repairs and maintenance and interest of mortgages, and adding the balance brought forward, there remains a balance of £23,756. The directors recommend a transfer of £3,500 to depreciation and renewal account, bringing this to £15,392, to add £1,701 to the sinking fund for redemption and mortgages, £609 to depreciation and investments, and dividends of 6 per cent. and 5 per cent. on the preference shares, and 7 per cent. on the ordinary shares. The amount carried forward is £1,758. The capital expenditure during the year amounted to £532, making the total capital outlay of the company £311,977. Having regard to the bad weather experienced continually throughout the year, and the serious depression of the shipbuilding industry on the north-east coast, the directors consider the result of the year's working very satisfactory. At the meeting on Tuesday the report and accounts were adopted.

GREENOCK AND PORT GLASGOW TRAMWAYS.—The report for 1907 states that the capital expenditure during the year amounted to £517, making a total expenditure on capital account of £193,641. The total revenue for the year amounted to £34,358, and the expenditure, including interest, rents, &c., repairs, maintenance, renewals, and depreciation to £25,592. To the balance of £8,766 has to be added £136 brought forward from last account, making a total available for distribution of £8,902. It is recommended that the sum of £1,780 be carried to reserve (sinking) fund, and that a dividend of 3 per cent. per annum on the ordinary shares be paid, carrying forward £172. With the addition above mentioned, the reserve (sinking) fund stands at £11,390. There is a decrease in the receipts of £640, compared with the previous year, due to the decline in the shipbuilding trade, but as the expenditure has been reduced by £817, there is an increased profit for the year of £177. At the meeting on Tuesday the report and accounts were adopted.

GUILDFORD ELECTRIC SUPPLY.—The report for 1907 shows gross receipts of £6,466 compared with £5,975 for 1906. After crediting depreciation fund account with £1,000, there is a net balance of £3,082, compared with £2,668 for the previous year, when only £502 were credited to depreciation account. After providing for interest on debentures, dividends on preference shares, and transferring £350 to reserve, there is a net balance available for distribution of £914. A dividend of 5 per cent. on the ordinary shares is recommended, and a balance of £220 is carried forward. The number of consumers is now 588, compared with 525 last year, and the total expenditure to date amounts to £53,271. The capital issued amounts to £49,586, and in order to balance the difference, the directors propose issuing further ordinary and preference shares and the balance of the debentures.

LIVERPOOL DISTRICT LIGHTING.—At the annual meeting last week, the report and accounts given in our last issue were adopted. The company's business, the chairman stated, was increasing so rapidly that a further £5,000 new capital was necessary. Reference was also made to the satisfactory position of the undertaking in view of the effect upon the revenue of the increasing use of metallic filament lamps.

LONDON ROAD-CAR.—At the half-yearly meeting last week, Mr. J. H. Moore, M.P., who presided, dealt at some length with the increasing competition with which the omnibus proprietors now have to contend. Prior to the opening of the Central London Railway, he said the passenger traffic within a certain radius on the north side of the Thames was almost in the hands of the London General Omnibus Co., London Road Car Co., the North Metropolitan Tramways Co., the Metropolitan Railway, and the Metropolitan District Railway. Since then, however, the London County Council had converted the tramways to electric traction, and by fixing ridiculously low fares, had attracted many of the omnibus companies' passengers. Further, in the interval between the opening of the Central London Railway in 1900 and 1907, the Baker Street & Waterloo, the Great Northern & City, the Great Northern, Piccadilly, & Brompton, and the Charing Cross & Hampstead tube railways had been opened, whilst there had also been increased competition amongst the omnibus companies themselves. In spite of the fact that the wet weather of last summer had mitigated greatly against omnibuses, and thus given a favourable inclination to the tube railway receipts, the fact remained that, taking for instance the tube railways under the control of the London Underground Company, whereas £621,000 was necessary to pay 4 per cent. on the capital of £15,513,000, the actual amount earned was only £174,000 per annum.

LONDON UNITED TRAMWAYS.—The report for the year ending December 31st, 1907 shows gross receipts amounting to £545,570, and working and general expenses, maintenance, and repairs £214,672, leaving, with the balance brought forward from last account, a net revenue of £131,747. After payment of interest on debenture stock and loans and the dividend on the 5 per cent. preference shares for the year, and providing for income tax, there is a balance of £10,260. An interim dividend at the rate of 2 per cent. per annum, less income tax, amounting to £8,970, was paid in August, leaving £1,287, which the directors propose to carry forward to the next account. The gross receipts show an increase of £17,674, and the total number of passengers carried was 58,725,980, an increase of 3,570,699. The directors regret that the profits have not permitted of any appropriation to the renewal fund, which it is their desire to augment year by year. The section of the company's system in Surrey, from Raynes Park to Wimbledon and Tooting, about 6½ miles of tramway, was completed and opened for public traffic in June last. The tramway mileage now in operation consists of 55¼ miles. The company's powers in respect of certain uncompleted lines expire in August next, and application is at present before Parliament for a further extension of time and also for powers to lay a line across Kew Bridge, forming a connection between the company's main lines and Richmond. The London County Council connection with the Wimbledon lines at Tooting has not yet been effected, and the question of through running over the respective systems still remains the subject of negotiation. It is with regret that the directors have to record the fact that, owing to the exceptionally cold and wet summer season, receipts for the second half of the year's working have proved to be disappointing.

At the meeting on Friday, when Mr. C. J. Cater Scott, the chairman of the company presided, the report and accounts were adopted. Dealing with the question of physical connections between the London County Council system and their own, the chairman said that at present there were only a few yards between the two systems in the south of London, and he hoped that it would not be long before the London County Council saw their way to bring about the much-desired physical connection. Speaking of the company's Bill now before Parliament, he mentioned that having passed the Standing Orders stage in both Houses with this Bill, the company had upset the veto of both the Surrey and Middlesex County Councils, which authorities had endeavoured to prevent the Bill going forward on the question of consent. He pointed out that the local authorities in question saw fit to ask from the company the sum of £4,000 for crossing Kew Bridge, and he thought this was using the veto for a most improper purpose. The present amount for wayleaves which the company paid to local authorities already amounted to £3,600 a year, in addition to which they had had to pay for street improvements and widenings the sum of £945,991. He asked the shareholders to take these figures, together with the attitude of the local authorities, into consideration, when they would realise that it was becoming almost impossible for a company to give facilities for London traffic. Dealing with the accounts, he pointed out that the gross receipts had increased by 5 per cent., and the number of passengers carried by 6 per cent., in spite of the fact that during the year there had been twenty-four wet week-ends compared with only nine during 1906. As an instance of how the weather affected tramway undertakings, he gave the figures for the week ending July 19th, which was a fine week, when the receipts amounted to £8,473, whereas during the week ending July 5th, which was a wet week, the receipts were less by £1,242. In conclusion, the chairman mentioned that Mr. J. R. Chapman, the Chief Electrical Engineer to the Underground Electric Railways Co., of London, Ltd., had been elected a member of the Board. The total route mileage now in operation is 55½ miles.

MADRAS ELECTRIC TRAMWAYS (1904).—The report recommends a dividend of 4½ per cent. per annum on the preference shares for the half-year ended December 31st, 1907. The sum of £1,500 is placed to depreciation and renewals fund, and £221 are carried forward.

MERSEY RAILWAY. The report for the half-year ended December 31st, 1907, states that the train mileage run during the half-year was 416,189 miles as compared with 416,555 during the corresponding six months of 1906. The number of passengers conveyed during the half-year ended December 31st, 1907, has been 5,604,295, as against 5,271,524 for the correspond-

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ing period of 1906, exclusive of season ticket holders. The total receipts from all sources for the half-year have been £51,027, as compared with £47,359 for the corresponding period of 1906. The working expenses, exclusive of the charges for pumping, ventilation, and litts, have been £33.205, equal to 65·07 per cent., as against £31,963, equal to 67·49 for the corresponding six months. These charges for pumping, ventilation, and hydraulic lifts for the past half-year amounted to £4,103, equal to 8·04 per cent., as compared with £3,921 0s. 2d., or at the rate of 8·28 per cent. for the corresponding period of 1906.

At the half-yearly meeting on Friday the report and accounts given in our last issue were adopted. Mr. J. Falconer, who presided, stated that the number of passengers carried had now reached the highest point since electric traction was introduced. The number carried during the past half-year was almost exactly 100 per cent. over that carried during the last half-year of steam working. He regretted that the receipts had not gone up in the same proportion, but this he thought was due to a large extent to the fact that many people who travelled first-class on steam railways now travel third-class on electric railways.

METROPOLITAN ELECTRIC TRAMWAYS.—The directors' report for the year ended December 31st, 1907, states that the total revenue for the year amounted to £297,223, including £27,476, the balance of the dividends received in the year 1906 from the North Metropolitan Tramways Company and reserved from the previous account. The directors have decided to spread this balance over the period ending June, 1910, during which the company would have continued to receive dividends from the North Metropolitan Tramways Company but for the surrender by that company of its lease of the London County Council's northern tramways. In pursuance of this policy £7,850 8s. has been brought into the present account, and the balance, £19,626, has been reserved. The traffic receipts, which amounted to £244,200, show the satisfactory increase of £64,599 over the previous year. After deducting all expenses chargeable to revenue, including £10,500 for reconstruction and renewals, and writing down preliminary expenses and other items by £6,220, there remains a surplus of £49,574, making, with the £3,791, the balance brought forward from the last account, a total of £53,365, which the directors recommend should be appropriated as follows:—Reserve fund, £5,000; dividend on preference shares, £25,000; dividend on ordinary shares at 4½ per cent. per annum, £17,610; carried forward, £5,755.

The company have discharged the balance of their liability in respect of the 3½ per cent. debentures of the North Metropolitan Tramways Company, by the payment of £51,700. The directors have, since the close of the year, issued a further £173,800 4½ per cent. debenture stock. There are now 40 miles 6 furlongs of line in operation, of which 29 miles 5 furlongs were opened prior to 1907. The company are promoting a Bill in the present Session of Parliament to authorise, *inter alia*, the construction of a tramway in the Harrow Road, from the terminus of the existing line to the Edgware Road. The London County Council have given the company notice under Section 43 of the Tramways Act, 1870, of their intention to purchase so much of the existing Harrow Road tramway as is situate within the County of London. Negotiations are proceeding with the Council as to these matters. The company have increased their holding in the North Metropolitan Electric Power Supply Company to 40,000 shares of £10 each, of which 30,000 are fully paid and the balance £5 paid. The dividend to be received in respect of this investment for the past year amounts to £12,285, being at the rate of 4 per cent. per annum on the amount paid up on these shares. The company have joined the British Electrical Federation, formed by various electrical traction and lighting companies for the purpose of co-operation and joint action in matters of common interest. The following statistics are given in the report, the figures in parentheses relate to the year 1906:—Number of passengers carried, 48,242,404 (36,318,774); number of car miles run, 5,037,204 (3,975,463); average receipts per car mile, 11·63d. (10·84d.); average receipts per passenger, 1·21d. (1·18d.); number of cars in stock, 187 (190).

Mr. E. Garcke presided at the annual meeting on Thursday, when the report and accounts were adopted. Having given some particulars of the companies in which they were interested, namely, the North Metropolitan Electric Power Supply Co., and the North Metropolitan Electric Power Distribution Co., the chairman went on to state that the Tramways Company was now working over 40 miles of tramways and light railways, the net receipts from which had increased from £134,000 in 1904 to £277,000 in 1907. The provision for renewals was larger than in the previous year, and the amount written off preliminary expenses had been doubled. To complete the whole scheme there were a further 22 miles of lines to be equipped, but it was the desire of the Board that the Middlesex County Council should not display any undue haste with regard to extensions. The feeling was that the additional capital required would be best raised by small issues of second debentures, upon which a smaller rate of interest would have to be paid than in respect of shares.

MILFORD ELECTRIC LIGHT.—At the annual meeting last week, the report and accounts were adopted. The total revenue for the year was £684, compared with £539 for the previous year, whilst the number of lamps connected were 3,527, an increase of 493. The total units sold were 43,250. After payment of debenture interest and all other charges, there remains a balance of £348, out of which a 4 per cent. dividend is paid upon the ordinary shares and small amounts placed to depreciation account and preliminary expenses.

RANDFONTEIN ESTATES.—At the annual meeting in Johannesburg, on February 7th, Mr. J. W. S. Langermann, who presided, stated that capital expenditure to the extent of £151,500 was to be incurred in connection with an additional cyanide plant, together with an electric power station in connection with it.

ROTHESAY TRAMWAYS.—The report for 1907 shows a total expenditure of £141,421. The total revenue for the year was £11,051, and after deducting all expenses chargeable to revenue, including £2,864 for debenture and other interest, and after setting aside £1,000 to renewals, sinking fund, and general depreciation and reserve, there remains a balance of £1,086, in addition to £325 brought forward from last account. A dividend of 2 per cent. on the ordinary shares is recommended, carrying forward £133.

WILLANS & ROBINSON.—The report for the half-year ended December 31st, 1907, states that as regards Rugby, after writing off £6,711 as depreciation, there is a profit of £22,946. As regards Queen's Ferry, there is a net loss (after contributing to debenture interest and to the directors' salaries) of £3,128. The net profit for the half-year is, therefore, £19,817, and the total amount available for distribution or otherwise, including £2,708 brought forward, is £22,526. The directors propose to pay a dividend at the rate of 6 per cent. per annum on the preference shares, to pay £874 interest upon funding certificates, to apply a like sum of £874, as arranged, to the redemption of funding certificates, and to pay a dividend at the rate of 10 per cent. per annum on the ordinary shares. A balance of £7,443 remains to be carried forward. At Queen's Ferry there has been an increased output, with better profits, from the steel works, and the result of the half-year's working would have been far from unsatisfactory (having in view the unfavourable conditions of working) were it not for certain failures in the motor-car trade, which have necessitated the reservation of a proportion of the Queen's Ferry earnings to meet bad debts either incurred or foreseen to be probable. The results obtained at Queen's Ferry, when considered with reference to the necessarily small scale of operations, and still more with reference to the limited and imperfect appliances at the disposal of the management, prove in the directors' opinion that the special products for which Queen's Ferry has now a high reputation (especially Vanadium steel) might form the basis of a sound and remunerative business in the hands of an organisation commanding adequate capital for the necessary extensions of plant. The Board greatly regrets that Sir Gilbert Clayton East, whose important services to the company are fully known to the shareholders, has definitely decided to retire. To fill this vacancy the Board recommends unanimously (except as regards Sir Gilbert, who expresses no opinion) the election of Mr. George F. L. Clayton East, at present the general manager at Queen's Ferry, where he has acquired experience which will be of value to the Board. It is not proposed to give Mr. Clayton East any additional remuneration as a director so long as he fills the office of general manager at Queen's Ferry and receives for his duties there his present salary of £800 per annum. But as the Board looks forward to finally disposing of Queen's Ferry, when the office of general manager will come to an end, it is proposed to arrange that so soon as Mr. Clayton East shall give up that office he shall be remunerated by a salary, as director, of £550 per annum. Owing to rearrangement of the work among the directors it is not considered necessary that there should in future be more than two giving their whole time to the executive work of the company. Under these circumstances Mr. Lazenby offers to retire at once if the company will pay him £600, being one-half the amount of the salary to become due to him under his agreement for the coming year. This proposal meets with the approval of the Board, who recommend its acceptance by the shareholders. The saving which would accrue from this reduction would be £600 for the coming twelve months and £1,200 per annum thereafter.

SOUTH LONDON ELECTRIC SUPPLY.—The report for the year ended December 31st, 1907, shows total receipts amounting to £33,992, and expenditure to £18,192, leaving, together with the amount brought forward, the sum of £19,605 available for distribution. After allowing for depreciation and interest on debentures and loan from bankers, there remains a sum of £15,479 to be carried to the general balance sheet. Out of this the Board recommend the payment of a dividend at the rate of 4 per cent. per annum on the original capital as it existed on December 31st last, carrying forward a balance of £2,479. At the end of 1907 there were connected to the company's mains the equivalent of 162,230 8-candle-power lamps, showing the satisfactory increase for the year of 17,608 8-candle-power-lamps. Applications were then also in hand for an ad-

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ditional 5,000 lamps. Although there has been, as of course was inevitable, a large decrease in the gross receipts from supply of current through the expiration of the temporary contract with the London County Council for supply to their tramways, the revenue from supply to the Corporation's other consumers has increased by £4,000 as compared with 1906, and the output by 551,641 units, being an increase of 27 per cent. The units sold for industrial purposes increased by over 46 per cent. In view of the high rates prevailing in the money market until quite recently, the Board have considered it desirable to defer the issue of debentures referred to twelve months ago until the present year, and arrangements have been made with the company's bankers for a renewal of the temporary advance in the meantime. The directors have been successful in coming to a satisfactory settlement with the borough of Lambeth over the long-pending dust destructor litigation, and consequently the appeal to the House of Lords against the decision of the Court of Appeal was withdrawn. The special resolutions for reducing the share capital of the company from £325,000 to £260,000, which were unanimously confirmed by the shareholders on January 7th last, came before the Court on March 14th, when they were duly confirmed by Mr. Justice Neville, and the readjustments of the various capital accounts rendered necessary by such reduction will be at once carried into effect. The meeting will be held on the 7th inst.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION.—The report for the year ended December 31st, 1907, states that, as intimated in the report submitted at the annual general meeting, held on July 27th, 1907, the late directors resigned their seats on the board, and the present directors were duly elected in their stead, and have since that date administered the affairs of the company. The working arrangement with the Treforest Electrical Consumers Co., Ltd., which was submitted to and approved by the shareholders at the last general meeting, has been put in operation, and the working of the Treforest Generating Station and the area supplied from that station was taken over by the Treforest Co. on September 1st, 1907. That company has already placed orders for about £26,000 for new and modern plant, which will materially reduce the cost of production. Negotiations are proceeding, and it is hoped will shortly be completed, for the formation of a similar consumers' company in the Cwmbran area, to take over and work the Cwmbran Generating Station. Agreements have been entered into with the Neath Rural District Council and the Bridgend Urban District Council for the sale of the Neath and Bridgend Generating Stations respectively. The directors are pleased to report that creditors in respect of the heavy liabilities appearing in the last balance-sheet have met the company in the most friendly manner by agreeing to accept preference shares in settlement of their claims, and liabilities for upwards of £78,000 have been settled in this way. A Bill is being promoted in the present Session of Parliament by this company jointly with the Treforest Electrical Consumers Co., Ltd., for the purpose, *inter alia*, of obtaining Parliamentary sanction to the matters referred to above. We report the proceedings on this Bill before the House of Lords in our "Parliamentary Intelligence."

TRACTION & POWER SECURITIES.—The report for the year 1907 shows a net revenue of £19,584, to which is to be added £3,242, brought forward from the previous account. The sum of £3,000 has been applied towards the depreciation of securities, and £15,000 has been transferred to the investments and reserve fund. The balance of £4,826 has been carried forward. Two of the company's securities—namely, the Mersey Railway 4 per cent. new first perpetual debenture stock and the Clyde Valley Electrical Power Co. ordinary £10 shares, for which there is no market quotation—have remained on the books at cost, and the directors stated that no revaluation of them will be made until their outcome is ascertained. Meanwhile, investments reserve fund stands at £65,000. During the past year the company's holding in the Mersey Railway debenture stock has increased by £19,297 in fulfilment of a contract previously entered into. The report points out that the earnings of the railway company in question continue to show a steady increase. Further calls have been paid up in respect of the company's holdings in the Clyde Valley Electric Power Co., the liability for unpaid calls being now reduced to £15,048. It has also been agreed to grant loans up to £100,000 to the Clyde Valley Electrical Power Co. for the purpose of extensions. Of this sum £29,684 was advanced last year.

WINDERMERE AND DISTRICT ELECTRICITY SUPPLY.—The report for the year ended December 31st, 1907, states that the gross revenue has shown a satisfactory increase, and the profit from installation work is somewhat larger than that of the previous year. The balance of the revenue account shows an improvement, which would have been much greater but for the increased expenditure on coal, mainly caused by the higher price. A first payment of 2 per cent. on account of arrears of interest has been received on the Keswick Electric Co.'s debentures, and the revenue account has benefited to the extent of £58 from this source, and the arrears of interest due from the Keswick Company have been reduced to the extent of £151. The sum of £245 has been spent on capital account, and, as foreshadowed in the last report, the increase in the company's business has necessitated the provision of additional machinery. The directors have therefore entered into a contract with the Brush Electrical Engineering Co., Ltd., for the supply and erection of a compound engine and alternator of the latest type, which should be at work before the end of June. The directors anticipate that this will effect economy in working expenses, and also believe that the provision of this additional machinery will largely diminish the risk of any interruption to the service. To obviate the necessity of supplying the Keswick Company with further capital, the directors have arranged that one of the machines now in use at Windermere will be moved to the Keswick works and lent to that company for a fixed annual payment. The balance of revenue account for the year is £2,061, to which is added £58 for interest on Keswick debentures, and £17 balance brought forward from last year, making a total of £2,116. Out of this has been paid debenture interest and bankers' charges, £774; interim dividend of 1 per cent. on preference shares, £250, leaving a balance of £1,092, out of which £500 has been transferred to depreciation reserve account, leaving for disposal a balance of £592. The directors recommend that a further dividend of 2 per cent. (making 3 per cent. for the year) be paid on the preference shares, which will absorb £500 and leave £92 to be carried forward to next account.

NEW COMPANIES

ELECTROLYTIC CO. (SPAIN AND PORTUGAL).—This company was registered on March 19th, with a capital of £255,000 in 250,000 ordinary shares of £1 each, and 100,000 founders' shares of 1s. each, to acquire interests in any invention relating to the production, treatment, application and use by electrolysis or otherwise of minerals and mineral substances, in particular to acquire the patents protecting the electrolytic process of L. M. Lafontaine in Spain and Portugal, to develop and turn to account the same, and to take over any mines, mining rights, and lands in Spain, Portugal, or elsewhere. The subscribers are J. Wilkins, F. Mitchner, H. Smith, F. S. Gee, J. Longworth, E. A. Chevalme, and S. Brillat. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first, subject to the right of the Société Française Electrolytique to nominate two. Qualification, 100 ordinary or founders' shares. Remuneration as fixed by the company.

L. J. HEALING & CO., LTD.—This company was registered on March 7th, with a capital of £100,000 in £10 shares (5,000 preference and 5,000 deferred), to adopt an agreement with L. J. Healing and E. Eddison, and to carry on the business of importers of electrical and other machinery, electricians, mechanical and general engineers, workers of and dealers in electricity, suppliers of motive power, &c. The subscribers are: L. J. Healing, W. Kunsley, J.P., R. Tozer, R. Millbourn, H. E. Fisher, A. L. Roberts and A. H. Tozer. Minimum cash subscription 500 shares. The number of directors is not to be less than two nor more than nine; the subscribers are to appoint the first. Qualification, £250. Remuneration £500 per annum. Registered offices: 84 Fenchurch Street, E.C.

HELPTOPHONE CO., LTD.—This company was registered on March 10th, with a capital of £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in all kinds of electrical and mechanical equipment and accessories used in connection with telephones and telephonic installations, &c., and to acquire from J. J. Chiswell the benefit of certain existing inventions relating to telephones. The subscribers are: J. T. Boyes, E. O. Gillard, L. N. Holding, W. J. Grinhan, F. Waite, C. F. Court, and A. Bischof. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first. Remuneration, 5 per cent. each of the net profits per annum. R. E. Smith is the first secretary. Registered offices: 42 Old Broad Street, E.C.

HYDE-BEADLE POWER SYSTEM.—This company was registered on March 10th, with a capital of £500 in £1 shares (125 preference), to acquire from C. Hyde Beadle the benefit of a certain invention relating to the transmission of power, to adopt an agreement with the said vendor, to carry out experiments for testing, utilising, and improving transmission gear, and to carry on the business of mechanical and electrical engineers, manufacturers of marine automobiles, and aërial motive power appliances, &c. The subscribers are: C. Hyde-Beadle, Mrs. M. E. Beadle, Capt. M. H. P. Riall-Sankey, R. A. Smith, J. P. Thompson, A. Arkell-Hardwick, Mrs. A. K. Arkell-Hardwick. No initial public issue. The number of directors is not to be less than three nor more than five; the first are C. H. Beadle, Capt. M. H. F. Riall-Sankey, and R. A. Smith. Registered office: Palace Chambers, Westminster, S.W.

"IDEAL" PLANTS.—This company was registered on March 7th, with a capital of £2,000 in £1 shares, to acquire the business carried on by R. J. Nicholson at Macdonald's Lane, Corporation Street, Manchester, as "R. J. Nicholson & Co.," and to carry on the business of electricians, electrical

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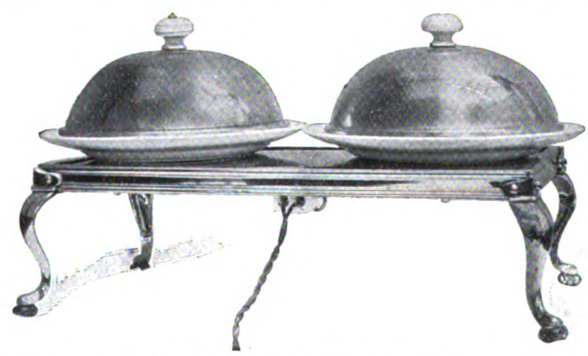
and mechanical engineers, manufacturers of and dealers in dynamos, motors, and apparatus used in connection with the generation, distribution, supply, and accumulation of electricity, &c. The subscribers are: J. H. R. Reich, C. R. W. Menzies, W. S. Smith, C. J. Nicholson, H. T. Smeeton, A. Tracey, and J. H. Carmichael. No initial public issue. Registered without articles of association. Registered offices: 3 Macdonald's Lane, Corporation Street, Manchester.

KARABON CO., LTD.—This company was registered on March 12th, with a capital of £10,000 in £1 shares (2,000 preference, 3,000 ordinary, and 5,000 deferred), to adopt two agreements with F. W. Grierson and T. Taylor, and to carry on the business of wholesale and retail import and export merchants, makers, turners or manufacturers and vendors of carriage fittings, electrical accessories, &c. The subscribers are:—T. E. Godbold, J. H. Thompson, F. J. Gigg, H. G. Skipp, C. P. Kitchen, A. E. Brown, and N. Malone. No initial public issue. The number of directors is not to be less than two nor more than five; the first are F. W. Grierson and T. Taylor. Qualification, £100 shares or stock. Remuneration (except managing director), one guinea each per board meeting attended. Registered offices: 3 Church Passage, Shaftesbury Avenue, W.

MACCLESFIELD ELECTRIC LIGHTING AND POWER CO.—This company was registered on March 11th, with a capital of £25,000 in £1 shares, to take over Provisional Orders and Electric Lighting Orders, to undertake the supply of electricity for light and other purposes in the United Kingdom, to carry on the business of electricians and engineers, &c. The subscribers are: A. V. Ward, W. P. Heermann, J. Clark, G. H. Park, S. Lloyd, W. T. Pullen, and C. Bucknall. Minimum cash subscription, 10 per cent. of the shares offered to the public. The number of directors is not to be less than three nor more than eight; the subscribers are to appoint the first. Qualification, £250. Remuneration as fixed by the company.

A NEW ELECTRIC HOT-PLATE

THE accompanying illustration represents a recent addition to the long series of heating devices useful for household purposes, which the British Thomson-Houston Co. have placed on the market. The device is a "hot-plate" for keeping plates and dishes warm, of sufficient size for accommodating two dishes. The actual dimensions are 18 in. long by 9 in. wide and 5½ in. high, and the material is copper with brass mountings. Speaking with some experience of household heating appliances, we do not think that anyone who has once kept their



breakfast hot electrically will ever return to methods which mingle a smell of methylated spirit with that of eggs and bacon. In addition to the complete form of electrical hot-plate illustrated, the company also supply electric heating elements for displacing the spirit lamp used on ordinary hot-plates, and any standard spirit-heated hot-plate, without water jacket, can be converted into an electric hot-plate by using one or more of these elements. To harmonise with the hot-plate for which they are intended, these heating elements can be obtained in either copper or silver plate. The devices are suitable for circuits of standard voltages.

CATALOGUES AND PAMPHLETS RECEIVED

CHOKING COILS FOR ARTIFICIAL INDUCTIVE LOAD.—Messrs. Morris & Lister, of Coventry, have issued a leaflet giving prices and particulars of the Morcom & Walshe design of special choking coils for use in conjunction with water resistances for testing alternators at any power factor. The apparatus in question was fully described in Messrs. Morcom & Morris's recent Paper before the Birmingham Local Section of the Institution of Electrical Engineers (see ELECTRICAL ENGINEERING, March 19th, p. 427), and is made in sizes ranging from ¼ to 1,050 k.v.a.

DRAWING OFFICE APPLIANCES.—A list from Messrs. Marriott & Stewart describes an apparatus for handling drawing paper in continuous rolls. In addition to the frame for supporting the reel of paper, there is an ingenious arrangement by which any length of paper can be easily cut off by means of a wire drawn through a narrow slot in an iron guide. The apparatus is made in vertical and horizontal forms for all the usual widths of paper.

ELECTRICITY IN PRINTING WORKS.—A well got-up pamphlet with this title has been issued by the Electrical Company, in which a number of excellent illustrations are given of electrically-driven printing machinery of a variety of types, and the advantages of electrical driving are pointed out. The various methods of control recommended for different sized machines are summarised, and a description is given of the methods adopted in the case of a large duplex rotary press.

FLAME ARC LAMPS.—The popularity of the "Excello" flame arc lamp has necessitated a third edition of the Union Electric Co.'s catalogue. The new form of the list sets forth various improvements relating to details of the lamp, improved arrangements of the carbons, and variations in the adjustments, which the extensive application of the "Excello" arc lamp for every class of exterior and interior illumination in various parts of the world has pointed out as desirable. A number of illustrations showing the lamps in use have been added.

PAPER SCALES AND TESTING APPARATUS.—A list is to hand dealing with scales of various forms for weighing samples of paper, micrometers, and a small testing machine for measuring tensile strength and elongation of paper. A set of tables of sizes and weights of different kinds of paper is given.

PORCELAIN INSULATORS.—A new list of insulators has been issued by the Sloan Electrical Co. A large number of types are dealt with, including the ordinary patterns, with iron bolt for supporting aërial lines from brackets and pole arms, shackle insulators, and insulators with swan-neck screws. Various patterns of bobbin and cleat insulators for surface wiring are also listed, together with rack insulators, leading-in tubes, and other accessories. A feature of the list is the series of designs of insulators made in two parts, whereby the conductor is mechanically clamped by the porcelain. Insulator brackets and other ironwork are included, as well as the Hoffman patent quick rivet jointer for connecting wires without soldering, and the "Clincher" wood plug, for fixing insulators in brick or stone.

RUBBER GOODS.—A catalogue from the Dunlop Rubber Company deals with general rubber goods required for engineering purposes, including hose-mats and matting, washers and packing, rubber gloves and belting.

TESTING SETS.—Messrs. Elliott Brothers have issued a new pamphlet describing their well-known "Century" portable-mains testing set, with details of the methods of using the apparatus for resistance, insulation, and capacity measurements and localisation of faults.

FORTHCOMING BOOKS

We are informed that an elaborate study of "Power Gas Producers," by Mr. P. W. Robson, chief engineer of the National Gas Engine Co., Ltd., is shortly to be published by Mr. Edward Arnold. It deals with the design and application of suction producers, non-bituminous fuel pressure producers, and bituminous fuel producers, and the author attempts to trace the connection between theoretical considerations and actual practice which should underlie all sound design. A feature of the book is to be the illustrations.

Messrs. Constable inform us that they have in view for immediate publication a work on the design, economical construction, and operation of central light and power stations. The purpose of this volume, "Steam Electric Power-Plant," by Frank Koester, is to give such information in regard to modern power plant practice as is essential to the engineer in designing steam-electric power plants. The book is the result of extensive experience in Europe and America, and will contain numerous excellent illustrations. Another new engineering work by the same publishers which will shortly appear is a concise pocket-book by Messrs. C. F. Marsh and W. Dunn, entitled a "Manual of Reinforced Concrete and Concrete Block Construction."

NEW PUBLICATIONS

"An Introduction to Electricity." By Bruno Kolbe. (London: Kegan Paul, Trench, Trübner & Co., Ltd.) 10s. 6d.

"First Stage Steam." Written to meet the requirements of the Board of Education Examination, and containing the examination papers set in the years 1901-1907. By J. W. Hayward. (Second edition.) (London: W. B. Clive.) 2s.

Fowler's Electrical Engineers' Pocket Book. Edited by William H. Fowler. (Manchester: Scientific Publishing Co.) 1s. 6d.

"British Engineers and Allied Professions in the Twentieth Century." Contemporary Biographies. Edited by W. T. Pike. (Brighton: W. T. Pike & Co.)

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ELECTRICAL ENGINEERING

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SUMMARY

A committee of the House of Lords has been appointed to consider the London Electric Power Bills after Easter. The chairman is Lord Cromer. (Page 542.)

A Paper by Mr. G. Stoney and Mr. A. H. Law was read at last Thursday's meeting of the Institution of Electrical Engineers, in which the development and present state of the designs of high-speed generators of Messrs. C. A. Parsons & Co. were described. Particulars and drawings of machines for both continuous and alternating currents were given in the Paper, including designs of historical interest as well as those illustrating the firm's latest practice. The most notable features of the continuous-current machines are the retention of the bipolar form up to large sizes, the preference shown for smooth as against slotted cores, the avoidance of carbon brushes, and the employment of compensating windings without commutating poles. All these points were severely criticised by the dynamo designers and others who spoke in the discussion. The alternators are more in accordance with prevailing practice elsewhere. The rotors are of the salient pole type, and a curious method of enclosing the field windings is adopted. The general opinion expressed in the discussion was that the slotted cylindrical form of rotor was preferable. The Paper concluded with a description of an ingenious arrangement for giving a certain amount of compounding effect to alternators. (Page 543.)

A short description is given of a new electrolytic method of making metallic mirrors for searchlights, which has been introduced recently. (Page 550.)

A long report on the arrangement of doors and seats in cars for underground electric railways in New York has been made by Mr. B. J. Arnold. The type recommended has double doors near the ends of the car. (Page 550.)

A map of Manchester, showing the position of the site of the forthcoming electrical exhibition is published in this issue. (Page 551.)

Some fine examples of manganese steel special work for tramway crossings and junctions have recently been put down in Newcastle. (Page 552.)

The tramway subway forming the connecting link between the northern and southern portions of the L.C.C. tramway system has been completed by the finishing of the construction of the extension from Aldwych to the Embankment, which will be opened to-morrow. Some views of the subway are given in this issue. (Page 553.)

Some statistics with regard to the electricity works in Germany are published. (Page 554.)

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The electrical equipment of the R.M.S. *Mauretania* was described by Mr. W. C. Martin in a Paper read last Friday before the Institution of Engineers and Shipbuilders in Scotland. The total cost of the installation was £65,000. Current is obtained from four 400-kw. turbo-generators, and over 6,300 lamps are used. Electrical power is used throughout the ship, and motors aggregating over 2,000 h.p. are installed. A complete telephone and bell system is provided. Other applications of electricity include electric clocks and fire alarms, releasing gear for life-buoys, and electrical indicators showing the position of the water-tight doors, and calling attention by an audible signal to the partial extinction of the navigating lights. (Page 555.)

A lengthy Paper on electrolytic corrosion was read last week by Prof. W. W. H. Gee before the Manchester Local Section of the Institution of Electrical Engineers. The author dealt with the ordinary phenomena of electrolytic and ordinary corrosion, and methods of preventing such action, including the cases of lead-covered cables and electrolysis of water pipes due to stray tramway return currents. The phenomena of electrical endosmose were also discussed, especially in relation to the conductivity of concrete. Experiments on alternating electrolysis and electrolysis at high current densities were described. An interesting discussion followed. (Page 559.)

Under Electrochemistry and Electrometallurgy we describe a method for obtaining pure chloroplatinic acid by the electrolytic solution of platinum black. Platinum anodes are under no conditions absolutely unattacked when electrolysed in solutions of hydrochloric acid. But they appear to pass into solution quite readily when they are in the form of platinum black. G. Gin has been awarded the Frenzel prize by the Council of the American Electrochemical Society for his Paper upon the electrometallurgy of the rare metals. (Page 563.)

Under Electrical Science, in the British and American section, will be found notes on a series of experiments on the E.M.F.'s of concentration cells, and on a proposed magneto-mechanical method of detecting the momentum of the orbital motion of electrons in the material atom. An account is also given of the fifth of Prof. J. J. Thomson's series of lectures on "Electric Discharges through Gases," given at the Royal Institution on Saturday. The lecturer dealt first with the question of spark potentials for very small spark lengths, and then went on to consider the nature of the discharge in a partial vacuum under various conditions. In the Papers abstracted in the continental section, La Rosa points out some peculiarities in the spectrum of the singing arc, Drysdale evaluates the light per watt emitted by an ideal lamp, and De Broglie studies the gases obtained from a spark gap. (Page 563.)

In a patent specification by A. Steinacker and A. Plisnier published on Thursday last, and describing some improvements in wireless telephony, it is stated that good results have been obtained by substituting a mercury vapour lamp for the copper-carbon arc in the oscillating circuit. Among the other specifications published is one by R. D. Archibald relating to a petrol-electric system for motor vehicles. The transmission is by polyphase currents, and no brushes or sliding contacts are used. The transmission can be made purely mechanical at high speeds, but the prime mover is always running at a constant speed. Another specification by R. C. Browne relates to an improved microphone transmitter, and one by the British Thomson-Houston Co. describes an automatic starting device for polyphase motors. (Page 565.)

At the last meeting of the Acton Urban District Council the deficit on the electricity undertaking was alluded to. Current is taken in bulk from the Metropolitan Electric Supply Co., and the costs, including the cost of conversion in the Council's sub-station and 0·78d. per unit for distribution expenses, work out to 5d. per unit. The average price received is 4d. per unit, and the question of erecting a generating station is being considered. A consulting engineer is to report upon the undertaking.—A circular has been sent to wiring contractors in the Beckenham district reserving the right of the Council to increase slightly the price of electrical energy should the general adoption of metallic filament lamps render this necessary.—The poll of the ratepayers of Dunfermline as to the course to be adopted with regard to the Electric Lighting Order resulted in only 861 votes, being recorded upon a register of 5,600. 323 ratepayers voted for the erection of a generating station.—The Leeds tramways carried 73,734,085 passengers during the year ended March 31st last, and the receipts per car mile amounted to 10·49d., a decrease of 0·7d. compared with the figure for 1906-7.—The Fulham Borough Council has agreed to the use of overhead wires upon the Hammersmith-Putney L.C.C. tramways.—The Highways Committee of the London County Council recommend the issue of a guide to the tramway system, to be placed on sale at 2d. per copy.—An agreement has been come to between the Nottingham Corporation and the Nottinghamshire and Derbyshire Tramways Co. with regard to the construction and working of certain of the company's tramways by the Corporation. (Pages 567–569.)

The Accrington Corporation is applying for a loan of £7,500 for cables, and the Carlisle Corporation for £5,000 for a similar purpose. The Derby Tramways Committee recommend extensions of the tramways costing £5,500. The Frome Urban District Council propose to spend £10,000 upon its electricity undertaking. A 500-kw. direct-current turbo-generating set is required by the Rotherham Corporation, and the Wallasey Corporation requires a supply of automatic overload and reverse-current single-pole circuit-breakers. The Wimbledon Electric Lighting Committee has provisionally accepted the tender of Messrs. Babcock & Wilcox for two boilers at £4,710, and of the British Westinghouse Co. for high-tension switchboard and gallery at £2,606. (Page 569.)

At the meeting of the Electric Lighting & Traction Co. of Australia, Mr. J. B. Braithwaite said that it was hoped to make arrangements within the next few weeks, which would place the company upon a sound financial basis. The sixth annual meeting of the South Wales Electrical Power Distribution Co. was held at Cardiff last week, when Mr. W. Gascoyne Dalziel, who presided, gave a general review of the position of the company, and remarked that, but for the friendly assistance which had been given by the large party of creditors, in accepting a settlement of their claims in preference shares, nothing could have been done to save the company. The report of the Midland Electric Corporation for Power Distribution for the year 1907 shows a loss of £10,139. (Page 571.)

The House of Commons Committee presided over by Mr. Luke White, rejected the Dublin and Central Ireland Electric Power Bill last week. The Committee were obviously unconvinced with regard to the finances of the proposed scheme; and after the promoters' case had been closed, the chairman intimated to Mr. Freeman, K.C., that the Committee would require considerable assistance from him in this respect. Mr. Freeman replied that it was impossible to say what financial support would be given to the scheme until the form in which the Bill was passed was known. (Page 572.)

The Highways Committee of the London County

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Council recommend the purchase of the Highgate Hill Cable Tramways, at an expenditure not exceeding £13,500. The price asked by the Tramways Company for their undertaking is £13,000. In a report by the Finance Committee on the matter, estimates are given for the reconstruction of the tramways upon either the conduit system or the overhead trolley system. (Page 574.)

Some recently introduced electrical appliances, including a time element cut-out, an electric kettle, and a new lamp-holder, are described on pages 575 and 576.

It is always interesting to hear descriptions of pioneering work in connection with an important branch of engineering, and it is often that a consideration of difficulties which have occurred and been surmounted in earlier days is of great assistance in solving the problems of the present. It was thus particularly fitting that the meeting last Thursday at the Institution of Electrical Engineers, which resolved itself into a debate upon details of design of present-day turbo generators should have been commenced with a historical sketch by the representatives of the firm of Messrs. C. A. Parsons & Co., for this firm was the pioneer of high-speed electrical machines as well as of the turbines by which they are driven. We have spoken of the Paper as historical, although it contains details of recently constructed machines; the designers who took part in the discussion were practically unanimous in the opinion that even the newer generators described in the Paper could hardly be regarded as representative of the tendencies that we may expect to see followed in the future. We do not for a moment suggest that the machines as at present designed by the authors of the Paper are in any way unsuitable for their work, and indeed they are probably in many respects far better than the work of firms of less experience in this direction; yet we cannot help inclining towards the opinion of the majority of speakers in the discussion that history will repeat itself, and that, in spite of the greater difficulties, slotted cores, carbon brushes, and multipolar designs will become as universal in the case of continuous-current machines for steam turbine drive as they have for dynamos of lower speed. The smooth core bipolar pattern, with metal brushes, has been the pioneer in both cases, and we do not blame Messrs. Parsons, after having laboriously conquered the difficulties attendant upon its construction for high speeds, for hesitating before they abandon their well-tried friend. Similar hesitation was shown by another well-known maker a few years ago in the case of lower speeds, but the change was inevitable. The relative advantages of compensating winding and separate commutating poles do not seem to be quite so clearly defined, although some designers are emphatic in their pronouncements in favour of a combination of the two. The case of the turbo-alternator is simpler, and, as Mr. Hobart pointed out, perhaps more hopeful, although on some points—especially as regards the construction of the rotor—there is still some divergence of opinion.

Professor Haldane Gee's Paper on "Electrolytic Corrosion" is an attempt to classify a rather wide range of phenomena, utilising results drawn from an extensive bibliography, and from his own experiments carefully directed to obscure points—some of which are, however, hardly cleared up by Prof. Gee's work. One useful fact which is brought out prominently is the large extent to which "passivity" affects electrolytic action. This seems to explain some cases of apparent immunity from the action of stray currents, and is not confined to metals of the iron group, as is generally supposed. The effect of different salts in the electrolyte formed by the moisture of the soil as favourable or otherwise to passivity seems to be more important than their chemical composition. The nature of the solid constituents of the soil is also an important element in modifying corrosion of buried metal exposed to stray currents. There is a good deal of reason to suppose that some soils act as depolarisers, and give rise to the apparent "metallic resistance" of earths noted by Claude. There is much else in the Paper throwing light upon corrosion, and suggesting further research. The discussion dealt mainly with electrolysis due to stray currents, but without disclosing any serious cases of damage in the United Kingdom. The South Staffordshire example alluded to by Mr. Watts was rather worse than he stated as to potential difference over the system, but it lasted for about twelve years with no claim for damage, and it may be stated on very good authority that the rails at the worst points showed no more corrosion than the rails on steam tramways of equal age in the same district. As they were anodes for all the stray current they ought to have suffered more severely than any pipe which could take but a fraction of the current. It is likely that concrete is as good a protection against electrolytic as against ordinary chemical corrosion. Mr. Cunliffe went into some speculations on the conditions of safety and danger which seem well founded. To his remarks on earth conductivity may be added that experiment shows that no decrease in resistance between earth plates twenty yards apart (as per the B.O.T. regulations) results from increasing the plate area beyond four feet square. Damage to cable sheaths seems more common than damage to pipes. The high combining weight of lead makes corrosion show sooner, but the root of the troubles is half-hearted earthing. Lead sheaths should be thoroughly and continuously earthed, or thoroughly and continuously insulated, and the latter is hardly practicable.

The rejection of the Dublin and Central Ireland Electric Power Bill last week by a Committee of the House of Commons draws attention to one aspect of private Bill legislation which may well create alarm in the minds of promoters. The plain inference to be drawn from the decision of the Committee which dealt with the Bill is that the financial position was considered too weak. One of the first points of attack made by an opponent to any scheme before a Parliamentary Committee is as to the sufficiency of the financial backing, but formerly this method of opposition did not have the same effect with a Private Bill Committee as it does now. In those days it was not a regular custom to insert a "cessor of powers" clause in Bills, so it was inevitable that some Acts of Parliament should be passed authorising works the erection of which was greatly delayed, or in some cases indefinitely postponed. So far as the electrical industry is concerned, a case in point was a

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group of London tube railways, the original promoters of which were unable to proceed with their schemes until the advent of American capital in connection with the conversion of the Metropolitan District Railway from steam to electric traction; in the case of the North-West London Railway, a scheme which was not taken over by the London Underground Electric Railways Co., of London, nothing of a definite character has yet been accomplished, although the line was authorised by Parliament in 1899. Four or five years ago a new policy was initiated in Parliamentary Committee rooms, which, in effect, laid it down that no Bill should be passed unless the promoters gave some sort of guarantee at the outset that the capital would be subscribed. Obviously if this policy is pursued relentlessly, it must tend to discourage private Bill legislation to a very large extent. Promoters of any scheme should arm themselves with the very best evidence of a financial character that they can secure; but there is always the one difficulty to be surmounted, namely, that very few people can be induced to guarantee capital before they are aware in what form the Bill will leave the Committee rooms, for it is quite possible that clauses may be inserted by the Committee of one of the two Houses of Parliament which, from the point of view of the investing public, may make the scheme a hopeless one. If there were an unwritten law that a Committee must reject a Bill if a substantial portion of the capital is not guaranteed beforehand, however promising its engineering and commercial prospects, serious injustice might be done, but it rests with the Committee itself to exercise discretion in each case. In this connection attention may be drawn to the North-East London Railway Act of 1906, in which a provision was inserted that half the capital was to be subscribed within twelve months, failing which the powers under the Act would cease. Without passing any opinion on the technical merits of the Dublin and Central Ireland Power Bill, which embodied a novel scheme for the utilisation of Irish peat bogs for the production of power gas to be employed in an electric power scheme, we cannot but think that, in a case like this, in which no alternative or competing scheme was proposed, the Bill should not have been thrown out merely because no definite guarantees could be given as regards the capital available for putting the powers into effect after they had been granted.

LONDON ELECTRIC POWER BILLS

FOLLOWING on the rejection by the House of Commons of a recommendation by the House of Lords that the London Electric Power Bills should be sent to a Joint Committee of both Houses, comes the appointment of a Select Committee of the Upper House to deal with the Bills in question. The committee is as follows:—Lord Cromer (Chairman), Lord Welby, Lord Lytton, Lord Cobham, and Lord Lamington. Lord Welby was Chairman of the Finance Committee of the London County Council when, in 1905, it entered a strong protest against the Council embarking upon a scheme for electric supply. Lord Lytton was a member of the House of Lords Committee of 1905 which passed the Bill of the Administrative County of London and District Electric Power Co., subsequently blocked at the third reading stage in the House of Commons. Lord Cobham was a member of the Royal Commission on London Traffic.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, APRIL 9TH.

Institution of Electrical Engineers: Leeds Local Section.

7.15 p.m. Annual General Meeting at the University for the election of officers for the ensuing session. The following Paper will also be read:—"Heating of Enclosed and Ventilated Motors," by Wilson Hartnell.

Institution of Electrical Engineers.

8 p.m. Ordinary meeting at 25 Great George Street, Westminster. Paper to be read:—"Electric Supply Prospects and Charges as affected by Metallic Filament Lamps and Electric Heating," by H. W. Handcock and A. H. Dykes.

L.C.C. School of Photo-Engraving.

8 p.m. Lecture by Sherard Cowper-Coles, on "Some Notes on Electrotyping."

FRIDAY, APRIL 10TH.

Institution of Mechanical Engineers.

8 p.m. Meeting at Storey's Gate, St. James's Park, London. Papers to be read:—(1) "The Governing and Regularity of Gas Engines," by James Atkinson; (2) "The Effect of Mixture Strength and Scavenging upon Thermal Efficiency," by Prof. Bertram Hopkinson.

Physical Society.

8 p.m. Meeting at the Royal College of Science, South Kensington. Agenda:—(1) "An Experimental Investigation of the Nature of X-rays," by Prof. W. H. Bragg, F.R.S., and Mr. Madsen. (2) "Short Spark Phenomena," by W. Duddell, F.R.S.

Royal Institution.

9 p.m. Evening discourse on "The Carriers of Positive Electricity," by Prof. J. J. Thomson, F.R.S.

SATURDAY, APRIL 11TH.

Royal Institution.

3 p.m. Afternoon Lecture VI., on "Electric Discharge through Gases," by Prof. J. J. Thomson, F.R.S.

Birmingham and District Electric Club.

7 p.m. Meeting at the Colonnade Hotel, New Street. Paper to be read, "Electrical Train Lighting," by S. H. Bridcut.

Institution of Electrical Engineers, Students' Section.

Visit to the Electric Lighting Station of L.N. & W. Railway, at Chalk Farm.

TUESDAY, APRIL 14TH.

Institution of Electrical Engineers: Manchester Local Section.

7.30 p.m. Meeting at the University. Paper to be read:—"The Management of Engineering Workshops," by Eustace Thomas.

CORRESPONDENCE

THE FUTURE OF THE TELEPHONE SERVICE.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—In a footnote to my letter of 16th inst., you state that I am mistaken as to Mr. Webb's relations with the National Telephone Company. The error, however, does not lie with me. The *Newcastle Chronicle* of March 10th states definitely that he is chief of that company's contract department, and this accords well with what has been generally known for a long time, although his official designation may be different. Under cross-examination at the last Brighton inquiry, where he had given evidence as an independent witness, he admitted that he was in the employ of the company. It is, therefore, too late in the day to pose otherwise than as a paid advocate. As such, and in that guise, he is, no doubt, entitled to a hearing and to have his views considered. But he comes forward as an unbiassed commentator, and I decline to discuss telephone matters with him on that basis, or to meet his statements about Glasgow or the other municipal telephone systems otherwise than by a direct denial of their truth. The municipal telephone authorities have long pressed for a Select Committee to enquire into their affairs. This Mr. Webb—*i.e.*, the National Telephone Company—and the Post Office are, above all things, anxious to avoid, because they know that the increased tariffs are artificial and incapable of justification. The position is that the Municipal Telephone Systems court inquiry, while their traducers shirk it. Let the telephone community adjust their views accordingly.

I am, Sir, &c.,

A. R. BENNETT.

Westminster,
March 31st, 1908.

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HIGH-SPEED ELECTRICAL MACHINERY

A PAPER by Mr. Gerald G. Stoney and Mr. A. H. Law was read at last Thursday's meeting of the Institution of Electrical Engineers, in which the development and present state of the designs of high-speed generators of Messrs. C. A. Parsons & Co. were described.

Continuous-current Machines.

The first high-speed dynamo made for direct coupling to a steam turbine was designed and constructed in 1884 by the Hon. C. A. Parsons. The armature was 2⅝ in. in external diameter, and the core, built of very thin iron plate, was 2¼ in. diameter and 8 in. long. There were 50 conductors, and at 18,000 revs. per minute (the normal speed) the output was 75 amperes at 100 volts, or 10 E.H.P. The surface speed of the armature was about 206 ft. per second.

In this early armature the spindle was of high carbon steel to give the greatest possible strength, the diameter at the centre being 1¼ in., and the bearing ½ in. diameter by 3½ in. long. The core was smooth, 2¼ in. diameter, with notched driving discs of red fibre at each end, and on it was wound a drum-winding with barrel ends, the whole being held together by binding wire to withstand the centrifugal force. The commutator was made up of sections held by dovetailed rings with asbestos insulation.

These armatures gradually increased in size until in 1889 they reached the size of 60 kw. at 6,000 revs. per minute, the cores being 7 in. diameter and 18 in. long, the output being 600 amperes at 100 volts. These early types of dynamos were all bipolar with shunt-wound horseshoe magnets. The number of commutator segments were usually 12 for 50 or 65 volts, and 18 for from 80 to 100 volts, and in all but the smallest sizes there was only one complete armature-turn per segment. In these plants the sparking was not at that time considered excessive at full-load, though it would be considered so according to present practice, but even as early as 1885 it was recognised that it ought to be possible to avoid both sparking and shifting of the brushes by a compensating winding, and such a winding through holes in the cast-iron pole-faces (see Fig. 1) was tried, but the benefit was found to be very small, and it was not gone on with. It is now known that the reason of its want of success was that the ampere-turns of the compensating winding were only about three-quarters of those on the armature and that, had these ampere-turns been trebled, the great improvement effected by the adoption of compensating winding in 1903 would have been accomplished some eighteen years sooner.

In 1889, on account of the temporary loss of the 1884 patent for spiral drum end connections, an armature was constructed with a series of insulated discs at each end of the core, each connected to opposite conductors, an arrangement identical electrically with the ordinary drum-winding, but although it worked very well the cost and difficulty of manufacture were found to be excessive, and it was decided to adopt a gramme armature. Besides this, it was early seen that for a given voltage a certain number of commutator segments were necessary, and that the sparking to a large degree depended on the ampere-turns in the armature, and since the gramme armature had twice as many segments as the drum for the same number of conductors, it appeared that the result should be better. Several turbo-dynamos were made with armatures of this type. At this time also was introduced the construction of commutator with steel rings shrunk on over mica holding the segments in place against the centrifugal force, a construction which has been universally adopted by all makers of high-speed dynamos. Also, in some cases, fan blades were fitted to these commutator rings for the purpose of both cooling the armature and also the commutator.

The chief defects of these armatures were that sparking was not reduced, owing to the large self-induction of a gramme winding, and that the heating was excessive both on account of the difficulties of effective ventilation and also through the heating of the spindle due to its revolving in the stationary internal field of the armature.

For these and other reasons on the recovery of the patents in 1894 the drum armature was reverted to with considerable improvements in detail, ventilating ducts being provided along the cores to give internal cooling, and the conductors being much more efficiently laminated. And here it may be said that in all these high-speed armatures the cores are smooth, or nearly so, and the windings extensively subdivided to prevent eddy currents. Slotted cores for high-speed armatures have been used with some success, but on account of the much higher self-induction of the windings it is, in the authors' opinion, impossible to obtain as good results as with the smooth core type. Slotted core armatures have been built by Messrs. C. A. Parsons & Co. on several occasions, but results were never obtained which could in any way compare with those given by smooth, or nearly smooth, cores.

In some of the most recently built armatures of large size the conductors have been laid in slight grooves in the core. These grooves provide a means of preventing the conductors from moving, and the iron between the conductors reduces the reluctance of the air-gap to some extent. The conductors are held to the core by binding wire made of steel piano wire, which experiments have proved to be better adapted to the purpose than bronze wire.

In all these earlier dynamos the magnets were of the ordinary type, generally horseshoe; but even when the size was limited to 200 kw. at 3,000 revs per minute, although the commutation was good when the brushes were properly set for the load, heavy sparking was experienced on large variations of load, such as are met with in the case of traction plants.

The first method of meeting the difficulty was to automatically shift the brushes according to the load, this being effected (see Parsons and Stoney's patent 9203/00) by moving the brush rocker by a piston controlled by a spring and actuated by the steam pressure at the inlet to the turbine. The angular movement required by the brush rocker is approximately proportional to the load, and the pressure at the inlet to a turbine is also proportional to the load, so that it is easy to arrange for the brushes to be shifted the right amount. This arrangement, however, was not rapid enough to meet sudden and large changes of load, and under such circumstances some sparking occurred during the interval of lag.

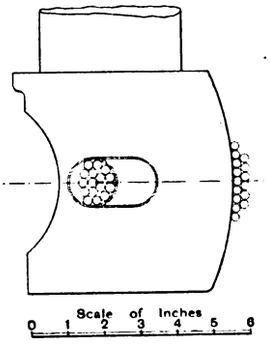


Fig. 1.—Compensating Winding, made 1885.

In 1903, after a series of experiments, Messrs. C. A. Parsons & Co. constructed a 300-kw. 2-pole compensated dynamo working at 3,000 revs. per minute at a voltage of 500, in which the ratio of compensating ampere-turns to armature ampere-turns were as high as 2·4. The armature dimensions (with the exception of the commutator, which was, of course, larger) were similar to the standard 200-kw. plant of that date, and at once remarkable results were obtained, since it could be loaded up to 800 kw., and when that, and even greater loads, were thrown on and off with a circuit breaker, there was no need to alter the position of the brushes nor any excessive sparking.

This compensating winding is chiefly concentrated on the pole-pieces, is made with from 2 to 2½ times the number of ampere-turns that are on the armature, and there is a very large excess sufficient both to neutralise the distorting effect of the armature windings on the field and at the same time to provide a commutating field for reversing, without sparking, the current in the coil undergoing commutation. Owing to the width of this field the brushes need not be so accurately set, and there is considerable range of sparkless commutation at all loads. Since this method of compensating has no iron commutating pole, it has the advantage that there is no self-induction to cause time lag at sudden changes of load; as the field in the gap between the poles is entirely in air it instantly responds to changes of current in the compensating winding, and thus the sparking often seen when there is a sudden change of load with commutating poles is avoided and the risk of a flash-over largely reduced. Also, since there is no iron to become saturated, the commutating field is always strictly proportional to the load, and thus the trouble due to saturation causing sparking at some loads and not at others is avoided.

The advantages of a compensating winding will easily be

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seen to be much more than those due to fixed brushes and better commutation, since it has enabled not only the number of segments for any given voltage to be reduced, but also the ampere-turns on a given diameter of armature to be increased. This enables a larger output to be obtained for a given speed, or, what is the same thing a higher speed to be used for a given output. It may here be mentioned that no difficulty has been experienced in running these compensated dynamos in parallel with one another or with other types, although in all cases they are self-exciting, no separate exciter being used.

Fig. 2 shows a 1,000-kw. dynamo for 500 volts running at 1,200 revs. per minute, two of these being coupled to a 2,000-kw. turbine. These dynamos are for 500 to 600 volts, and carry an overload of 25 per cent. for two hours without sparking or undue heating. They are 4-pole, the armature core being 36 in. in diameter and 23 in. long, with 192 conductors. The commutators have 96 segments and are 18 in. in diameter with an effective length of 24 in.

Fig. 3 is a 750-kw. at 1,800 revs. per minute for 480 to 560 volts. It is a 2-pole, the core being 27 in. in diameter and 25½ in. long, the commutator having 42 segments, the diameter being 14 in. and the effective length 33 in., the number of conductors being 84. This machine has very good commutation, an overload of 33 per cent. or 1,000 kw. being able to be suddenly thrown on or off without any sparking whatever being visible at the brushes.

The authors have found brass-wire brushes running on a grooved commutator to give the best results. The grooving has the advantage of increasing the surface of contact, and of allowing the brush to better follow the irregularities of the commutator. The formation of commutator before referred to, and at present used by all manufacturers of high-speed continuous-current dynamos, was first designed in 1890 by Mr. Parsons, and has since been used with very few modifications. The bars are held in place against centrifugal force by massive steel rings shrunk on over mica bushes, and the commutator as a whole is supported on cones at each end. One of these cones is so arranged that it has a small amount of liberty to slide along the shaft longitudinally, and thus allow for the expansion and contraction of the copper. In building the commutator, the bars with mica insulating strips attached are first assembled and held in place by massive clamps, or by one or two layers of steel binding wire put on temporarily. The mica for one of the rings is then built up by slipping pieces of leaf mica under large rubber bands, and when a sufficient thickness has been obtained the mica is tied in place with string and the rubber bands removed. A steel ring is then slipped on at a red heat, stops being arranged to make it take up its proper position. As it goes on it burns away the string and grips the mica so tightly that the latter can readily be turned and trimmed back close to the ring, and presents a smooth black surface like a solid mica sleeve. In a commutator with only one section there are two of these steel rings, one at each end, but in long commutators several are required to counteract the centrifugal force tending to bend the commutator bars.

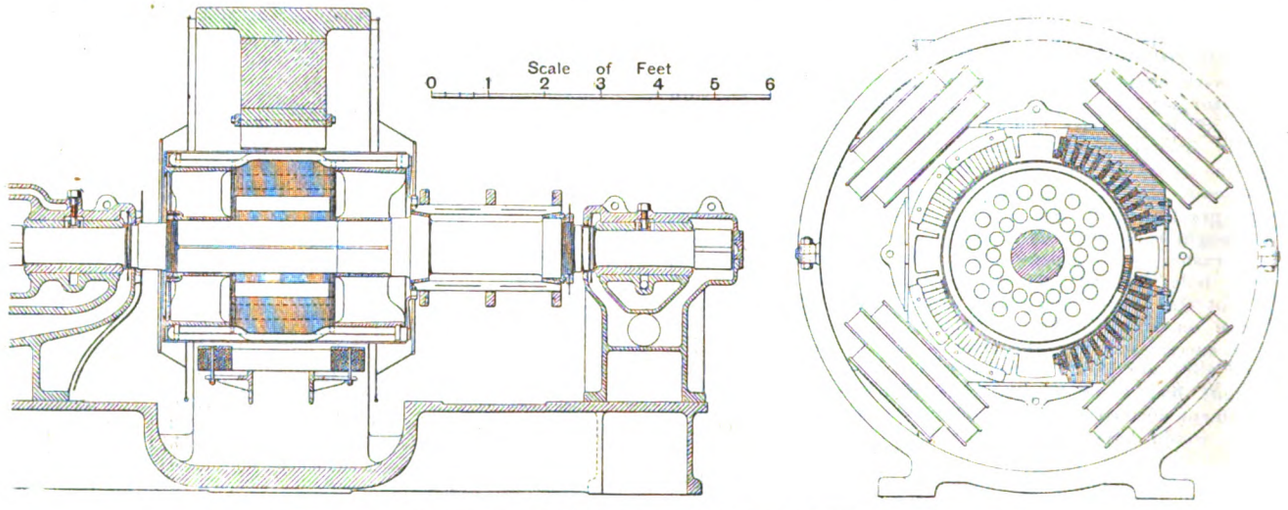


Fig. 2.—1,000-kw. Turbo-Generator, 500 volts, 1,200 revs. per min.

Alternators.

The first turbo-alternators made were for the Newcastle and District Electric Lighting Company, Ltd., four 75-kw. sets being installed in 1889 in their Forth Banks station. They generated single-phase current at 1,000 volts, and being 2-pole on a supply at 80 ~ ran at 4,800 revs. per minute. They were of the revolving armature type, and had a smooth core 7½ in. diameter by 30 in. long with a single shuttle winding held on by binding wire, the ends being brought to slip rings. External or surface ventilation was solely relied upon for the dissipation of heat. A considerable number of turbo-alternators of 150 kw. at 4,800 revolutions were made for the electric supply stations in Newcastle, Cambridge, Scarborough, and other places, having cores 8¼ in. diameter and 32 in. long. A square 4-in. spindle was employed with radial ducts and holes through the winding to pass air for cooling. In 1894 the first of a series of 350-kw. turbo-alternators were made for the Manchester Square Station of the Metropolitan Electric Supply Company. These supplied single-phase current at 1,000 volts, and had 4-pole revolving armatures running at 3,000 revs. per minute, giving 100 ~ Their cores were 17½ in. diameter by 57 in. long, and were provided with twelve 1¼ in. holes passing the whole length of the armature, air being drawn through by a fan though no radial cooling was provided. The first few were surface-wound, but owing chiefly to the eddy currents developed in the conductors, which were large and insufficiently laminated, there was considerable trouble from heating, and they were subsequently altered to a tunnel winding with sixty holes ¾ in. diameter, forty of which were filled each with one conductor, the remaining twenty holes being empty since the alternator was single-phase. Two- and three-phase alternators were also made on the same lines, the most noticeable of this type being the two 1,500-kw. 2-phase 2,000-volt plants, which were installed in 1904 at the Neepsend Station of the Sheffield Corporation. The crossing of the windings at the ends, however, makes the problem of a revolving polyphase armature much more difficult, especially at high voltages, though, on the other hand, the iron loss, especially in 2-pole plants, is only about one-third of what it is with a revolving field. The real trouble came when it was attempted to make a 1,500-kw. 40-periodicity 4-pole 3-phase alternator, with a revolving armature running at 1,200 revs. per minute, and a voltage of 6,000. It was found impossible to insulate the end winding sufficiently, and at the same time to get rid of the heat generated, and as a result the modern type of revolving field was adopted.

The design of the stationary or high-tension element follows low-speed practice fairly closely. It has, however, been found necessary to introduce a special system of brackets or clamping rings to hold the end windings against the enormous forces developed in case of a short or other serious disturbance on a system.

Fig. 4 shows a longitudinal and cross-section of one of the 4,000-kw. 3-phase alternators at 6,000 volts installed at Carville power station. The stators are split long the horizontal diameter and so arranged that the top half can be lifted by breaking only four electrical joints. This construction has the advantage for plants of large size that the rotor can be lifted out direct, but it rather complicates the end windings. The plant illustrated is capable of carrying 6,000 kw. for two hours, and on its official trial was loaded for half an hour up to 7,000 kw.

It is, however, in the rotors of high-speed alternators that the greatest diversities of design are to be found. A great deal has been said as to the relative merits of salient pole

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as compared with cylindrical-type rotors, especially as regards the voltage regulation of the alternators, but it appears that a much more important question is whether one design shows marked advantages mechanically over the other. Any difference there may be in the two types as regards voltage regulation is certainly small, and can easily be compensated for at small expense by other features in the design.

Newcastle-upon-Tyne Electric Supply Company, Ltd.. has a ventilation scheme with separately driven fans which were installed to enable the alternators to carry heavier overloads, although in the first instance the machines were run for some years with natural ventilation, and were well inside the figures guaranteed for temperature rise.

Messrs. C. A. Parsons & Co. have constructed 2-, 4-, and

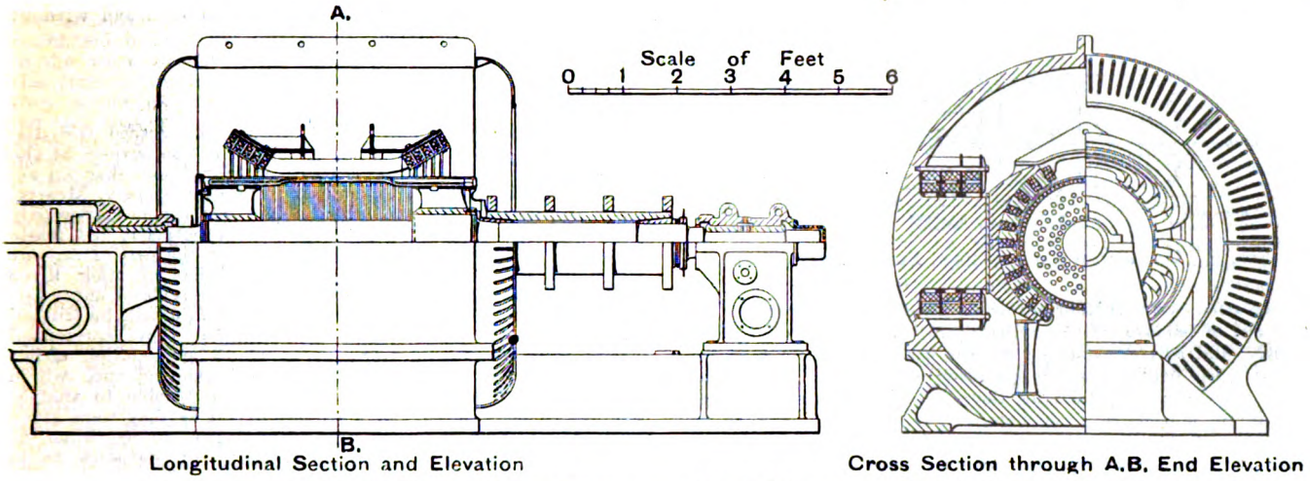


Fig. 3.—750-kw. Turbo-Generator, 480 to 560 volts, 1,800 revs. per min.

The question of ventilation is of very great importance in modern high-speed plant owing to the compact nature of the machines, which is a result of the limit placed on the diameter of the revolving portions by the high speeds of revolution, and in consequence it becomes necessary to make the maximum possible use of the space in the rotor which is at the designer's disposal.

The output of a given design may be regarded as directly proportional to the iron required to carry the flux, and nearly proportional to the copper to carry the required magnetising current, with the necessary insulation, so that if these can be increased at the expense of area to carry air ventilation and materials included for mechanical purposes only a valuable saving may result. This has been effected in many cases by providing artificial ventilation for cooling the iron and copper of the stationary element. The ventilation scheme which some makers have adopted is to provide a centrifugal fan at each end of the rotating element, or to make the rotor itself create the draught. Thus air is driven both round the end windings of the stator and also through the ducts in the iron core, and out through a chimney at the top of the stator casing. In other cases a separately driven fan is provided, forcing air

6-pole rotors of the salient-pole type. In the smaller 2-pole and 4-pole designs a solid construction with the coils wound in place is adopted. The 2-pole rotor is thus very similar in appearance to the old Siemens shuttle or H-type armature, with which many of us must have been familiar in the early days of electric lighting. The formation is excellent mechanically, since there are few loose parts, and the solidity of the construction enables great mechanical strength to be secured. The rotor body is bored at each end and shaft ends of special high tensile steel forced in, and then the whole turned up and accurately balanced. The balancing is done in three stages before winding the coils :—(1) By ensuring static balance on a pair of carefully levelled knife edges; (2) by careful measurement; (3) by running up to about one-third above normal speed in a specially constructed balancing machine. The combination of these three methods is essential, since while the balance may be perfect on the knife edges, this may be the result of one end of the rotor being heavy at one side while the other end is heavy on the other. In this case, though in perfect balance on the knife edges, there will be present when running a powerful couple travelling round at the same speed as the rotor and causing vibration. Careful measurement will generally

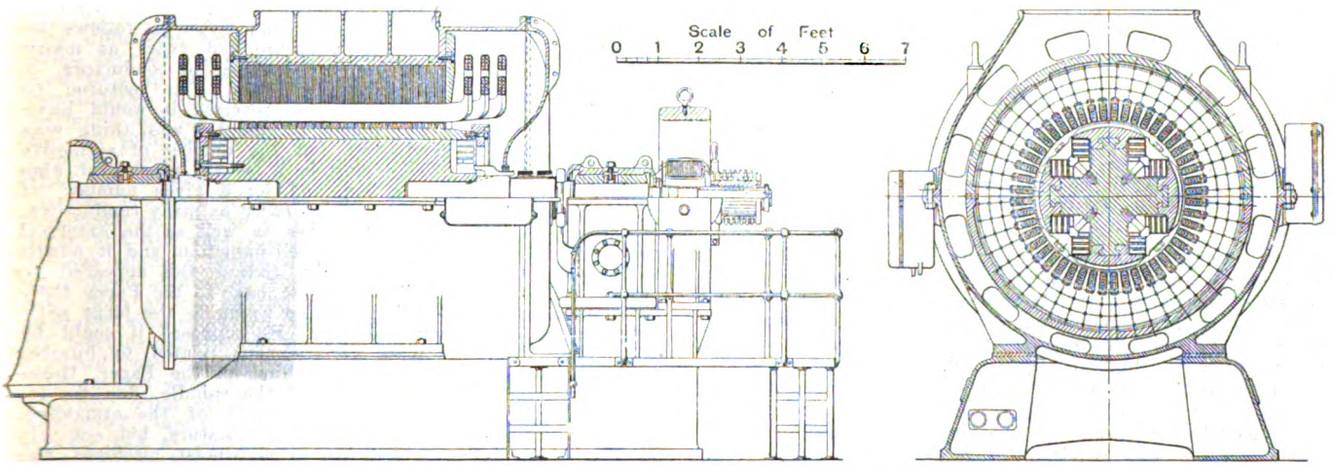


Fig. 4.—4,000-kw. 6,000-volt 3-phase Alternator with Exciter.

through both the stator and rotor of the alternator. In both these methods, or a combination of them, the exra pressure obtained results in the passing through the generators of large quantities of air, which is often arranged to be drawn from outside the building, so as to be as cold as possible, thus largely reducing the final temperature of the windings.

Among other stations, the Carville power station of the

show where weight should be removed or added to give both good static and dynamic balance, which is corrected and improved by actually running and fitting weights as required.

The rotor, after being thus balanced, is put into a horizontal winding machine, and the coils wound into coil cases, which are made of tinned steel and completely soldered up after the winding is completed. The ends of the coil are brought out

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through a brass lip, soldered into the case, and fitting tightly round the connection to the next coil or to the slip rings, thus making a hermetically sealed coil.

A further advantage of coils thus wound and protected is the permanence of the balance of such rotors. Formerly with unprotected coils the windings had to find their own place as they were squeezed up by the centrifugal force, by the sliding of the insulation along metal surfaces more or less smooth. Thus the insulation was sometimes damaged and perhaps one

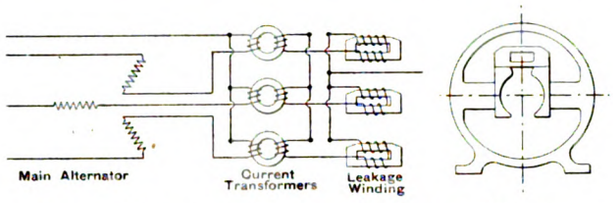


Fig. 5.—Diagram of Connections, Leakage Winding.

or two coils went further up than others, thus throwing the rotor out of balance. On running again other coils would move slightly, and so the balancing process had often to be repeated several times before a stable condition was reached. With the metal cases the coils take up their final position at once and stay there, and it is a common occurrence for a rotor to go straight up to 25 per cent. over speed the first time it is turned round without requiring any further balancing. In the case of large rotors the pole-tips are made to slide over a tee-shaped projection on the rotor body, and the coils are wound separately in coil cases and slipped over the poles before the pole-tips are put on.

As in the case of continuous-current machinery, one object is to get the maximum output at the highest speed possible. The strengths of the materials limit the diameter and length of the rotor and therefore both the available flux and ampere-turns This again limits in the stator the output for a certain inherent regulation. If, however, any method of compounding

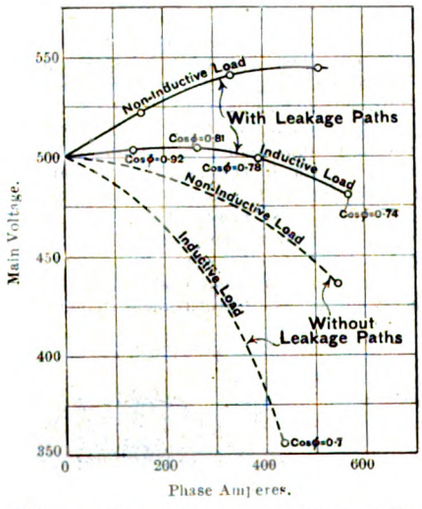


Fig. 6.—450-kw. Turbo-Alternator Voltage Regulation Putting on Load. Rheostats Unaltered.

the alternator to improve the regulation is adopted, much larger outputs can be obtained from a given carcase. Many methods of doing this have been proposed, but most of them depend on either commutating a portion of the alternating current or causing certain parts to become saturated as the load increases, or by varying the effective resistance of the winding on the exciter magnets. The first is objectionable on account of the trouble given by commutators, the second since the compounding will vary with varying voltage, and the third is generally too slow to allow for rapid changes of load. A method of compounding has recently been brought out (see Parsons' and Law's patents 24141/05 and 13712/07) which avoids these difficulties.

The exciter is provided with an alternative path for the magnetism in parallel with the armature which we call a "leakage path." This "leakage path" is provided with a winding, which is in series with the stator winding, and as the alternating current in this rises it chokes back the magnetism, or, in other words, increases the magnetic resistance of the leakage path. Thus more flux goes through the armature, and therefore the voltage of the exciter rises and compensates for the tendency of the main voltage to drop. In a 3-phase alternator there is generally one leakage path in each phase, and if the primary current is at high voltage, a current transformer is generally used. These leakage paths are easily adjusted for any desired amount of compounding; or for any power factor. Fig. 5 shows diagrammatically this arrangement fitted to the exciter of a turbo-alternator, and Fig. 6 gives the comparative regulation on varying load with and without the leakage path in action.

DISCUSSION.

Prof. Silvanus P. Thompson, F.R.S., who opened the discussion, said that in looking at the Paper it was obvious at the outset that it did not pretend to be anything more than an account of the highly successful doings of one firm, namely, Messrs. C. A. Parsons & Co., and as the object was confined avowedly to the manufactures of that firm and the progress it had made from the beginning, it would be invidious on the part of anyone discussing the Paper to drag in the products of other firms by way of instituting comparisons either favourable or unfavourable. If, therefore, he criticised the Paper in detail, he trusted that neither the authors nor the firm that they represented would think he did so from any want of appreciation either of the Paper or of the years of patience and advance which the Paper represented. He had taken the trouble to analyse the figures of a number of machines so far as they were given from the earliest types to the latest types, to see what he could get from these figures in the way of statistics as to the utilisation of materials. The result showed a very remarkable progress in the utilisation of copper and iron, giving a machine of larger and larger output in proportion to the quantity of material used, or, in other words, giving two machines which, in proportion to their output, were smaller and smaller. He had multiplied together the diameter and length of the armature core and divided that by the kilowatts of output, giving the "Steinmetz" coefficient. Beginning in 1884 with a small 8-kw. machine, the coefficient of size in proportion to output was 2·4 for a continuous-current machine. In 1889 the relative size had gone down to 2·1 for a 60-kw. machine, and in two recent examples of continuous-current machines of 750 kw. and 1,000 kw. respectively, this had further gone down to 0·917 and 0·8928; nearly almost exactly one-third, or three times as much output in proportion to the size of the armature as measured by the product of diameter and length. Turning to alternators, the result was even more striking. The earliest mentioned machine was 1889, namely, a 75-kw. single-phase machine, and the ratio was 3. A little later, with a machine of 150 kw., the ratio had gone down to 1·76. In 1894, with a 350 kw., the ratio was 2·8, but in 1894 to 1896 for a 1,000-k.v.a. machine the ratio had gone down to 1·73, and with the most modern machine described in the Paper, which was a 4,000-kw. 3-phase machine made for the Carville power station, this figure had gone down to 0·64. Thus the ratio had gone down from 3 to 0·64, a little more than one-fifth, or five times as much output in proportion to the size measured as a product of diameter and length. The firm that could do this in the years between 1889 and 1903 had certainly made a very remarkable advance. Early in the Paper there was a comparison between the winding of the Gramme armature and the drum type as follows:—"... and since the Gramme armature had twice as many segments as the drum for the same number of conductors, it appeared that the result should be better." He ventured to think that if the argument had been reversed it would have been argued the other way round, because the vital thing was not the number of conductors, but the number of segments for the commutator. There must be a certain number or else the commutation would be bad, and for a given number of segments the Gramme armature had twice as many conductors, because it had all the internal ones as well as the external ones, and that would increase the self-induction, and it ought to be worse and not better, and so, indeed, this appeared to be recognised by the authors, because later in the Paper they stated that sparking was not reduced owing to the large self-induction of the Gramme winding. He supposed it could be taken that this little piece of argument related to bipolar machines, because, in the next few lines of the Paper, there was a reference to the heating of the spindle, due to its revolving in the stationary internal field of the armature. That would be true for a bipolar ring armature, but scarcely so for a four-pole machine, as in multipolar machines the internal field through the shaft was negligible. The authors made an extremely interesting statement about the use of smooth core armatures in continuous-current machines, which appeared to be still preferred in these high-speed machines to slotted armatures, and the reason given was that better commutation could be obtained. But was this the only reason? It seemed to him that there must be another reason, namely, that with these very high surface speeds, if slotted armatures were used with slots of usual size, the frequency of change of the magnetism where the teeth go in and out of the polar edges would be deleterious, and that there would be set up in the

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pole pieces eddy currents of a rather severe kind, resulting in a severe iron loss as a result of having a very high frequency of change. Surely that was one reason why teeth should be avoided in machines of this type. The authors stated that since the method of compensating used by Messrs. Parsons had no iron commutating pole, it had the advantage that there was no self-induction to cause time lag at sudden changes of load. He thought this statement was somewhat difficult to understand, because it seemed to him that if there were sudden changes of load, this would equally affect the current through the armature and the current round the series winding; it could not increase or decrease at a greater rate in one than in the other, and either or both might have self-induction, and the increase or decrease as a whole might be retarded, but they would both be affected equally, and, therefore, he could not see that the self-induction had anything to do with the want of compensation between the two. Another interesting detail was the arrangement of the commutator segments, first designed by Mr. Parsons in 1890, in which longitudinal expansion took place, which allowed for the expansion and contraction of the copper, the commutator as a whole being supported on cones at each end. He supposed that there was some kind of spring arrangement to take up the expansion—(Mr. Stoney: Yes)—otherwise the end of the ring would be liable to part company on contraction. In the Paper there was a brief discussion of the relative advantages of having the poles of the field magnet wound solidly as a whole, or having, on the other hand, the winding distributed in several slots. The authors stated that any difference there might be in the two types as regards voltage regulation was certainly small. Was that all that was wanted to be known? In those cases where the winding was divided over several slots, the middle region of the pole had more ampere turns round it than outlying parts, and the result would be that even if the air-gap was practically of a uniform width over the pole face, the flux would be concentrated more at the middle of the pole than towards the edge, because it was desired to have a distribution nearly approaching, in space, a sine function. That could be obtained in other ways, such as by the shape of the pole and overhanging tips; but was it not true that if the pole phase were entirely solid, they were more liable to have distortion of the magnetism laterally when there was an inductive load by the cross magnetisation? Thus, if the winding were concentrated in the way suggested by the authors, and making deliberately a stronger piece of pole in the middle, if the initial distribution of magnetism at no load was approximately a sine function without any cross magnetisation, that would be sheared over, and the E.M.F. curve would no longer be a true sine curve, and the heating would no longer be a minimum in the armature iron. There might be some advantage in that form of pole, because there would be less liability to such distortion and therefore less heating at full load. This might not be important; but he mentioned it to ask whether it had been found from the heat point of view that the iron loss at full load was really different between these two types. For the method of compounding through the excitor of the alternator mentioned in the Paper, he had nothing but the utmost admiration.

Mr. E. J. Fox (Messrs. Willans and Robinson) said that those who had been engaged in working up the turbine side of the business know well enough the difficulties to be faced quite apart from the electrical side. Mr. Parsons and his associates had had to work at the two together, and he was quite sure the difficulties would have disheartened most other people. Some four or five years ago, when Messrs. Willans & Robinson first took up the manufacturing of steam turbines, they found considerable difficulty in getting generators for coupling to turbines, and the few remarks in criticism of the Paper which he was going to make were based on experience with different types of generator made by different makers. He was sorry that the authors had confined their Paper as regards direct-current machines to those with smooth cores and corrugated commutators. He knew that machines of this type had, in the past, and still were, doing very excellent work, but he thought it was setting a comparatively low limit if they were to put this down as finality, which was practically what it amounted to. Both as far as the smooth core armature and the commutator were concerned, he was perfectly certain that the type of machine described in the Paper had got to give way to the toothed core machine and carbon brushes if direct-current turbine sets were going to seriously compete with reciprocating engines. First of all, as far as the smooth-core machine was concerned, surely nobody could call it mechanical. The conductor had to be laminated in order to avoid eddy currents, and had to be driven in the same way as the smooth-core machines were driven ten or fifteen years ago, by means of driving pegs. Then the conductors on the outside of the surface had to be bound down with steel binding wire, and it seemed to him that they were very liable to shift. Mr. Fox then referred to the success of the slotted core machines of Messrs. Brown, Boveri & Co. The authors stated that the objection was that they did not get such good commutation; but he did not think this was the case. With some dynamos with slotted cores, which Messrs. Willans & Robinson had put down, and others which he had seen on the Continent, the commutation was as good as was wanted. In principle these machines seemed to differ from the authors' designs in that, in addition to compensating winding there was a commutating pole, but it would seem as if this latter was the natural consequence of events. The commutating pole would certainly save a good deal of copper on the compensating winding, in so far as the air-gap was considerably reduced, and in addition to that it gave the commutating field just where it was wanted, instead of an indefinite field not concentrated so closely as it was possible to concentrate it with a commutating pole. Dealing with the commutator, he thought that the corrugated commutator with wire brushes was bound to die a natural death very soon. The only reason that he could see why wire brushes were used was that if the commutator got out of balance it did not matter to the same extent as with carbon brushes. He had been looking at some drawings of a new type of commutator which Messrs. Brown, Boveri were experimenting with at the present time, designed for working entirely with carbon brushes. The idea was to support the commutator in such a way that as the bars heated up expansion took place end-ways, and prevented bulging on the periphery. With regard to alternators, the authors had touched on the question of the salient pole *versus* the cylindrical type. He was entirely in agreement with them here. Messrs. Parsons had adopted the salient pole type of machine, and he thought from his experience that there was, at all events, very little to choose between the two. The salient type had perhaps these two advantages: (1) that better regulations could be obtained; and (2) bigger overloads could be maintained, due to the greater amount of copper. One final remark on the subject of alternators, dealt with the author's advocacy of compound alternators. There had been a good many of these brought out from time to time and discarded, and he thought the best machine was an ordinary alternator without any of the complications of compounding, and if closer regulation or voltage regulation were required, the use of a Tirrill regulator would enable them to do the thing as simply and cheaply as possible.

Mr. W. PARKER (Messrs. Siemens Brothers' Dynamo Works, Ltd.) said that the authors had dealt with the history of the direct-current turbo; he would like to add a few remarks upon the history and development of the direct-current machine in general. The authors had advocated metal brushes and smooth armature cores. Looking back to the early stages of the electrical industry, and more particularly to that period when the bipolar machine was at the height of its popularity, it was found that metal brushes and smooth cores were used exclusively, and in spite of the fact that these machines had to run on lighting circuits with very steady loads and at low speeds, it was found that these brushes required a fair amount of attention in order to get them to run sparklessly. With the advent of traction and fluctuating loads and large overloads, the fixed position of metal brushes was found to be entirely unsuitable. Carbon tips were tried, and while they effected some improvement they were found to be insufficient. Something new was required, and this was found in the exclusive use of the carbon brush. In this way carbon brushes were established, and smooth cores were abandoned, as the introduction of carbon brushes rendered possible the use of slotted armatures. He was therefore very much surprised to find that the authors still advocated that antiquated construction, the smooth-core armature and metal brushes, and a type of machine in which the commutation difficulties were exceedingly severe, and in which it was extremely desirable to get an armature wound in such a way that the winding could not shift, otherwise the machine would rapidly get out of balance. Moreover, he was convinced that in the very near future users would insist on carbon brushes and slotted armatures. When his firm first took in hand seriously the designing of direct-current turbos suitable for operating with carbon brushes, they soon found difficulties. The real difficulty was not vibration, as had been anticipated, but excessive heat from the commutator. Vibration could be got over by a suitable brush holder, but excessive heating did not lend itself to any very easy solution. They found it absolutely necessary, if carbon brushes were to be used on high-speed commutators, that artificial cooling should be employed. The particular form used by his firm was to have holes arranged axially in the segments of the commutator, with a fan attached to the shaft for introducing a powerful draught of air through these channels. There were other methods of cooling a commutator, such as diverting a stream of air on the surface of the commutator by means of a motor-driven fan, situated in the basement along with the other auxiliary machinery. He had found that the method of artificial cooling by means of axial holes, that the temperature of the rest of the commutator with carbon brushes, could be kept down to less than 40° F., and with a density under brushes of 45 amperes per square inch, the brushes used being those of Le Carbone manufacture, X and Z qualities. In connection with this question, he mentioned that one of the largest firms on the Continent, who had built upwards of one hundred direct-current turbos, had given up metal brushes entirely, and had gone over to carbon brushes, and they had always used slotted armatures. On the question of commutating poles and compensating windings, he said he

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noticed the authors advocated the latter only. According to the Paper, their reasons were that when commutating poles were employed (1) there was sparking with sudden variations of load; (2) a tendency to flash over on the commutator; (3) that machines so fitted sparked at some loads and not at others; (4) that the sparking was bad at varying voltages. These statements were certainly incorrect. He had himself seen several machines fitted with commutation poles giving absolutely sparkless running under all these conditions, with the circuit-breaker tripped, and the full load current on the machine. With regard to sparking at varying voltages, he had seen machines fitted with commutation poles running absolutely sparklessly when the voltage had been varied from zero up to the maximum normal value. His firm, when testing these machines for commutation, in order to make the final adjustment in the test house before the machine left the works, always tested on short circuit. The brushes were short-circuited, and the machine gave its full current at 10 to 12 volts. On the question of machines with commutating poles tending to flash over, his opinion was that the flashing over problem was independent of whether there were commutating poles or not. He had seen machines run sparklessly and then flash over, the reason being that the volts between the adjacent segments were too high. This brought him to the disadvantage which the use of compensating windings alone possessed. According to the Paper, it appeared that the practice of Messrs. Parsons was to employ about 2 to 2·2 times the ampere turns on the compensating winding to that of the armature. It appeared quite clear that with such an excessive amount of compensating winding on the pole shoes, not only would they get the commutation flux reversing, but there would also be a very large distortion in the main pole, because if the compensating ampere turns per inch of circumference in the pole shoe were less than the ampere turns per inch of periphery on the armature, then clearly the distortion was not entirely neutralised. If, on the other hand, the ampere turns per inch on the pole piece were greater than the ampere turns per inch on the periphery of the armature, then they got flux distortion in the other direction, and he thought that with the large number of ampere turns utilised by Messrs. Parsons, the distortion would be actually greater than if no compensating winding was used at all. He thought there was very little doubt that the best construction for large units for direct-current turbos was a combination of commutating poles and compensating windings, as these were becoming now practically universal not only in England but also on the Continent.

Dr. R. Pohl (Phœnix Dynamo Manufacturing Co.) said that the main and critical features of Parsons' latest machines agreed very well with those factors which he had the honour of putting before the Institution a few months ago, the only difference being that the voltage per segment was about 50, as against 40 which he recommended. The main features of Parsons' direct-current machines were the compensating winding, the bipolar construction up to very large construction; the smooth core and the metal brush and corrugated commutator construction. Three of these points had already been dealt with by previous speakers, and he was quite in agreement with the opinions expressed as being in accordance with best modern practice. He was of the opinion that the smooth-core armature would have to give way in a very short time, and also the metal brush and the corrugated commutator. As regards over-compensating windings, he agreed with the previous speaker, who said that the field distortion was by no means eliminated. As a matter of fact, if they worked out the design of the 750-kw. generator, and calculated the field distortion, it would be found that the negative field distortion was about twice as much as it would be if there were no compensating winding at all. He did not mean to suggest that in Parsons' machines there was any great field distortion. It was kept down quantitatively by employing smooth core and a very big air-gap, and he believed the reason Mr. Storey advocated smooth core was that he employed his over-compensating winding. If he would concentrate the over-compensating winding in the neutral zone only, leaving so much ampere turns on the field as to prevent field distortion, he would find that the slotted core with the very much smaller air-gap would give better results. The second portion of the Paper, dealing with alternate-current machines, was very interesting reading, and contained one or two points which were distinctly novel. The first was the winding of the coils in hermetical sealed coil cases. He would like very much to have a more detailed description of how this winding was carried out. He did not see how the slipping of the coils in the cases was prevented, and he did not understand how the coil cases were secured. Another point of particular interest in the alternating-current dynamo was the leakage path method of compounding described in the Paper. The idea was very ingenious, and he congratulated Mr. Law; but at the same time he had some doubt as to whether it would work out in practice as a commercial success. The curves in the Paper showed that in order to maintain approximately constant voltage, an increased pressure of about 60 per cent. was necessary with a negative load of 0·8 power factor. That would mean that the total flux must be increased in the ratio of 1 to 1·6, or an enormous flux must pass through the leakage path. There was another consideration. As soon as that leakage path was completely saturated, say, 24,000 C.G.S. units, even then the permeability of the material was somewhere between 30 and 40. Assuming that the leakage between the pole tips, without any such leakage path, was 5 per cent., then the leakage which was left, even at the highest density, would be between 150 and 200 per cent. In other words, it seemed to him that the exciter fitted with such a leakage path would be about three times as large as an ordinary exciter. He did not know whether he had made a mistake, but it seemed to him that that was about the case. There was, further, the additional expense of the choking coil and of the current transformer, and he had some doubt as to whether that expense would be compensated for by the saving in the construction of the alternator.

Mr. F. H. Clough (British Thomson-Houston Co.) criticised the opinion expressed by the authors that the salient pole was preferable, more particularly for high speeds, which it was now the tendency to use. The salient pole machine could be regarded as, say, a four-pole machine, having four large slots, and necessarily, to get the same excitation, the conductors in each slot, and consequently the size of the slots, must be very much increased, *i.e.*, there were large size conductors and considerable difficulty in getting rid of the heat. Another feature, of course, was that in the overhanging portion of the slots, viz., the pole tips, there might be very heavy bending stresses, and the limit in the peripheral speed of the machine generally ceased there. Dr. Thompson had spoken of the distribution of flux round the periphery. With a definite pole machine this could be made practically anything that might be desired. With a cylindrical rotor, if advantage were to be taken of most of the periphery, then there was only a small portion in the centre of each pole which was not wound; consequently, there was a very increased density in this portion. With a well-distributed stator winding the effects of the higher harmonics could be very nearly eliminated by the coils in different slots being connected in series. The winding was then so distributed that the higher harmonics were eliminated, and consequently there was at disposal the use of any distribution of flux that they might care to use, and therefore, in order to keep down the density in the centre, it was desirable to make this a flat tip, *i.e.*, an even distribution of density across the pole tips. His company had made some machines with a modified cylindrical type of rotor. In these, the diameter over the poles was rather larger than between the poles, and the conductors were carried in slots. Consequently, they had the advantage of the exciting winding distributed in comparatively small slots, no bending stresses, and also, by the use of the increased diameter, the flux distribution could be spread over a considerably larger portion than if a purely cylindrical rotor had been adopted. The reluctance of this machine was variable, and was bigger between the poles than over the pole faces. Another advantage was that this increased diameter allowed a double depth of ring for retaining the winding. Some machines were running at 300 feet per second, and this ring, being sufficiently thick, required no internal support. The rotor was therefore made with a large hole in the middle, and adequate ventilation without any auxiliary fans was obtained.

Mr. Miles Walker (British Westinghouse Electric & Manufacturing Co.) said the question of salient poles *v.* cylindrical windings was a very important matter for the designer, and time would show which machine would survive. In his own opinion the cylindrical machine was the type which would survive, for the reason that from such machines it was possible to get the largest output from a given amount of material. The first striking difference in the two types was that in the cylindrical type there was a very short pole with a winding distributed over a great width, whilst with the salient type there was a comparatively long and narrow pole, from which there was a leakage across, whereas in the former there was very little leakage indeed. In the case of the cylindrical type the winding was supported mechanically in small sections, allowing the use of very much higher peripheral speeds. In the other type, the winding was more or less huddled together, and therefore the cooling of the copper was very much worse. In the Paper the authors had stated that the output of the machine was proportional to the sectional area of the pole into the sectional area of the copper, but he wished to point out that there were two other factors of very great importance which must also be considered. One was the current density at which it was possible to work in the copper, and the other the flux density at which it was possible to work in the steel. With the cylindrical type of winding it was possible to work the copper at least 50 per cent. higher than in the other case. Considering the saturation curves of the two machines, he pointed out that in the case of the salient pole type the limit of working must be fixed lower down on the saturation curve than if the cylindrical core were adopted. The reason was that as the flux increased the leakage increased, and a point was reached where the ampere turns in the pole were increased, and consequently the leakage, to such an extent as even to make the characteristic curve bend downwards, without increasing the flux at all. In the other case, a point was ultimately reached when the iron was saturated over a larger area than was the case originally, so that the curve was

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always rising, and they could work at a higher point and still keep up the voltage on heavy loads. Why was it, he asked, that the cylindrical type had not been more used by many designers who really were very competent to judge of these things? One of the main reasons, he thought, lay in the construction of the end connections. It was easy enough to have a cylinder with a number of slots in it; and it was easy enough to hold the winding inside the slots, but difficulties arose in the portions which protruded at the ends. This was the trouble which had stopped the cylindrical type from being used, but he believed that if this difficulty were got over, and the end connections supported, then the cylindrical type was bound to supersede the other. The difficulty was that there was only a limited space, and bands or a ring were required to hold the wire down. In a type of construction which he had seen a good deal employed recently, and which had been successful in a very great number of cases, the copper bar was cut down to about half its width where it left the slot, and end connectors were then built up with copper straps, which went from one bar to the other. These were grooved with V grooves at the side, assembled and covered with mica, and held by means of end rings after the manner of a commutator. A steel ring, insulated with mica, is placed over the whole, where the bars are cut away. This form of construction enabled the use of enormous peripheral speeds without danger. He could give figures of the enormous outputs to be obtained from very small sizes. It was possible with a rotor of about 20 in. diameter to get 60,000 ampere turns. If they tried to put this in connection with a salient pole, and yet preserve a fair amount of the iron—because they must consider how much iron they would have—they would not be able to get within 50 per rent. of that figure, because they had to work at a lower current density, and there must be some kind of mechanical support, which always took up a lot of room, whereas with the other winding they mixed up the iron and copper electrically and mechanically. This enabled the building of a 2,000-kw. machine with a rotor of 20 in. diameter, and the active iron only 20 in. long; *i.e.*, a 2,000-kw. rotor about the size of an old-fashioned garden roller. This was the reason why the distributed winding looked promising in the future. Another reason was that it made the construction of the compounded alternator, which he described some years ago, more simple indeed. These alternators were used in a great number of places, in sizes varying from 500 kw. to 3,000 kw. capacity. They would hold their voltage on the ordinary power factors met with in practice from no load to full load. These compounded alternators had two features which were not to be found in an ordinary compounded alternator. Any arrangement in which the exciter was made to increase its voltage at the time when the load came on always had the drawback that there was a second or two seconds' lag, due to the self-induction of the field; so that if the load was jerked on, there was flickering in the lamps before the compounding could work; but with the arrangement mentioned above, the armature reaction was made to strengthen the field, and incidentally as the load came on the volts corrected themselves. It was possible to throw the whole load on from no load to full load with a switch, and with a lamp in parallel with the load there was not the slightest flicker or increase in brightness when the load came on.

Mr. H. M. Hobart thought they were very far from finality in this question. There were reasons for this, he thought. It was possible to overcome reactance voltage and armature reaction with compensating windings and interpoles, and both were fairly satisfactory, but they did not, of course, affect the peripheral speed, which was one of the chief troubles. The trouble of finding a brush to work smoothly with peripheral speeds of 30 to 40 metres per second was a mechanical trouble. It seemed to him that the reason why no very great success had yet been obtained with turbo-dynamos was that they were going contrary to fundamental laws, whereas in connection with alternators they were working in accordance with them. All designers knew that the properties of the alternating-current machine came out better the higher the speed, although he felt that this was being rather overdone; in fact, he thought the speed might be dropped a little, even if there was not so much economy. But the reverse was the case with continuous-current dynamos. The slower the speed the better would the direct-current dynamo come out, and they ought to be satisfied with a continuous-current dynamo running at slow, or, at any rate, medium speeds. There was another reason. The turbine did not show up favourably in comparison with reciprocating engines for steam consumption below 1,000 kw.; they did not want them to, and the thing worked out nicely in this respect. It was only in the larger sizes of turbines and alternators that the great economy over piston engines was shown.

Mr. A. H. Law, replying briefly to the discussion, dealt with a few of the points raised, and reserved a full reply for the journal. Dealing with Prof. Thompson's constants for different sizes of machines, he said that it must be borne in mind that these old machines were a good deal smaller than the later ones, and if they were to build a 20-kw. plant now at 18,000 revolutions, he did not think they could do any better than Mr. Parsons had done in 1885 as regards smallness for a given output. Mr. Stoney had himself gone into the design of the 1885 machines, and it was wonderful how near Mr. Parsons had been to good modern practice of to-day. A good deal had been said about the relative advantages of smooth core and slotted armatures. The fact was that Messrs. Parsons were simply relying on experience of both types. As was stated in the Paper, slotted cores had been built, and they would be the last to say that no good result had been obtained with them. Mr. Stoney and himself had both seen them running, but at the same time such exceptionally good results had been obtained recently with large two-pole smooth core machines with distributed compensating winding, that having that experience they were extremely loth for the moment to alter their design and go in for slotted cores and carbon brushes. The question of carbon brushes had been raised by nearly every speaker, and he was pleased that it had been raised, because anybody who said that carbon brushes were not going to be used in the future would be taking a very bold step. Neither Mr. Stoney nor himself had made any such statement. There was the possibility, or even a probability, that some form of carbon brush would eventually be used, and all commutators constructed by Messrs. Parsons were so designed that if the carbon brush became a thoroughly practicable proposition, the change could be made at very small expense, *i.e.*, sufficient surface was provided to enable carbon brushes to be used. No doubt it was a more difficult thing to design a continuous-current generator which would commutate satisfactorily with metal brushes than a machine using carbon brushes, and he could not help wondering whether the anxiety of some people to see carbon brushes used by everybody else might not be due to experiencing difficulties in designing dynamos which would commutate satisfactorily with brass-wire brushes, and he submitted that if a dynamo could be made which would commutate successfully with brass-wire brushes—and at present there was not the slightest doubt that it could be done—let them construct the machines for the moment with brass-wire brushes, and as soon as the ideal carbon brushes and holder came along then adopt the improved method of commutation. He would like to mention that they had in their works at present a large number of motors driving various machines, and the best commutating motors in the place were some comparatively old bipolar smooth core motors, built by Messrs. Crompton, and running with gauze brushes. They looked old-fashioned, and probably they were rather big for their output according to modern machines, and could not be built as cheaply as the modern motor, but, at the same time, for reliable running there was no motor in the works to equal them. He would like to correct one statement of Dr. Pohl's, who stated that the volts per segment were 50 in the only machines of which the figures were given. As a matter of fact, the value was 42 to 43 volts per segment, which was practically the same as Dr. Pohl had mentioned as being suitable. Dr. Pohl had raised the question of the size of exciter when using leakage paths and compounding. As a matter of fact, it was true that exciter magnets had to be somewhat larger, but the only thing this affected was the iron in the exciter magnets, and the iron of the exciter magnets was only a small proportion of the total cost of a large alternator. Copper was slightly increased by the amount necessary for the somewhat larger pole and the increased iron, so far as he could remember, did not exceed 50 per cent. at the outside. One point had been mentioned by Mr. Miles Walker and Mr. Clough in connection with the salient pole and barrel windings. One difficulty of the barrel windings was the end windings, which had to be supported by some form of gap unless the extremely ingenious arrangement shown by Mr. Walker was adopted. (Mr. Law here mentioned that the Chairman had reminded him that a similar arrangement had been invented by Brown years ago.) If this were done it was necessary to cool the windings under the cap, and that took away the possibility of cooling them along the barrel of the rotor. They could not have the same high density along the barrel and in the cap unless there were ventilation facilities. With regard to the time lag referred to in the exciter compounding, as a matter of fact there was no time lag in the exciter magnets with the leakage path compounding, for this reason, that the flux in the exciter magnets was almost the same, only in one case it passed through the leakage path, and when the load came on it was diverted and sent through the armature; therefore there was very little change in the flux in the magnets of the exciter, and consequently there was no time lag in the exciter. There was a time lag in the main motor magnets which would slightly delay the compounding action, but almost the same test mentioned by Mr. Walker had been applied to this winding. A lamp was put in a dark room and full load thrown on, but there was no flicker in the light whatever, so that, as far as that went, the time lag might be neglected.

Royal Institution.—Among the lecture arrangements after Easter are the following:—"The Development of the Modern Turbine and Its Application," by Mr. Gerald Stoney (two lectures); "The Scientific Work of Lord Kelvin" (with experiments and typical apparatus illustrative of his discoveries and inventions), by Prof. J. J. Larmor, F.R.S. (Friday evening discourse). Among succeeding Friday evening discourses will be one by Prof. Sir James Dewar, F.R.S.

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A NEW METALLIC MIRROR FOR SEARCH-LIGHTS

EVER since the introduction of searchlights for battleships, attempts have been made from time to time to substitute metallic mirrors in place of glass ones, which are unsatisfactory, due to the fact of their being so readily broken by concussion when firing the guns, and that the silvering at the back of the mirrors is very liable to blister and leave the surface of the glass. The difficulty of making true parabolic mirrors has been overcome by the Cowper-Coles Electrolytic Process, which briefly consists of depositing by chemical means on the convex side of a glass former or mould a thin silver film and then spinning the former in an electrolytic cell charged with copper anodes and a copper electrolyte so as to deposit the copper on the silver surface, the process being continued until the silver film has received a sufficient thickness of copper to give the desired rigidity to the parabolic mirror. The glass mould and the electro-deposit are then removed from the depositing cell and placed in a vessel containing cold water, the temperature of which is gradually raised until the expansion of the copper is sufficient to cause the metallic mirror to leave the glass former. The silver-faced mirror thus produced has as highly polished a surface as the glass, and is finally subjected to an after-treatment to prevent the silver from tarnishing and then mounted in a metallic ring (which fits in the projector case) provided with knife edges, which firmly grip the edge of the mirror without distorting it. A large number of mirrors made by this process have been supplied to the British Government, some of which were sent out to the South African War.

Mr. Cowper-Coles is now introducing a new metallic mirror, which is only partially made by electro-deposition. The mirror has a surface composed of alternate bands or rings of gold and white reflecting surfaces which, it is claimed, give a more penetrating beam of light both at night and in foggy weather. Objects on which such a beam of light is thrown stand out in greater relief than in a light thrown from a silver white metal mirror, and the intensity of the light is so great that it is impossible to aim accurately at the projector. Another great advantage claimed for the new mirrors is that they are not fractured by concussion, and even when penetrated by bullets the area of distortion is very small.

Action against Marconi Co.—Before Mr. Justice Bigham, in the King's Bench Division on Wednesday and Thursday last week, an action by the Buitenlandsche Bank of Amsterdam against Marconi's Wireless Telegraph Co. to recover damages for an alleged breach of contract in connection with the erection of a number of wireless telegraph stations in the Dutch East Indies and the formation of a company to own and work the stations was heard. For the plaintiffs, it was stated that a year ago it occurred to some gentlemen acquainted with the Dutch East Indies that the islands afforded a good field for the operations of a wireless telegraph system, and they applied to the Dutch Government for a concession, and put themselves into communication with the defendants. The result was that in November, 1906, it was agreed between the plaintiffs and the defendants that the former should form a company under Dutch law with a share capital of about £200,000. It was also agreed that the defendants should arrange for the creation of 38 stations, and provide the necessary working capital of the new company up to £50,000. The concession was granted on June 5th, 1907, and according to Dutch law £1,000 had to be deposited, and 10 per cent. of the amount of the subscribed capital of the new company had to be paid. In the previous January the defendants had registered the Sanfil Co., and assigned to them any benefits they were entitled to under the agreement. The £1,000 required as a deposit was provided by the Sanfil Co., but the defendant company lent them the money with which to send the cheque. In the result the concession was cancelled, and the company came to nothing. Defendants said that they were not under any obligation to the plaintiffs until the Dutch East India Co. was formed and in a position to commence business, and that, as they had transferred their benfits and obligations to the Sanfil Co., they were under no liability to the plaintiffs. Mr. Justice Bigham, in giving judgment, said the defendants contended that under the contract they were to be released from liability if they formed a company and assigned to that company all their benefits and obligations under the contract. It was clear that the defendants formed a company called Sanfil, Ltd., and assigned to it all their benefits and obligations under the contract with the plaintiffs, and in his opinion the defendants were under no liability to the plaintiffs in respect of the failure to erect the telegraph stations and to provide the working capital for a company to be formed to take over and work the stations. Therefore, he entered judgment for the defendants, with costs. If the case should be taken further, and his decision was reversed, he assessed the amount of damages to which the plaintiffs would be entitled at £1,000.

CARS FOR UNDERGROUND ELECTRIC RAILWAYS

A LONG report on the design of car bodies for electric underground railways has been submitted to the New York Public Service Commission by Mr. Bion. J. Arnold, and is published in abstract in the *Street Railway Journal* (New York). The following analysis is given of the average time required under present conditions of working on the New York subway with cars of the type shown in Fig. 1:—(1) To open doors of cars after train has stopped—average, 2 seconds: (2) to unload an average of 163 passengers through 14 doors (15 to 20 seconds)

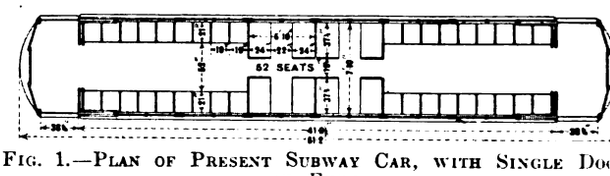


FIG. 1.—PLAN OF PRESENT SUBWAY CAR, WITH SINGLE DOORS AT ENDS.

—average 20 seconds; (3) to load an average of 206 passengers through 14 doors (15 to 30 seconds)—average, 20 seconds; (4) to close the car doors and give the signal by means of bell rope to motorman—average, 13 seconds; (5) total average time of express trains at station platforms between stopping and starting during the height of the rush hours—average, 55 seconds.

By means of the changes in car design recommended in the report, however, it is expected that the following schedule can be obtained without altering the conditions in other respects:—(1) To open doors after train is stopped, 2 seconds; (2) to

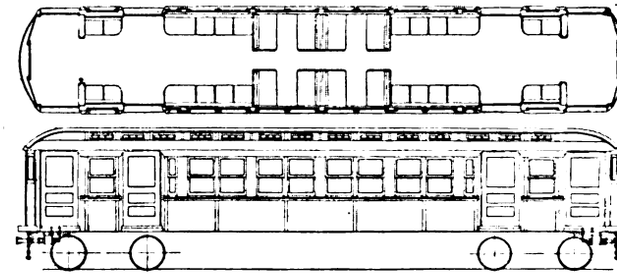


FIG. 2.—SUGGESTED ALTERATION TO EXISTING CAR BY THE ADDITION OF EXTRA DOORS NEAR ENDS.

unload 163 passengers through 14 doors and to load 206 passengers through separate doors, both processes being carried on at the same time, 20 seconds; (3) to close doors and give signal to motorman, 8 seconds; (4) total average time of trains at express stations during rush hours should not exceed 30 seconds.

In a general consideration of the question, the following requirements are laid down for successful working:—(1) Separate entrances and exits; (2) a space which can be cleared so as to be ready to quickly receive the passengers boarding a car; (3) convenient means of circulation inside the car; (4) standing room space contiguous to the exits; (5) as many cross seats as

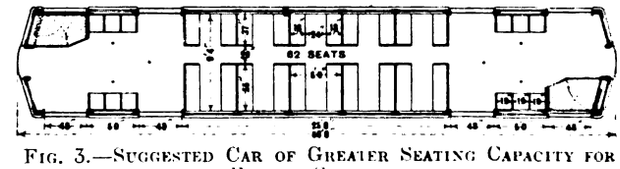


FIG. 3.—SUGGESTED CAR OF GREATER SEATING CAPACITY FOR FUTURE SUBWAYS.

practicable; (6) exit and entrance doors sufficiently removed from each other to allow for the car stopping convenient to guiding rails on the platforms; (7) doors located so as to minimise the danger from open spaces at curve platforms.

A number of types of car in use in America are then considered in some detail and compared, including cars with central side door and end doors, cars with two quarter side doors, cars with three doors near centre, cars with multi-side doors, and cars with double doors near ends.

The final course recommended is the alteration of the existing cars in the manner shown in Fig. 2, by introducing additional side doors, one near each end of each side of the car, and as near as practicable to the present end doors, the distance between the doors being at least sufficient to furnish a pocket for the sliding doors. These additional doors can be added without

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disturbing the present seating arrangement of the car to any great extent. It is true that the introduction of these doors will make it necessary to remove eight seats from each car, but the operation of the cars in actual service will make it possible to pass so many more cars through the subway that the loss of eight seats in the added cars, and the extra standing room, so convenient to the separate exit, is a feature which will decrease the station waits and thereby increase the schedule speed.

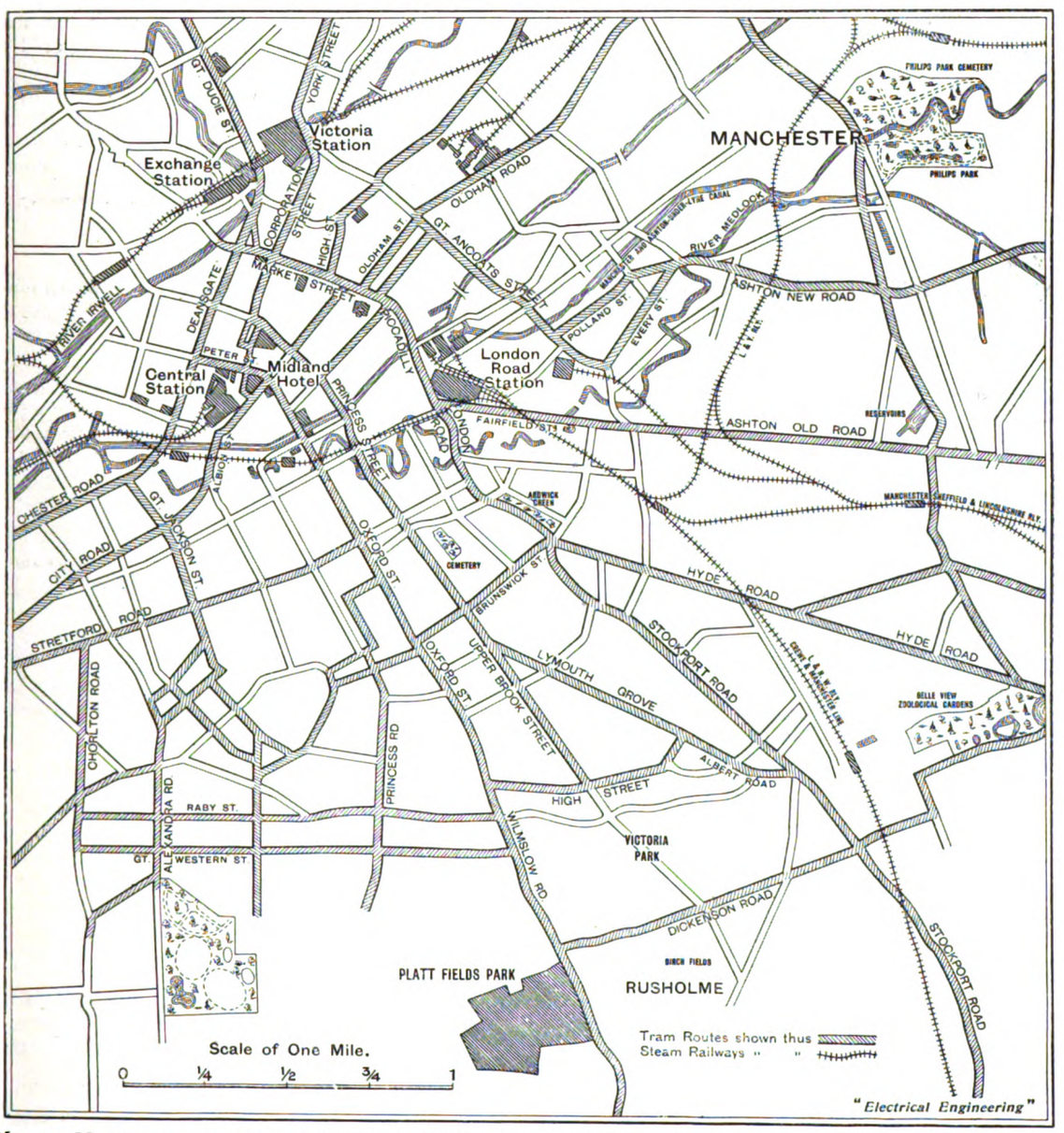
The new doors can be used for exits, and the present end doors for entrances, thus providing at once the means of carrying on the process of unloading and loading simultaneously and without the present conflict which during rush hours has become so objectionable. This car provides a separate space for leaving passengers to collect around the exit doors without blocking the space which should be provided for the passengers entering the car. The result will be that passengers will move in and out much more quickly than at present, and the movement of passengers into the car will facilitate the movement of passengers out of the car.

An advantage over cars with central doors is that the exit and entrance doors are both directly under the eye of the gateman, who can accentuate the circulation by opening the exit door slightly in advance of the entrance door, which can be done by mechanical or pneumatic means.

The seating capacity in future cars of the same overall dimensions, and with the arrangement of doors described, could be increased from 44 to 48 by the provision of more longitudinal seats. But for future subways, the wider type of car, shown in Fig. 3, is recommended.

THE MANCHESTER ELECTRICAL EXHIBITION

In our last issue we announced that final arrangements had been made as to the place and date of the Manchester Electrical Exhibition, which is to be held from October 3rd to October 31st, in special buildings to be erected at Platt Fields Park, Fallowfield, and we are able this week to reproduce a map of Manchester, showing the position of the site in relation to the principal railway stations and tramway routes. This site, which is in the important residential district of Fallowfield, has been offered rent free by the Manchester Corporation, and is easily accessible by tramcar from the centre of the city. The special building which is to be erected is to cover a space of somewhat over one hundred thousand square feet.



Sketch Map of Manchester, showing Position of Exhibition Site at Platt Fields Park, and Principal Tramway Routes.

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As already announced, arrangements have been made with the Electricity Committee of the Manchester Corporation for a full supply of the necessary electrical energy. We now understand that the charge to exhibitors for lighting (at 200 volts continuous current) will be 2d. per unit, and that the rate for power (at 400 volts either continuous or three-phase, or for motors of less than 3½ h.p., 200 volts continuous) will be 1d. per unit. The rent for meter and necessary fuses will vary from one to two guineas, according to the size demanded.

Having regard to the fact that the exhibition is to be held in Manchester, it is proposed to invite manufacturers of textile and mining machinery to be represented, and to arrange for various exhibitors to have working exhibits of such machinery, and owners of works, mills, factories, and mines (of which there are a vast number in the north) will be able for themselves to see exactly how electricity can be applied to the business in which they are interested.

Intending exhibitors are asked to write to this effect at the earliest possible moment, giving some idea as to the amount of floor space that they would desire to occupy, and the class of goods they would show. This will assist in securing a favourable position, and will also assist the committee in arranging the final details of the building, a plan of which, together with rules, regulations, and application form attached, will be circulated.

The profits of the exhibition will be distributed by the committee as follows:—(1) In a percentage return to exhibitors; (2) in a percentage return to contributors and donors; (3) contributions to charities connected with the electrical industry, and the surplus, if any, to be specially dealt with by the committee as they think fit.

NEW TRAMWAY TRACK WORK IN NEWCASTLE-UPON-TYNE

THE vigorous expansion of Newcastle does not appear to be affected by such temporary considerations as engineers' strikes, if one may judge by the remarkable progress which is being made in city improvements. At the present time a new thoroughfare is being opened up in the heart of the city, which will in course of time become one of the main arteries of the commercial portion of the metropolis of the north.

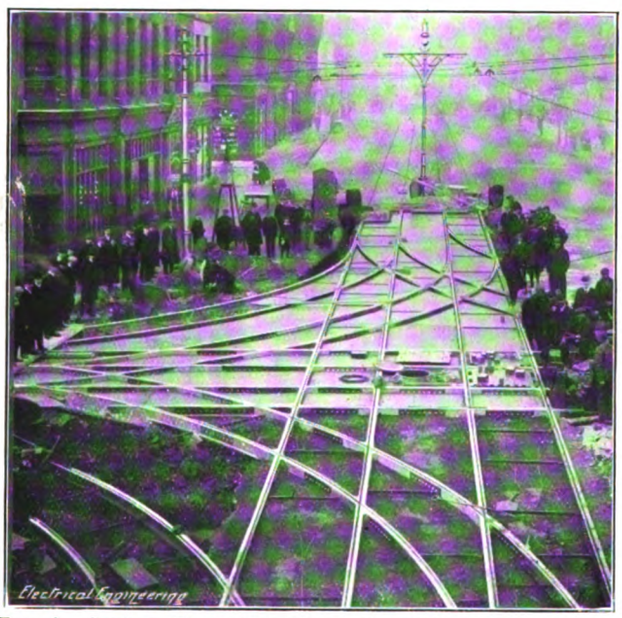


Fig. 1.—Special Tramways Junction at Market Street and Pilgrim Street, Newcastle.

Along this extension, which will possibly be called New Market Street, the tramway authority has already decided to make provision for tramway service, and as a result of this decision it has become necessary to materially alter the permanent way in one of the busiest streets of the city.

A large tramway junction measuring 148 ft. by 143 ft. is being placed at the intersection of Pilgrim Street and Market Street, containing curved tracks on three sides of the main diamond crossing, which is almost at right angles. The total number of crossings is 30. Messrs. Edgar Allen & Co., Ltd., of the Imperial Steel Works, Sheffield, provided all the work for this lay out, executing it in manganese steel throughout. So far as it is known it is the first time that cast manganese steel rails have been used throughout in such a large junction of this nature.

It was decided to place the work down in position, and for this purpose it was necessary to divert four lines of tram routes. Gangs of workmen were placed in continuous night and day operation on the change-over work, the day gang numbering about 50, the night gang 20. In order to facilitate the operations of the latter a series of five enclosed arc lamps were connected by means of a bamboo pole and hook arrangement to the existing trolley wires and to earth, giving an excellent general illumination, and materially assisting operations. As a result, the whole work, involving

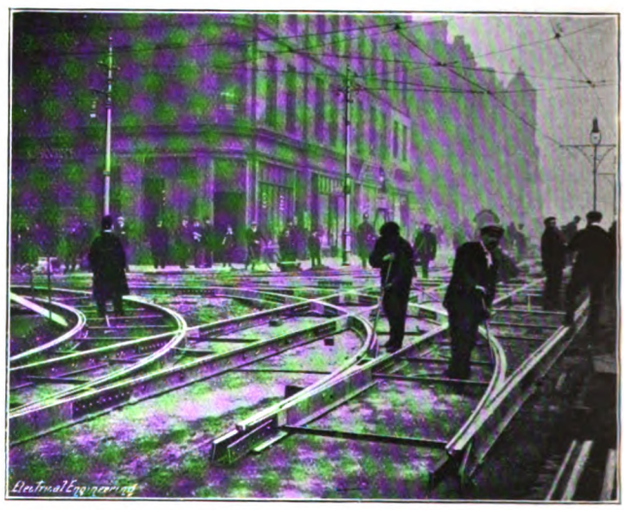


Fig. 2.—Special Junction in Process of Construction.

the diversion of traffic, including the laying of between 400 and 500 square yards of concrete, the steel work, and the filling in of wood pavement, has been accomplished in the exceptionally short time of one week. The credit of this performance is due to the excellent organisation of the City Engineering Department, under Mr. Kirkpatrick, who carried out the work of laying the junction, and the smartness of this achievement is emphasised by the fact that it was necessary to allow certain work connected both with the electric lighting and other companies' mains to be carried out before the completion of the undertaking. As a result, Newcastle will be equipped with one of the finest examples of junction work in the United Kingdom, and the efficiency of manganese cast steel for permanent way construction will be admirably demonstrated. The first illustration which we produce by courtesy of the City Engineering Department conveys an idea of the extent of the work undertaken. The second shows some of the work in course of construction.

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THE ALDWYCH EMBANKMENT L.C.C. TRAMWAY SUBWAY

THE extension of the Kingsway tramway subway from Aldwych to the Embankment, which forms the connecting link between the northern and southern systems of the London County Council tramways, is now complete, and will be formally opened to-morrow, when a special inspection of the subway will be made.

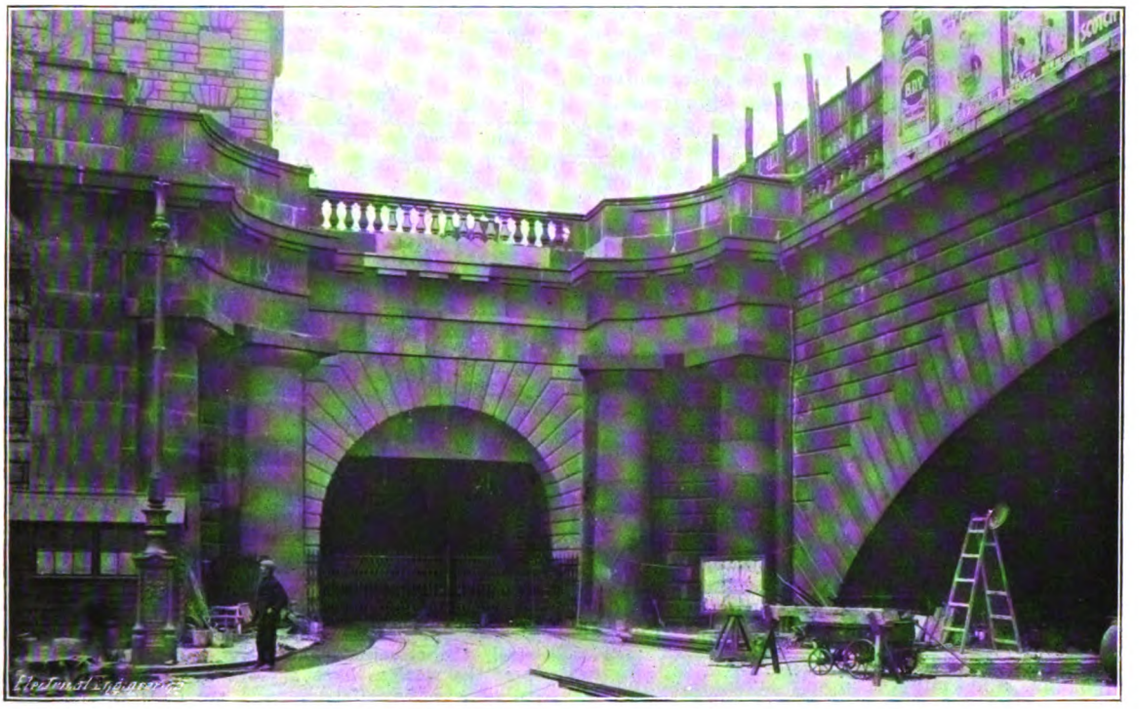


Fig. 1.—Entrance to Subway from Embankment.

Visitors will assemble at the London Day Training College, Southampton Row, at 3 p.m., and will proceed to the Holborn subway station, whence they will proceed by special car through the subway, along the Victoria Embankment, and over Westminster Bridge on an inspection of a portion of the southern system, travelling thence through the subway to the "Angel," Islington, and returning to the Holborn subway station at about 4.30 p.m.

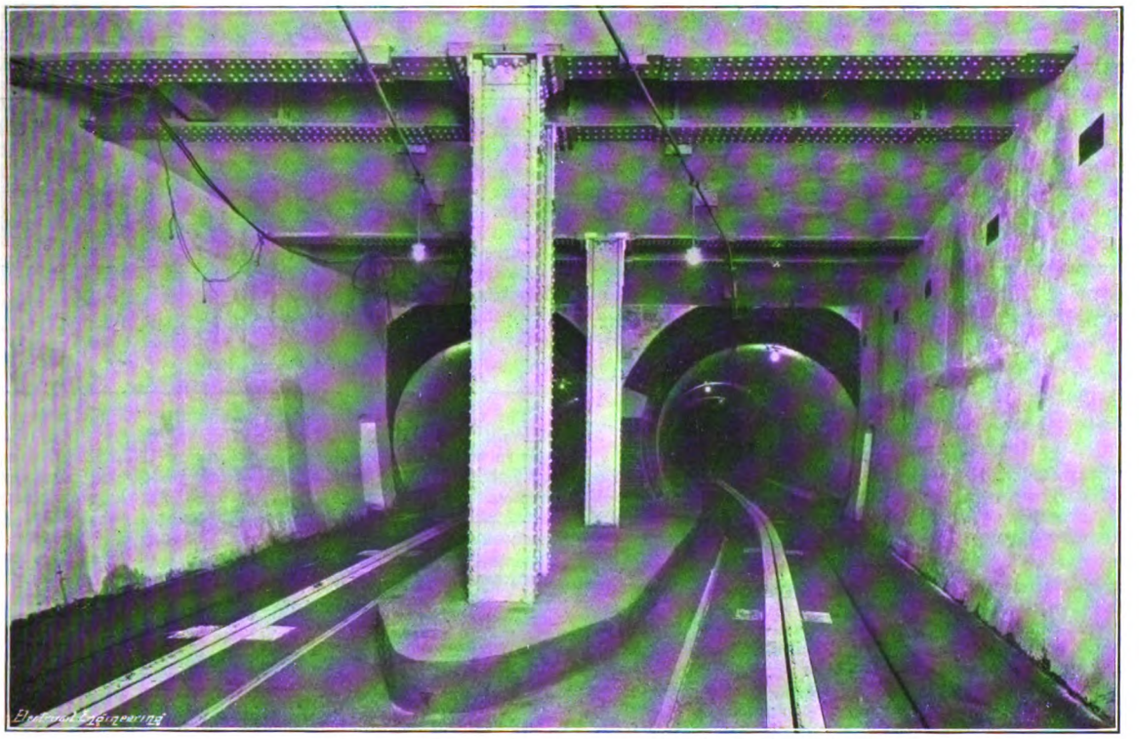


Fig. 2.—Interior of Subway at Entrance of Twin Tube Tunnels.

The main features of the subway and the special form of conduit tramway construction were dealt with pretty fully in an illustrated description in Electrical

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Engineering, March 5th, page 343, when the work was in progress, and we are now able to reproduce a couple of special photographs showing the appearance of the completed subway. Fig. 1 is a view looking across the Victoria Embankment, and showing the entrance to the subway by the side of Waterloo Bridge. Part of the special work of the junction with the Embankment line is seen in the foreground, and the rearrangement of the old stone pillars, &c., in forming the new arch is clearly shown. Fig. 2 is from a photograph taken inside the subway at a point under Wellington Street, about halfway between the Strand and the beginning of Waterloo Bridge, looking in a northerly direction. This shows the point of transition from the double-track form of subway with girder construction to the twin cast-iron tubes through which the lines pass under the Strand to join the double-track section lined with concrete under Aldwych. These tubes are 14 ft. 11 in. in diameter, and this is sufficient to allow even on the curved portion a clearance of 2 ft. all around to cars.

The special form of conduit construction used in the subway was fully described by the aid of detailed drawings in the article already referred to, and the photographs now given serve to illustrate the different arrangement of the slot. The arrangement at the entrance to the subway and across the road seen in Fig. 1 is the standard road construction as used elsewhere in the L.C.C. tramway system, while in Fig. 2 the special construction employed within the subway, where the weight of ordinary wheeled traffic has not to be borne, is shown. In this latter arrangement the standard fixed slot rails are replaced with iron covers 5½ in. in width, of a special bulb angle section laid in short lengths, and supported by special shaped castings at the ends. These can be easily taken up at any time, and uncover practically the whole width of the conduit. Another important difference is the absence of the heavy cast-iron yokes used in the standard construction. Detailed sectional drawings of the two arrangements will be found in Electrical Engineering, Vol. I., page 9, in connection with the Embankment line, and the article on the subway extension in the issue of March 5th, page 343. The double-truck single-deck all-steel cars that will be used on the through routes passing through the subway have already been in use in the older part of the subway and other parts of the system. Their overall length is about 33 ft., and they accommodate 36 passengers. The whole of the track and conduit equipment, and also the construction of the subway, was carried out by the Works Department of the London County Council to the design and under the direction of Mr. Maurice Fitzmaurice, C.M.G., Chief Engineer to the Council, to whom we desire to express our thanks for permission to take photographs in the interior of the subway. The laying of the cables and other electrical details have been under the supervision of Mr. A. L. C. Fell, Chief Officer of Tramways.

Light Railway Order.—The Board of Trade has confirmed the London United Tramways Light Railways (extension of time) Order, 1908, amending the London United Tramways (Light Railway Extension) Order, 1904.

Institution of Electrical Engineers. The following is the result of the ballot for new members at the Institution on Thursday:—Associate Members: L. C. Bose, A. R. Gundry, H. F. Haworth, F. A. King, G. Lloyd-Jones, W. T. MacCall. Associates: F. Berry, A. E. Kiralfy. Students: J. R. Abbott, A. N. Aikman, A. J. Airston, C. G. Barker, R. F. Blackmore, S. H. Bridcut, H. Brittan, W. A. A. Burgess, G. W. Burley, H. Ching, J. Claughton, J. Davies, A. E. H. Dinham-Peren, S. Dudman, K. N. Eckhard, A. C. Evans, W. A. Fletcher, W. B. Garrett, B. C. Gupta, L. G. Harris, C. D. Hayhurst, C. H. Hayward, H. C. Heath, L. R. Hickman, A. R. Hinde, D. W. J. Janes, W. G. Johnson, G. H. Landon, F. C. Lunnon, G. M. Meyer, P. Nutter, D. A. Pearson, G. F. H. Satow, E. S. White, A. M. Willis.

GERMAN ELECTRICITY SUPPLY STATISTICS

A recent issue of the *Elektrotechnische Zeitschrift* contains the statistics of the electricity works in Germany, which are published annually in that journal. According to these statistics, there were in April, 1907, 1,526 generating stations in operation as against 1,334 in the previous year (see Electrical Engineering, Vol. I., p. 733), an increase of 192 as against an increase of 163 between 1905 and 1906. The following tables summarise the information contained in the statistics, and give a good idea of the extent to which the various systems of generation and distribution are in use in Germany:—

Table I.—*Systems of Supply.*

System.	Number of Stations.	Plant capacity, kw. Generators.	Plant capacity, kw. Accumulators.
Continuous current	1,217	178,169	64,853
Single and two-phase...	41	26,201	115
Three-phase	129	151,123	1,536
Combined three-phase and single or two phase	2	975	14
Combined continuous current and single or two-phase...	19	13,828	2,838
Combined continuous current and three phase	116	334,492	58,146
Combined continuous current and alternating (single and polyphase).	2	25,963	588
Totals	1,526	730,751	128,090

Of these 1,526 stations, 1,025 are under State or municipal control, the remaining 501 only being under private control. 634 of the stations have a plant capacity (including accumulators) of less than 100 kw., 625 are between 100 and 500 kw. capacity, and 165 are between 500 and 2,000 kw. Of the 64 stations of over 2,000 kw. capacity, 12 have a capacity of over 10,000 kw. The Berliner Elektricitäts-Werke heads the list with a total capacity of 138,700 kw., which is the combined plant capacity of the six generating stations in Berlin, exclusive of the new 12,000 kw. station at Rummelsburg.

Table II.—*Motive Power.*

Motive power.	Number of stations.	Plant capacity, kw.
Steam engines	669	544,581
Water power	161	16,352
Gas and oil engines	210	25,089
Water power and steam engines ...	288	116,088
Water power and gas or oil engines ...	86	6,681
Steam and gas or oil engines	53	15,952
Steam, gas or oil engines, and water power	27	5,263
Electric power (from another station)	32	745
Totals	1,526	730,751

The total lamp connections amount to 486,828 kw. for incandescent lamps, and 89,456 kw. for arc lamps. The total horse-power of motors connected amounts to 582,862 h.p., equivalent to 524,577 on the assumption of 900 watts per horse-power connected. This gives a total of 1,100,861 kw. connected. The total plant capacity for the 1,526 generating stations, including accumulators, is 858,841 kw.; or 0·78 kw. of plant per kw. connected. It is interesting to note that of the 1,526 generating stations in operation in 1907, over 1,100 were less than ten years old. At the end of the year 1888 only 14 stations were in existence, but the number rapidly increased from that date. In the year 1900 alone no less than 144 new stations were set in operation, this being the maximum number for one year.

Electrification of the Swedish State Railways.—The sum of £210,000, which was granted for the purchase of water-power rights, has already been expended, and the Railway Administration have asked for a further grant of £270,000. The generating stations which will be erected at the waterfalls will give a supply for industrial purposes as well as for the State Railways.

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THE ELECTRICAL EQUIPMENT OF THE "MAURETANIA"

MR. W. C. MARTIN read a paper last Friday before the Institution of Engineers and Shipbuilders in Scotland in which he described the electrical equipment of the Cunard steamer *Mauretania*. Before proceeding to details, he outlined the general history of electric lighting on board ship from the first vessel to be fitted, the American steamer *Columbia*, the lighting of which, by 115 10-c.p. lamps, was carried out under the direction of Mr. Edison in 1880. In order to give some idea of the great progress this branch of electrical engineering has made within the last 26 years, he mentioned that the total cost of the installation on each of the latest Cunarders was £65,000.

Generators.—In the *Mauretania* the total output of the four electric generators is about 2,200 E.H.P., while the actual power required for all the lights and motors running at one time is 2,773 h.p. It is found in general practice that, the power being very intermittent, two generators are capable of doing the work, thus leaving a large margin in hand for emergencies. To find space for such powerful plant and to fit the installation on the safest and most reliable system, presented some interesting problems. The first of these was to determine the most suitable type of steam generator. After due consideration, the Cunard Co. and the builders of the vessel decided to adopt the steam turbine, by the use of which the space required was reduced to a minimum, with less weight and more freedom from noise or vibration as compared with ordinary high-speed engines. There are four sets of Parsons' turbo continuous-current generators. Each dynamo is shunt wound and is capable of giving an output of 3,750 amperes at 110 volts and 1,200 revolutions per minute. These generators are placed on an elevated platform abaft the engine-room, in two separate compartments divided by a water-tight bulkhead and arranged so that, in the event of either dynamo room being flooded with water, the ship could still be lighted from the unflooded side. A better arrangement for the generators would have been to place them nearer the centre of the ship, but being a vulnerable part, the Admiralty required them to be placed below the water line, hence the reason for placing them so far aft.

Main Switchboard.—To control this great power with safety and efficiency in a confined space exposed to a high temperature and possible trouble from vibration, required controlling switchgear of a substantial design, yet sensitive in action. The main switchboard, Fig 1, is divided into two parts, one section being erected in the port generating room and the other in the starboard generating room. Each board has two generator panels, 12 feeder panels, and one disconnecting panel. Normally the two switchboards are connected together as one board through the disconnecting switches, but may be separated in a moment from *either* room, and each side of the ship operated as a separate installation. The use of fuses for the control of the large currents dealt with would have been inconvenient and unsafe, and instead automatic circuit-breakers (performing the function of both switch and fuse) were fitted. These circuit-breakers are of massive construction, the contact surfaces being pressed firmly together by levers. The make and break contacts are massive carbon blocks, at the extremity of the switch arms, and the main circuit-breakers are so arranged that the flash at breaking takes place in fire-proof compartments well clear of the attendant. To accomplish this object and to make the operation of the switches easy, the handles are placed below and connected to the switches by insulating links behind the board. These switches are held in the closed position by engaging with a trigger which may be released either by hand or by a trip coil. In order to prevent the opening of the circuit breakers during a momentary overload, a relay is introduced which closes the trip-coil circuit when an overload occurs, after a period adjustable up to 15 seconds. Should, however, a reversal of current through the generator take place, the relay promptly closes the trip-coil circuit and thus cuts the machine out of circuit. The opening of the circuit-breaker in turn breaks the trip-coil circuit, and prevents damage to the coil or waste of energy. The feeder switches are operated in a similar way, but without the reverse current arrangement. They have, however, in addition, a trip coil in series with the main current, adjusted to open the circuit with a greater current than the relay is set to operate at, but instantaneous in action. Thus, should a short circuit or heavy overload occur, and the relay fail to operate, damage to the cables and machinery is effectively prevented. The relay is simple and reliable in operation. It consists of a small motor, similar to that used in meters, through which part of the current is shunted. This motor tends to wind a strong silk cord on to a drum against the pull of a weight fastened to the other end of the cord. The cord passes round a drum to which the contact arms are fitted. When the current exceeds the overload limit, the torque of the motor is sufficient to wind up the cord, and thus close the trip-coil circuits. The adjustments are affected by altering the weights and varying the distance between the contacts.

All the ammeters and voltmeters are of the moving coil type, the former being operated from shunts in the main circuits. By this means it is possible to have the reading instruments in any convenient place, and in the *Mauretania* two instruments are fitted for each machine, one being in the port and one in the

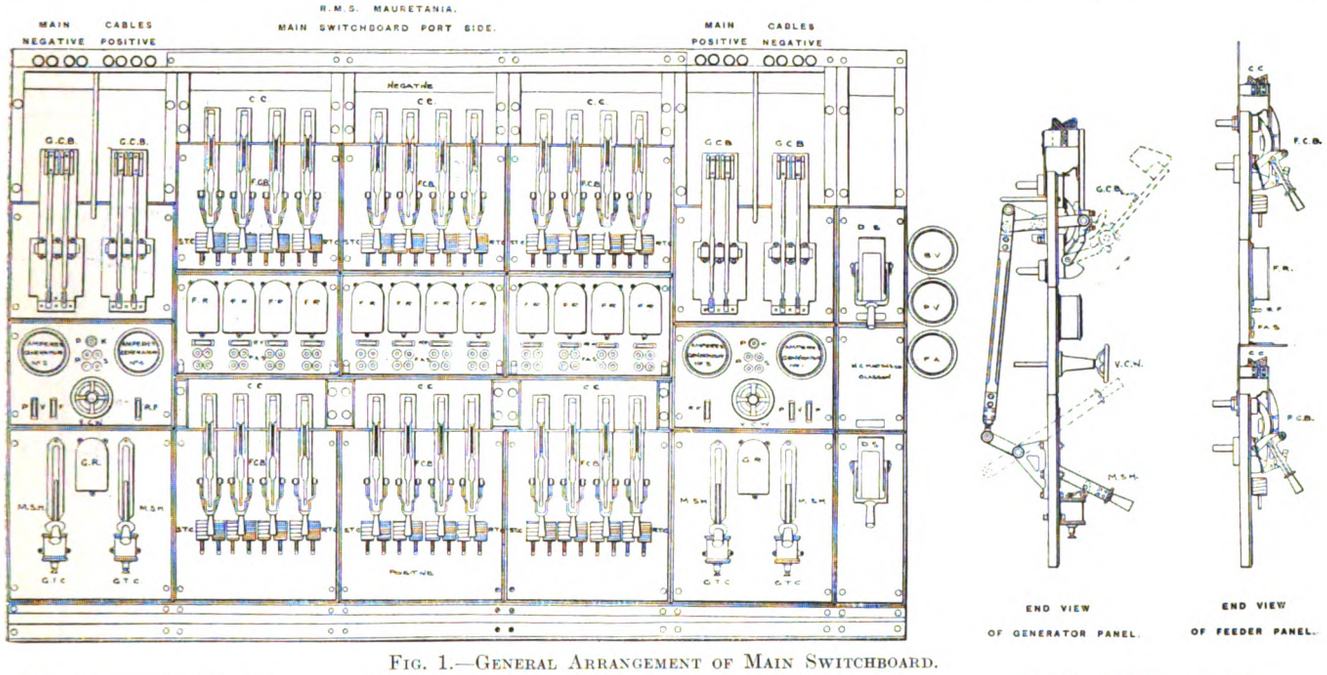


FIG. 1.—GENERAL ARRANGEMENT OF MAIN SWITCHBOARD.

GCB	Generator Circuit Breaker.	*RF*	Relay Fuse.	*FCB*	Feeder Circuit Breaker.	*FAS*	Feeder Ammeter Socket.
PK	Paralleling Key.	*GR*	Generator Relay	*STC*	Series Trip Coil.	*DS*	Disconnecting Switch.
PS	Paralleling Socket	*MSH*	Main Switch Handles.	*RTC*	Relay Trip Coil.	*BV*	Bus-bar Voltmeter.
VCW	Voltage Control Wheel	*GTC*	Generator Trip Coils.	*FR*	Feeder Relay.	*PV*	Paralleling Voltmeter.
PVF	Paralleling Voltmeter Fuse	*CC*	Carbon Contacts.	*RF*	Relay Fuse.	*FA*	Feeder Ammeter.

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starboard room. On each board, one additional ammeter is fitted, connected to bars behind the feeder panels, and so arranged that it may be connected by a plug to any one circuit at a time. By this means the current in any feeder may be ascertained without the expense of separate instruments for each circuit. Two station voltmeters and two paralleling voltmeters are provided, and the shunt regulators, which are placed behind the boards, are operated by a hand wheel on the front.

Main Cables.—The Cunard Company, with their usual precautions for the comfort and safety of their passengers, decided that a high voltage would not be advisable, which accounts for the current being generated at only 110 volts. This necessitated cables of a great carrying capacity, and also very heavy switch gear. The Admiralty further required all main cables to be run under the water line, and to accomplish this it was necessary to utilise the only available spaces in the coal bunkers or through the boiler rooms. Those who have had experience in the lighting of ships will know that these spaces generally are most objectionable for electric wires, especially the coal bunkers. The high temperature of the boiler-room, and the very large cables necessitated special precautions being taken to prevent the heat softening the insulation and allowing the cable to sink through the rubber, causing a short circuit. With

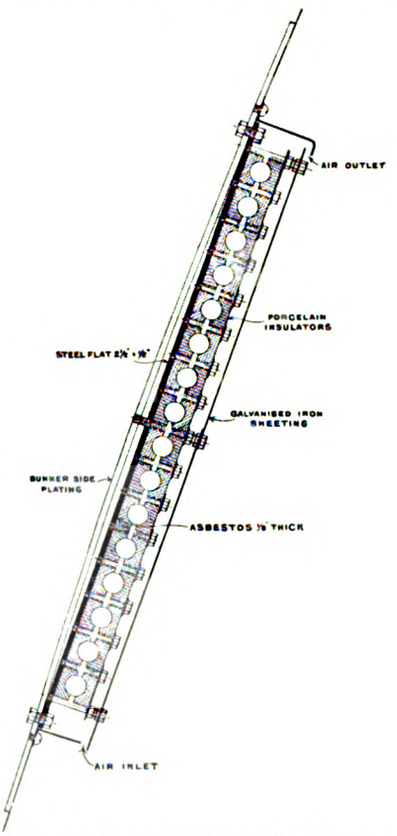


Fig. 2.—Rack for Main Cables on Bunker Side Plating.

ordinary armoured and lead-sheathed cables, the heat would readily affect the insulating materials. It was, therefore, necessary to adopt fire-resisting covering as well as the usual vulcanised rubber, so that in addition there is a heat-resisting compound and an outer covering of two coats of asbestos braid fitted on the cables. Fig. 2 shows the method of fixing and protection of cables. The double wire system is used throughout, and there are 48 main cables of about 2 in. external diameter running from the generating station to the various sections of the ship, Fig. 3. The power is divided into 24 sub-stations of approximately 100 h.p. each, 12 of these being on the port side of the ship, and 12 on the starboard side. Eight of these stations provide power for forced draught fans, two to supply the engine-room machinery, and two for engine-room lighting, the remaining 12 being connected to auxiliary switchboards at convenient distributing centres throughout the ship.

Auxiliary Switchboards.—These 12 auxiliary switchboards are placed directly opposite each other, port and starboard, and cross-connecting cables are fitted so that, in the event of one section failing, the supply can be maintained from the other side. It should be mentioned here that, as the motors are only used intermittently, there is always sufficient surplus carrying capacity in the cables to provide for emergencies of this nature, thus guarding against any total extinction of the light. The auxiliary switchboards are fitted in fireproof chambers, prin-

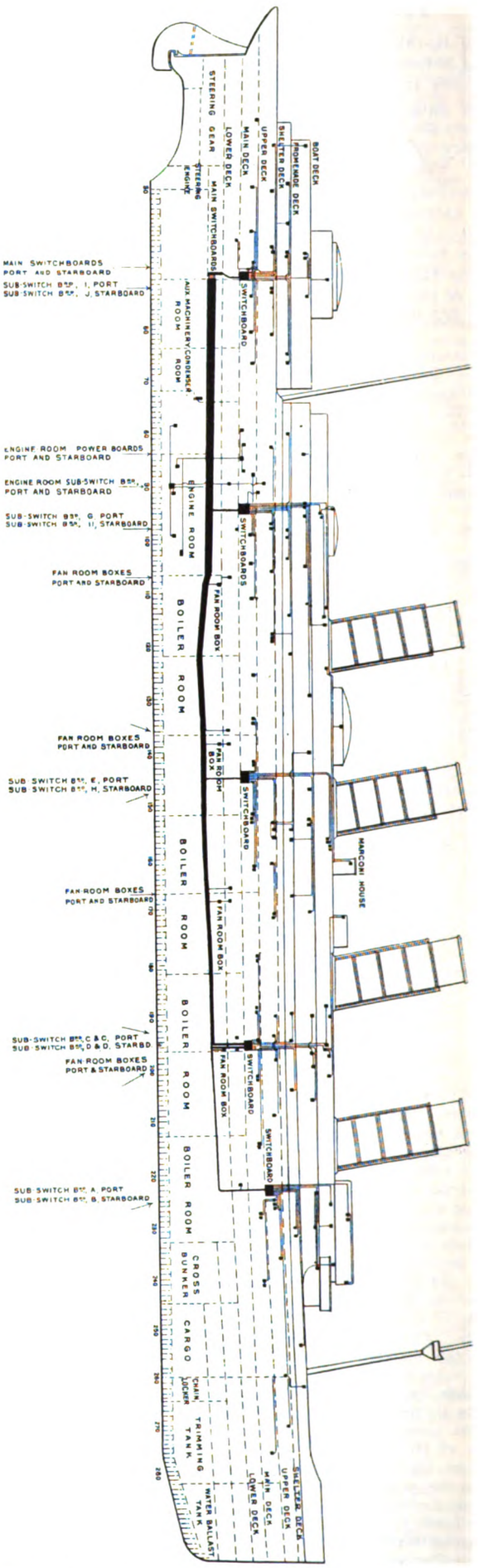


Fig. 3.—Elevation of R.M.S. "Mauretania," showing Position of Main Cables, Switchboards, &c.

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cipally on the main deck. The switches are single pole, and the fuses double pole—Mr. Lackie's patent zinc fuse—which breaks circuit with a minimum flash. Each board is provided with a spare panel containing spare fuses ready at a moment's notice.

Branch Cables and Wires.—From these auxiliary switchboards vulcanised rubber cables are carried in wood casings to section fuse boxes, which again provide distributing boxes at convenient positions for supplying the lights, the wires being run without joints. It will be noticed that these cables running from the main deck to the different sections above are like the trunk of a tree, with branches spreading out to the different decks. Special precautions were taken to keep all positive and negative wires in separate grooves. In the corridors the casings are arranged so that all wires are accessible at all times. In all the rooms of the ship the frieze forms a covering to the electric casings. No fuse boxes have been fitted, but all fuse panels are built in specially arranged recesses in the panelling, the panel itself forming the door; a door is also fitted behind for access to the wires. Inside the door, a tablet or card is fitted, giving information of what each branch supplies, with size of fuse.

In the wiring of engine and boiler spaces, and other parts of the ship exposed to rough work, the protection of the branch wires calls for special treatment. Some engineers think screwed iron conduit or galvanised iron tubes are most suitable, but experience has proved that tubes sweat and retain condensed moisture, which very soon destroys the best insulation. The best results are obtained with parallel twin conductors, each conductor being separately insulated with pure rubber and vulcanised rubber, braided and bound together, then sheathed with an outer armour of galvanised iron wire. This system of armoured twin conductors has special advantages for engine rooms and other exposed parts. It is compact, requires less space, and has as strong a mechanical protection as an iron tube, but does not harbour moisture about the insulation as in the case of tubes. When well coated with paint the armouring is further protected from corrosion. It is water-tight and fireproof, has no soldered joints, and is always accessible. In addition to the lighting and power circuits, there are single core and multiple core cables for electric bells, telephones, fire alarms, electric clocks, and the Stone Lloyd system of indicating the position of water-tight doors. These cables are too numerous to give in detail. There are over 200 miles of wire fitted, the copper in which weighs over 100 tons.

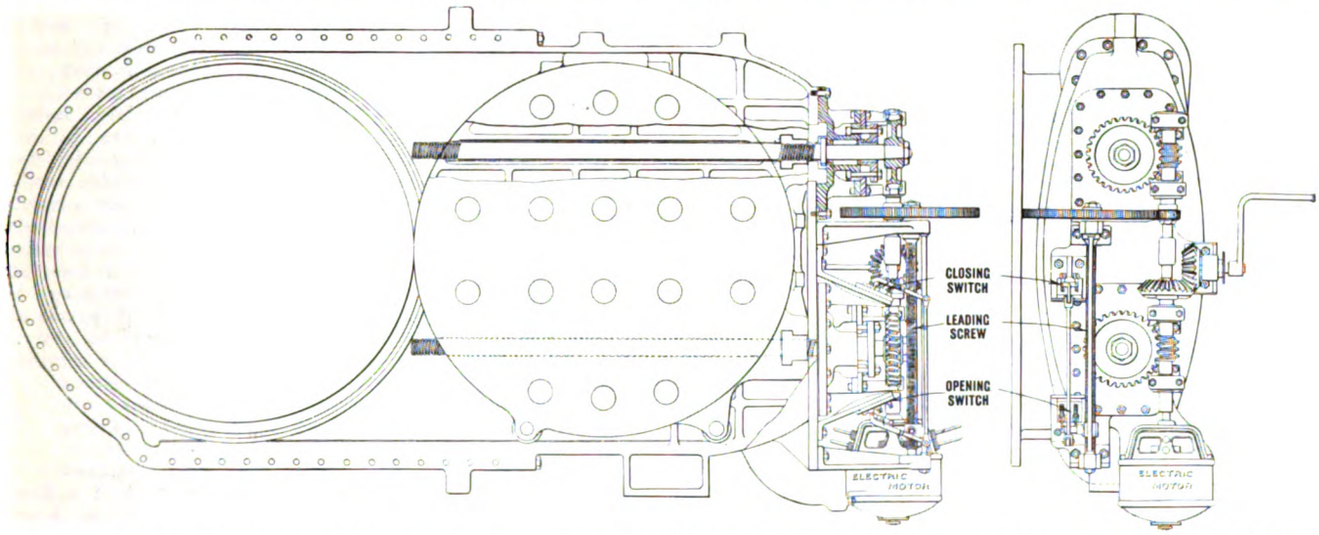


Fig. 4.—Electrically-operated 75-in. Sluice-valve. Closed by Motor Running at 1,150 r.p.m. in 2 minutes. Closed by Hand in about 146 Minutes.

Electric Lighting.—There are over 6,300 lamps distributed over the ship, fitted to pendants, electroliers, and brackets of various designs to suit the furnishings of the respective rooms. In the public rooms and state rooms the fittings are of a most handsome design, and the arrangement of concealed lamps for lighting the dining saloon dome gives a beautiful sunlight effect, while other compartments are brilliantly illuminated with beautiful crystal fittings. A special feature throughout has been to design the fittings so as to obtain reflected lighting from the ceilings as well as from the lamp itself.

Electric Power and Heating.—The Cunard Company and their engineers realised that if steam were used for auxiliary work the loss through condensation in the enormous lengths of steam pipes would be very great, and also that the annoyance to passengers would be unbearable. They therefore took full advantage of the simple and more economical method of distributing the power electrically throughout the ship.

In this installation there are :—16 motors aggregating 800 h.p. for forced draught; 28 motors aggregating 276 h.p. for ventilating of machinery space; 18 motors aggregating 400 h.p. for auxiliary machinery in engine-room; 16 motors aggregating 52 h.p. for ventilating the ship; 53 motors aggregating 156 h.p. for the thermotanks supplying heated air; 4 motors aggregating 64 h.p. for refrigerating machinery; 2 motors aggregating 16 h.p. for two passenger elevators; 4 motors aggregating 108 h.p. for lifeboat winches; 8 motors aggregating 48 h.p. for electric jib cranes; 6 motors aggregating 78 h.p. for mails and baggage hoists; 6 motors aggregating 20 h.p. for hoists and stores; 2 motors aggregating 10 h.p. for printing machinery; 1 motor aggregating 5 h.p. for wireless telegraphy; 20 h.p. for pantry and kitchen service machinery and hot plates; 80 h.p. for 106 electric radiators for special state rooms, bath rooms, and hospital. This makes a total of 2,133 h.p. independent of the supply for lighting.

The forced draught for the main boilers is supplied by 32 fans arranged in pairs, and driven by 16 electric motors of 50 h.p. each; the motors are of the enclosed type, developing the power at 450 revolutions per minute, with the current at 110 volts. The fan impellers are of the single inlet type, being 66 in. in diameter, and each capable of delivering 33,000 cubic ft. of air per minute, against a water pressure of 3¼ in. on the discharge side when running at 450 revolutions per minute. Owing to the high temperature in which these motors have to work, a very ingenious arrangement is provided whereby they may be cooled. Situated between the motor at the commutator end and one of the 66-in. fans, is an auxiliary fan with separate casing, the disc being 48 in. in diameter, and made of sheet brass. The discharge is connected to the under side of the motor and plate, the air being circulated round the commutator and armature, and leaving at the opposite end. Each fan is provided with a water-gauge and tachometer. Each motor is also fitted with a controller or switch capable of regulating the speed in equal increments by field variation from 225 to 450 revolutions per minute. Low voltage and overload automatic releases are fitted to these controllers, giving complete protection to the motors under all conditions. When running at the lowest speed the approximate output of air from each fan is 17,000 cubic ft. per minute, against a water pressure of 1 in. Each fan room is also ventilated by eight single inlet fans 21 in. in diameter, each being driven by a motor of the totally enclosed type, capable of delivering 1,000 cubic ft. of air per minute against a water pressure of 1 in., when running at a speed of 900 revolutions per minute. The motors are of the four-pole series wound type, and are each capable of developing normally an output of 5 h.p. when supplied with current at a pressure of 110 volts, and running at a speed of 900 revolutions per minute. Each motor is supplied with a controlling panel consisting of a one double-pole quick-break switch, tubular fuses, and starting and regulating resistances, the whole being self-contained and mounted upon a panel suitable for erection on the bulkhead.

In the engine-room the electric motor performs a most important part in the manipulation of the main turbines and other gear. For dismantling the turbines there are six sets of lifting gear, each consisting of a 30 h.p. motor, driving a horizontal shaft above the turbine, coupled to two seven-inch diameter

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vertical lifting screws and worm gear, by which means the turbine casing or rotor can be lifted in turn. The weight of the L.P. rotor is about 125 tons and the H.P. rotor 72 tons, and these can be lifted in 30 minutes.

One of the best illustrations of the adaptability and usefulness of electric motors on board ship is to be found in the case of the electrically-controlled sluice valves. There are two 75-in. and two 60-in sluice valves in connection with the high-pressure turbine exhaust steam, and in each of these is fitted a 12 h.p. motor operating a worm gear, as shown in Fig. 4. Each is controlled from switches, Fig. 5, on the starting platform, where an index shows the action of the valve. The fact that the valves can be closed in a minute or two by the electric motor, and that it would take four men 2½ hours to close it by hand, shows a remarkable saving in time and labour in favour of the electric motor. Other useful applications of the electric motor in the engine-room is the 30 h.p. motors installed for the turning gear, and 25 h.p. motors which drive centrifugal pumps drawing off surplus water from the condensers. For ventilating

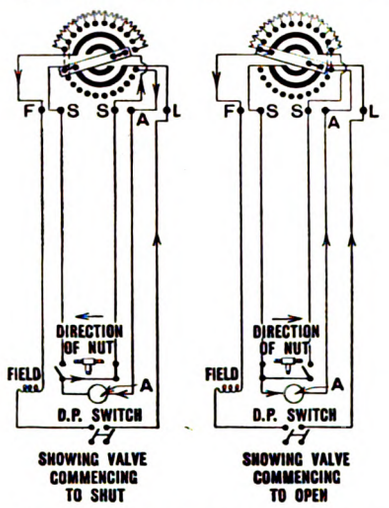


Fig. 5.—Diagram of Connections for Sluice-valves.

the engine-room there are 10 Sirocco fans of 25 in. diameter, each driven by a 5 h.p. motor; six fans of 30 in. diameter, each driven by a 30 h.p. motor; and four fans of 15 in. diameter coupled to 1½ h.p. motors.

The general heating and ventilating of the ship is maintained by 53 thermotanks, each fitted with a motor-driven fan, the motors varying from 2½ to 4 h.p., making a total of 156 h.p. Each motor fan supplies a section of the ship with warm or cold air, or, by arrangement of valves on the tanks, the fans can be made to extract the air from various compartments.

Deck Winches and Other Appliances.—Electric power driving is also extensively used for deck winches, passenger hoists, and other appliances to the extent of 270 h.p. For the passenger lift two motors of 8 h.p. supply the power to the winding gear, while other two motors of 15 h.p. supply the power for two 40-cwt. baggage hoists, and two 5 h.p. motors operate two 10-cwt. store hoists, while two more of 1½ h.p. control the two 2-cwt. pantry hoists for conveying food from the kitchen. There are also two mail hoists fitted with 12 h.p. motors (see Electrical Engineering, Vol. II., p. 885). In addition to these there are four electric jib cranes, each made to lift 12 cwt. The lifting motions are operated by a 12-h.p. motor through worm gear, and the slewing motion through worm and spur gearing by a 2½-h.p. motor, the motors being series wound of the enclosed type. These cranes do their work absolutely without noise of any kind and are conveniently placed on the boat deck for lifting stores, or luggage and mails, from tenders that come alongside. Another important part performed by electric power is the hoisting and lowering of the lifeboats. This work is done by four electric winches placed alongside the lifeboats. The motors attached to these winches are each of 27 h.p., connected to worm gear running in an oil bath. The rapidity with which the lifeboats can be manipulated, as compared by hand, must be apparent to all.

An interesting application of electric driving is in connection with the refrigerating machinery. The two gas compressors are each coupled direct to a 12-pole shunt-wound motor of 35 h.p., giving a constant torque between 40 and 110 revolutions per minute. The armature is provided with two windings, which are in series at starting, and, by turning the hand-wheel on the switchgear, the starting resistance is cut out and a variable resistance inserted in the shunt circuit to regulate the speed between 35 and 75 revolutions per minute. By transposing the armature windings from series to parallel connections without resistance, and by inserting the shunt resistance again, the speed can be increased to 110 revolutions per minute. The two brine pumps are operated by shunt-wound motors of 3½ h.p. each.

In addition to the large number of motors already enumerated, there are still a great number of other applications, but time will only permit me to refer to them briefly. Among these are the motors for driving the printing machine and the Marconi apparatus, of 5 and 3 h.p. respectively, and provision is made by having connections on deck for driving winches of 112 h.p. on the quay or in barges. In the galleys and cooking department an electric motor drives a machine capable of making bread for 3,000 people; and in the cooking ovens there are four vertical spits, driven electrically, capable of dealing with a half-ton of meat at a time; other motors are fitted to knife-cleaning machines, dish-washing machines, circular knives for cutting bacon, potato peelers, whisking machine, freezing machines for making ice-cream, and numerous electric hot plates for keeping food warm during service.

Telephone and Electric Bell System.—Telephone instruments are fitted throughout the first-class state-rooms. Having an exchange on board, passengers can converse with one another without leaving their rooms. On arrival in port the exchange is connected to the Liverpool or New York Exchange, so that passengers may be in communication with their homes or offices up till the hour of sailing or immediately on arrival. Another telephone system connects the captain and officers on watch on the bridge with the engine-rooms and crow's nest on the foremast. These consist of Graham's navy pattern loud-speaking telephones, and are used for docking and steering as well, connections being fitted on the forecastle, in the wheel-house aft, and in the steering-gear room at the stern of the ship. For the officers' use there is an intercommunication telephone service fitted, consisting of the Parsons-Sloper secret instruments, each officer being able to call up another from his own room.

In addition to the telephone system there is a large installation of electric bells with Gents' patent indicators. In every first-class state-room there is a combination fitting of electric bell push, electric light switch, connection for portable reading lamp, or curling tongs heater, and electric fans, while a number of special rooms are fitted with electric radiators. A complete installation of electric clocks is fitted on the magnetic system. In the public rooms and principal entrances and corridors there are fitted in all 48 clocks, controlled from the master clock, situated in the chart-room adjoining the bridge. There is also a complete electric fire-alarm system. A brass plate and red lamp indicate the position of the alarm push in the corridors, these being connected to indicators in the engine-room and the navigating house on the bridge deck. There is also a subsidiary fire alarm apparatus fitted near the bridge, consisting of a small cabinet into which a number of tubes are led from the various holds, a small electrically-driven fan continually exhausts the air from the tubes, and in the event of a fire it would be easily detected from which hold the smoke issued. A mercury-contact type fire alarm indicator is also fitted in the case, which, with the rising temperature, rings an alarm bell. In addition to the ordinary life buoys, there are two special buoys fitted on the bridge deck operated by Martin's electric release gear, which can be operated from various positions.

In connection with the Stone-Lloyd system of water-tight doors, an electric indicator is fitted in the navigating house which shows the position of every water-tight door in the ship. The doors are closed or opened by hydraulic power simultaneously by the officer in charge moving a handle which operates the control valve. The function of the electric indicator is to show the officer exactly what doors are open or closed. The indicator has a small lamp for each door with wires led to a contact switch at the door which, when the door is closed, completes the lamp circuit and lights the lamp.

Another important fitting on the bridge is Martin's automatic indicator for the navigating lamps. The indicator controls five lights, each light consisting of a duplicate filament lamp, one filament being lighted normally. In the event of this filament failing, the armature of a small electro-magnet which is in circuit is released, and falls against an auxiliary contact, which completes a circuit through the remaining lamp filament and through the indicator lamp corresponding to the light affected. Attention is also drawn to the occurrence by an electric horn attached to the indicator. On the officer in charge pulling a handle the horn ceases to sound, and the electro-magnet is inserted in circuit with the second filament; should this latter fail the horn again sounds, and cannot be stopped until the lamp is replaced or switched off. The several lamp circuits are controlled by the slipper switches under the indicator, and the latter is connected through a change-over switch from either the port or starboard feeder systems, thus guarding against a failure in the navigating lights.

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ELECTROLYTIC CORROSION

THE Paper which Prof. W. W. Haldane Gee read before the Manchester Local Section of the Institution of Electrical Engineers last week formed a very complete study of the subject of Electrolytic Corrosion. The author reviewed several aspects of the subject in a general way, and gave the results of numerous laboratory experiments. The influence of the phenomena discussed upon engineering matters was also dealt with. The ordinary phenomena of the corrosion of an anode were first treated, and experiments tracing the anode efficiency for different current densities were described. The remarkable behaviour of some metals in becoming "passive" as anodes under certain conditions was also referred to. Anodic corrosion furnishes convenient methods for the preparation of plating solutions and insoluble oxides and compounds. The anodic stripping of tinned iron is now an established industry. Electrolysis may also be employed for the drilling of holes in hard steel plates, and efforts are being made for the application of anodic etching in photo-engraving processes. Kathode effects are also applied for certain practical purposes. When solutions of alkalies and their salts are used as electrolytes with iron kathodes, the effect of the liberated hydrogen will be to reduce any oxide films and leave the surface clean; beyond this there will be no further attack, for the alkaline solutions have no power of rusting iron. These facts may be utilised for the cleaning of iron and steel articles and for the prevention of corrosion. An electrolytic cleaning process is now coming in favour, and is to some extent replacing the use of acid pickles. Kathodic protection is the method most frequently recommended to protect underground ironwork against stray currents. It may be also used in chemical works and in manufacturing processes where metal is brought in contact with corrosive liquids. H. S. Anderson and J. W. Bennie protect the metallic screens used in mining planta against the action of acids and salts by making them kathodes against a carbon or other suitable anode. They are then able to use steel wire or punched steel screens, which are much less expensive than those made of brass or copper. To prevent the surface condenser tubes from corrosion at the Long Island power station of the Pennsylvania Railroad Company a small booster is used, the negative pole of which is connected to seven points in each condenser. J. H. Schoenberger and G. W. Frazier have designed a method for protecting the metal sheathing of ships by making it a kathode.

The action of the single galvanic couple was then dealt with, and the effect of the potential of the hydrogen at the kathode surface was discussed, and experiments made to test the actual relative rate of corrosion in the case of such couples were described. The effect of oxide coatings in accelerating corrosion was emphasised. Many examples of the disastrous effects of disregarding the principle that the more positive metal is attacked are brought under notice from time to time. Copper-bottomed ships have been the cause of legal action, as at Leghorn, where the ships and vessels lying in the harbour were found to be materially damaged by the galvanic currents set up from the copper bottoms of the yachts, electrical connections being made with the steel vessels through the ropes and hawsers which were used to make them fast to the different buoys. Damage to the ships being proved, the copper-bottomed vessels had to be removed from the harbour. The *Bancroft*, a steel practice cruiser of the U.S. Naval Academy, was abnormally corroded owing to the presence of the *Santee*, a coppered wooden vessel, some 90 ft. away—both being moored by chains to a single anchor. The commission of engineers appointed to investigate the cause of the failure of the Tay Bridge, reported that when cast iron and wrought iron were connected by rivets in many parts of the same structure, the rivets and connecting wrought-iron work had corroded by local galvanic currents. Examples of the use of couples to prevent corrosion are found in suggestions made from time to time for protecting copper surfaces from the corroding action of sea-water by providing the surface with iron strips or rods placed at intervals along it, and in electrical contact with the copper, and the mitigation of boiler corrosion by suspending in the water zinc plates in metallic connection with the boiler. Notes then follow on multiple galvanic couples, and the question whether all corrosion is not really electrolytic is entered into.

The corrosion of iron and steel in air is discussed at some length, and it is pointed out that the crusting of iron, the presence of oxygen, water, and carbon dioxide all together appears to be essential. The author considers that there can be little doubt that the carbon dioxide of the air is an important factor in causing rust. Its solution in water will provide the necessary electrolyte to give a current with the aid of the anodic and kathodic particles in the iron.

The effect of the presence of sulphur dioxide in changing the chemical nature of the corrosion is described, and the importance of the effect of structure, as revealed by the microscope, in determining the extent of corrosion is mentioned.

In speaking of lead, the Paper continues:—Lead is a very durable metal as far as atmospheric corrosion is concerned, but its liability to corrode by the action of the salts in soil, plaster, ashes, and refuse, &c., presents problems to the electrical engineer which cannot be lightly regarded. It is chiefly with the smaller sizes of lead-covered cables that the trouble is noticeable. Many examples can be given of the destructive action of the moisture of walls and the action of organic acids produced by decaying matter. Lead-covered cables are, of course, especially liable to mechanical injury, and probably this is the chief cause of faults. The whole subject has already been brought under the notice of the Institution by Atkinson and Beaver, and they conclude that "extreme care is necessary to avoid conditions which tend to produce lead faults," and they think "that the use of lead-covered cables on large networks carrying heavy currents will probably be limited in the future." Lead being electro-positive to copper and brass the contact of the two must be avoided. The same applies when the copper is tinned. The use of solder always introduces risks if a suitable electrolyte is present, hence the wisdom of the electrical instrument maker in forbidding the use of soldering fluids which contain metallic salts. On the other hand, lead is electro-negative to iron, and should not be used for fixing iron in stonework. These facts are well known, but they are disregarded only too frequently. Galvanic action has been set up between lead and tinned copper wires in the presence of moisture, causing the lead coverings to be corroded through in about two years. In this case the lead had been applied externally directly over the outer conductor.

Aluminium is largely immune from corrosive attack by the atmosphere, owing to the remarkable film of oxide which is always present on its surface. In spite of this, however, aluminium remains electro-positive to iron and copper, hence its contact with these metals must be avoided. Since it is difficult to solder aluminium, if a mechanical joint is made, it is necessary that it should be also of aluminium, otherwise a detrimental electrolytic action may be expected. There is not as yet much evidence as to the durability of aluminium transmission lines, but such experience as there is appears to indicate that it is not suitable for use near the sea coast. The oxide film being of an insulating character, aluminium wire without any other covering may be used for winding coils. The film action gives us the rectifier, the condenser, the controller, and the lightning protector.

In speaking of electrolysis produced by stray currents, the author remarked that the matter was far less serious in this country than either in the United States or Germany, owing chiefly to the limitation of drop of potential imposed by the Board of Trade. Reports of electrolytic injury to pipes come from all parts of the United States. S. Sheldon has given before the American Institute of Electrical Engineers some interesting information regarding Brooklyn, where the P.D. between the rails and hydrants, and the rails and gas mains, may be as high as 25 volts. Between the ends of Brooklyn Bridge a difference of 20 volts has been recorded. Gas services and water-service pipes have been extensively corroded. Cast-iron mains, on the other hand, have been to a large extent immune owing to their siliceous coating. It is mainly at the joints that trouble is found. Measurements made by L. T. Blake upon a line of 6 in. cast-iron water mains, which had been in service for thirteen years, in the case of a length of 339 ft. having nineteen joints gave a resistance of the joints as 88·2 per cent. of the total resistance of the pipe. Electrolytic pittings were found on many sections near the joints, but only on the positive where the stray current was shunted round the joint. The asphaltum coating of the pipe is not a sufficient protection, for under the coating—although apparently intact—pittings are found. C. E. Phelps records that 20 per cent. of the whole faults in underground cables at Baltimore during seven years were due to electrolytic action.

Very complete information as to the magnitude of the effect in Germany is contained in a report of the Deutscher Verein von Gas und Wasserfachmännern, a table from which is reproduced in the Paper, showing in the worst case (at Strassburg) a P.D. of 11·5 volts between pipe and rail. Taking H. F. Parshall's statement that, owing to the great surface of the

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track and the good conductivity of the earth, about one-third of the return current passes through the earth, the question must be asked what proportion of this do neighbouring pipes carry. The experimental answer is that, as a rule, such conductors carry little or no current when the line is worked under Board of Trade conditions. The smallness of this current through cast-iron pipes has been verified by Claude. The current through the pipe is not only small, but only a small proportion of it causes electrolytic effect. Herrick shows that the corrosion of iron only reached 3·5 per cent. of the theoretical loss. The researches of the German investigators have thrown light on the reason of these small losses. The details will be found in two important papers by Haber, first in conjunction with Goldschmidt and then with Liese. Great importance is attached to whether the iron is active or passive. The change from the active to the passive state depends on the current density and the nature of the salts in the soil, the most important being the nitrates. Iron in an alkaline carbonate becomes passive, but in the presence of free carbonic acid it is attacked; on the other hand, the chlorides are always likely to produce corrosion. Generally it is found that the earth conducts electrolytically and not metallically, and its specific conductivity can be calculated from the concentration of the salt solution present in the soil. When the iron is active electrolysis is produced with just sufficient voltage to overcome the hydrogen at the kathode, but since the air of soils acts as a depolariser, this voltage will be small. Finally it is decided that a P.D. of 1 volt will not, as a rule, be harmful.

A serious aspect of electrolysis due to stray currents is the possibility of causing the solution of lead in drinking water. A case of "Plumbism due to Electrolysis" is said to have taken place in the district of the South Hants Waterworks Company. There is, however, some doubt as to whether the cause of the trouble was in reality electrolytic. Fortunately such cases are very rare, and a little consideration will show that the conditions for electrolysis to produce corrosion *within* a pipe must be altogether exceptional. If this arises it must be at the joints. If these are made in a lead pipe the resistance should be low.

Some alarmist statements have been made by Tweedy and Dudgeon on the destruction that is taking place in the overhead equipment of tramways. Through the combined effects of chemical corrosion, local action, and direct electrolysis, a very short life is predicted for overhead work. The author is unable to verify that these troubles are so bad as is represented. Of course, all exposed metal work in a town atmosphere is liable to decay, and constant inspection followed by renewals is necessary, especially in the parts of the town where chemical works are situated. Much may be done in the way of preservation by the use of protective coatings. Eternal vigilance is essential with all town metal work. As to the alleged electrolysis, if we take the leakage current across a span wire as one-thousandth of an ampere, which may be considered a limiting estimate for Manchester, with its triple insulation, then the corrosion of iron or copper will be per month less than 1 gramme, which nevertheless should cause noticeable pitting. This supposes that the whole of the current passes from bare metal to an insulating surface covered with moisture, due to very frequent rain, and that the leakage is continuous. As a rule, the leakage current will be about 1-10,000th of an ampere.

Mr. A. Watts undertook about five years ago a series of tests for the National Telephone Company at Liverpool, Dundee, Sheffield, Leeds, Bradford, and Hull, but found no evidence of sufficient potential differences due to stray currents likely to cause electrolytic trouble. The engineers of the Postal Telegraphs in London are experiencing trouble with small distribution cables, but they find that it can be guarded against by the use of petroleum jelly liberally supplied when drawing in lead-covered cables. Although the Board of Trade conditions have been fulfilled, when the cable sheaths have been cut and an ammeter inserted, readings as high as ¼ of an ampere have been noticed. Currents have also been found on the sheathing of cables on the routes of conduit system tramways with an insulated return. In a recent case, when a cable was damaged, a current of about 30 milliamperes was leaving the cable in the damaged section of the pipe. The local electric supply was alternating, and the nearest tramway (on the conduit system) was two miles distant. There were no works in the neighbourhood to account for the *direct* current which was measured. Stray currents are found circulating in the pipes and cables in every part of the Metropolis.

The question of electrical endosmose is then discussed. The effect is a common cause of faults in buried conductors, which are usually found at the negative main. On the negative side there is a constant strain on the insulation tending to drive water through the insulation to the copper. When the water gets in, electrolysis of the alkaline salts that are in solution takes place, and alkalies or alkaline metals are produced. The free metals in contact with water liberate hydrogen which, when mixed with air, forms an explosive mixture that may have caused some of the mysterious detonations that have taken place in mains. The endosmose trouble will be aggravated at high voltages and may prove an obstacle in high-pressure D.C. systems. C. H. Wordingham has noted that certain makes of rubber are porous, and water may enter and eventually destroy the whole of the rubber on the negative conductors. Some experiments are described in the Paper, showing the variation in resistance of a concrete cable duct due to this cause, and also with concrete blocks and other materials.

The rapidly increasing use of concrete for structural purposes, &c., makes the study of its electrical properties of some importance. Its specific resistance, according to the measurements that have been given in the case of pure cement, vary from 20 ohms per yard cube when wet to 1,900 when fairly dry. The addition of sand does not make much difference when the concrete is wet, but its effect when very dry is to greatly increase the specific resistance. The specific resistance thus depends on the presence of water to a very important extent. The experiments on electrical endosmose show that water may be electrically conveyed and accumulate at kathodes. The corrosion of structural steel embedded in concrete by the action of stray currents is a matter of concern in the United States. Toch has shown that steel embedded in steel can be electrolytically corroded at the anode, but if a good insulating paint be applied to the steel corrosion can be prevented. Some drastic experiments showing the effect of relative large currents on iron in concrete have been described by A. A. Knudson (Electrical Engineering, vol. I., page 564). In the absence of vagabond currents iron in properly made concrete is perfectly preserved without loss of weight, and even if used in a rusty state it will recover after some time the tint which it originally possessed. This almost incredible fact is thought to be due to the action of the cement in forming a protective coating of silicate of iron. Efforts are being made to apply electrical endosmose for the drying of peat, the extraction of sap, and in the processes of tanning.

The Metropolitan Water Board having been successful in forcing the North Metropolitan Electric Supply Company to include in their 1907 Bill a clause by which the company is liable for any electrolytic action from their alternating system has brought under debate the question whether or not alternating currents can produce corrosion. The question is one of considerable scientific interest, and is settled as far as laboratory methods are concerned. Even with a periodicity as high as 600 per second copper can be rapidly corroded in a solution of potassium cyanide. This may be due to the great rapidity of the reaction between the copper liberated during half a period, and the cyanide leading to the formation of complex substances which cannot be decomposed by the reversed current. The periodicity of commercial alternating currents being more of the order of 50, the conditions for corrosion are more favourable, but, fortunately, the salts in the earth have not so far been found to give rise to complexes. On the other hand, it is found that the efficiency of corrosion is very small, and that passivity may be produced and prevent corrosion altogether.

J. L. R. Hayden (Electrical Engineering, vol. I., page 585) has made a long series of experiments with lead and iron electrodes, using solutions of salts contained in the soil, and with the soils themselves, and he finds that the amount of corrosion rarely exceeds ½ per cent. of the amount that would be produced by the equivalent direct current.

The result of some experiments made under the author's direction may be quoted here:—Plates of commercial lead, copper, and soft iron about 5 in. × 1¾ in. × 1·12 in. thick were immersed for 144 hours in either 1 per cent. or 7 per cent. solutions of sodium sulphate, and the value of the chemical corrosion obtained. Pairs of plates, which had been each weighed, were placed in breakers containing one or other of the above solutions. The cells were arranged in series, and an alternating current of 80 ~ and 2·5 (R.M.S.) amperes was passed for 6½ hours. The plates were then withdrawn, washed, dried, and re-weighed. The results are given below:—

Metal.	Solution. Per cent.	Total corrosion in 6½ hours. Grammes.	Chemical corrosion in 6½ hours. Grammes.	Equivalent direct-current corrosion. Grammes.	Percentage of A.C. corrosion to D.C. corrosion.
Lead ...	7	0·038	0·002080	56·50	0·060
Lead ...	1	0·032	0·002030	56·50	0·053
Copper ...	7	0·030	0·000902	17·24	0·150
Iron ...	1	0·061	0·003740	10·70	0·500

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In a second series of experiments a normal solution of sodium chloride was used, and the electrodes were of soft commercial lead and transformer iron. The area of each plate was 100 sq. cms. They were first allowed to corrode for 613 hours, and after being cleaned, dried, and weighed, were submitted in pairs of the same metals to alternating-current electrolysis with a virtual current of 1·5 amperes at 60 ~, the voltage across each cell being 1·5. Gas was observed on all the plates, and in the case of iron a considerable amount of rust was produced whenever a bubble adhered to the surface. The alternating current hence seemed to promote rusting. The lead plates were dipped in very dilute acetic acid before cleaning and drying. The average results are shown below :—

	Hours.	Combined corrosion.	Chemical corrosion.	Current corrosion.	A.C. Equivalent D.C. corrosion.	A.C. corrosion. D.C. corrosion.
		Grammes.	Grammes.	Grammes.		Per cent.
Lead...	15	0·127	0·00510	0·122	81·9	0·015
Iron ...	15	0·075	0·00147	0·073	22·2	0·330

One aspect of the leakage of alternating currents is whether they are capable of rectification by the valve action of certain metals such as iron, lead, and copper. This requires investigation.

An appendix by Mr. S. Butterworth contains a calculation of conductance capacity of an electrolyte due to the presence of galvanic couples of simple geometrical form, and a further appendix describes the following experiments, illustrating what takes place when the anode or the kathode are submitted to electrolysis with a small area and correspondingly high current density. A copper wire was used as an anode in a normal solution of sodium chloride, the kathode being a copper plate enclosed in a porous pot. With a current density of 0·15 amperes per sq. cm. gas commenced to be evolved, and when the current density was increased to 4·48 a loud hissing sound was produced and the anode was rapidly disintegrated. In another experiment a piece of trolley wire No. 0000 was bent in the form of a hook, so that the end could be seen on looking from above. Indiarubber tubing was slipped over the wire to insulate all but the end. The electrolyte was as before, and the kathode was of copper placed in a porous pot. With 114 volts a current density of 9·53 amperes per sq. cm. produced boiling round the electrode, and small sparks appeared at the edges. With 144 volts the current density increased to 10·6, and then a passive stage was reached. On raising the voltage to 150 the current density was only 0·42, but a bubble of gas escaped every half-minute and allowed rushes of current. A brilliant light was produced, which was still more marked at 233 volts. These experiments were made with a battery of storage cells without any external resistance, excepting that of the electrolytic cell. On changing over to the dynamo circuit a lower voltage of 200 gave a current density of 11·6. On changing back to the battery and inserting a choking coil a current density of 11·6 was obtained with 200 volts, when the amount of self-induction was adjusted above a critical point. Continuing the experiments with the dynamo, 300 volts gave current density 27·5, 500 volts of 32·8, and 600 volts of 42·4. At these higher voltages the luminous effects were brilliant, and a loud sound was produced. At 600 volts the current was 40 amperes, so that the electrolytic cell was absorbing 32 h.p. As the containing vessel was only about 1 ft. in diameter and the same deep, the experiment suggests an easy way of absorbing power, but it must be remembered that the current that is produced is a pulsating one. The electrodes were then changed to arc-lamp carbons with the high-current density at the anode; a passive state was reached at 117 volts, when light appeared. From 150 to 500 volts from the dynamo there was a Wehnelt effect. At the last pressure the current was 30 amperes, and the effect very brilliant and the noise violent. On increasing the voltage to 600 the current fell to about 1 ampere, and a slow boiling took place with the production of a yellow light. A second passive stage was thus produced. On reversing the current, the luminous effect resembled a flame arc, and 75 amperes at 400 volts was absorbed.

The final appendix is a bibliography of electrolysis due to stray currents.

DISCUSSION.

Mr. A. Watts (National Telephone Co.), referring to electrolysis due to stray currents, alluded to the experiments mentioned in the Paper which he had carried out some five to eight years ago in Liverpool, Dundee, Sheffield, Leeds, Bradford, and Hull. It would be remembered that when electric traction was first seriously thought about in this country there was somewhat of a scare as to what was going to happen to the different gas and water pipes, &c., owing mainly to alarming stories as to damage from the other side of the water. Amongst other things, the National Telephone Co. have a considerable interest in ducts, and cables underground, and it was determined to make some tests to see what was happening, and also whether the Board of Trade regulations were being carried out with any reasonable amount of care, and the speaker took a series of tests on some of the first systems opened to find out what voltages were present at different parts of the cable system. This was easily done by joining up one of the spare circuits in the cable, so that a connection from almost any point in the town could be obtained in the test-room at the exchange. The case of Sheffield was about the worst. The most important test was from a point 5·6 miles from the centre of the town, where there was a drop on the cable of 1·5 volts when practically the maximum load was on. Readings were taken between the rails and adjacent cables, and the highest readings on the outskirts of the town were about 1·25 volts with the rails positive to the cable, and in the centre of the town within a small area of about a quarter of a mile square there were readings varying from zero to 1·25 volts with the cable positive to the rail. The tests were all repeated when the tramway power station shut down to make quite sure that the readings obtained were due to the tramway currents. They had been told that there were practically no stray currents in the United Kingdom, and that they must go abroad for examples, but he had come across one case some years ago where he had found a considerable amount, viz., on the South Staffordshire tramways system, which was brought into use before the Board of Trade issued their regulations. Between the power station and Darlaston there was a drop of 13·4 volts, and from the power station to the far end of Walsall there was a drop of 16·7 volts. They had only a part of the telephone system underground in Walsall, and as they had no differences of potential in that particular case of more than 3 volts, they left it alone, but he was afraid the water people were likely to suffer before very long. There were two questions he should like to ask :—(1) The author mentioned that the Post Office engineers have obtained some readings of a quarter of an ampere by cutting a lead-covered cable. He would like some further particulars as to how the test was made and the instruments used, and the conditions. (2) With reference to the concrete tests, it struck him that some of the tests made in this case were not quite commercial tests. They were apparently made with standard sand or granite of various kinds, presumably quite clean and free from clay, &c. The ordinary man who was using concrete did not always use such good material, and it might be interesting to compare some commercial concrete with the standard material.

Mr. J. S. Cunliffe also confined his remarks to corrosion due to stray currents. Parshall in England and Claude in France have shown that although comparatively large currents flow in the earth, yet only very small currents (in the neighbourhood of one ampere) are to be found flowing in the pipes alongside the track. He had endeavoured to find the reason for this, and although his experiments were by no means complete, he could suggest a theory. He had made experiments with a view to determining the factors affecting the electrical resistance between two metallic bodies buried in the earth. The general shape of the curves obtained was about the same under all conditions within the range of the experiments. At small distances the resistance was high, whilst at larger distances it was relatively small. With the plates close together the length of the extended stream lines was disproportionately great, so that the effective area of the path was not much greater than the area of the plates themselves. With the plates far apart the percentage increase in length of the extended stream lines was not so great and the effective area of the path was enormous compared with the area of the plates. It thus appeared in the case of tramways that the resistance between the rail and the pipe which is laid beneath the surface of the same roadway was high, whilst the resistance to flow through the earth direct was small. Thus the majority of the leakage current flowed in the earth itself, only a very small percentage flowing in the pipe. Again, between adjacent lengths of a pipe system the resistance to shunting of the current round the joint must be high, and he had himself found this to be as high as 30 ohms with only $\frac{1}{4}$ in. space between the pipes. Thus, even if there is a current flowing in a pipe the resistance of the joint must be very high in order to compel that current to take the earth path. He claimed that no definite information could be obtained from electrolytic surveys. As a matter of fact, the potential difference between a pipe and the rail at any point was greater the smaller the leakage current flowing in the pipe, so that if the latter was zero, the potential difference was equal to the potential difference between that point on the rail and the point where the rail was at the potential of normal earth, *i.e.*, the potential difference between the pipe and the rail had the maximum possible value under conditions of maximum safety, whereas generally this high potential difference was accepted as a sure sign of danger. In speaking of overhead lines he referred to the ordinary insulator bolt. Under the influence of capillary attraction and to a far greater extent of electrical endosmose, water charged with atmospheric impurities was drawn between the iron bolt and the insulating material, and was forced through from the positive metal of the bolt to the negative metal of the hanger. This

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impure water was a very powerful electrolyte, and electrolytic corrosion immediately commenced, and rust was formed in the practically capillary spaces, with the inevitable result that as the rust film increased in thickness the insulation was burst asunder. This applied to practically every form of traction line insulator, and could be remedied by inversion of the insulator bolt, or by reversal of the polarity of the line. This reversal of polarity had the effect also of reducing the current density where leakage currents left an underground pipe, as was shown by every possible method of computation of leakage current density, and since there was far more chance of the pipe metal becoming automatically passive at low current densities, he thought that the suggestion was worthy of consideration.

Professor A. SCHWARTZ showed a sample of an earthing clip, which was very unsuitable from the point of view of electrical corrosion, as there was tinned copper in contact with lead in contact with zinc which was on iron, again in contact with brass. With regard to the life of steel embedded in concrete, a good deal depended upon the nature of the concrete. He had made some experiments some time ago on steel embedded in coke breeze concrete, and had found that after exposure to steam and to air and water with the various strengths of cement and sand and coke breeze which are usually employed, severe corrosion followed in every case. But if the steel were coated with neat cement, then this seemed to exert a considerable protective influence upon it, and he thought in the early days of steel ships it was not an uncommon practice to coat the interior with a rendering of cement. There is one point with regard to the rusting he would like to ask the author. The presence of carbon dioxide seemed to be necessary, and they knew iron and steel had the power of occluding a considerable amount of gas. They could occlude as much as 10 or 12 times their volume of gas. On heating such a piece of iron or steel they found that carbon dioxide was given off at the lower temperatures, and he would like to ask the author whether in his opinion the CO_2 thus given off on heating, even if the surface of the material were protected by paint or some other protective medium, would be sufficient to cause corrosion. In conclusion, he referred to the action of endosmose and the production of metallic sodium and potassium, and consequent explosions in culverts; he thought, however, that this was more due to leakage of gas than liberated hydrogen, as suggested in the Paper. Cases had occurred at St. Pancras and Liverpool.

Dr. C. C. GARRARD (Messrs. Ferranti, Ltd.) criticised the method adopted by Professor Gee in some of his investigations. The true criterion in all electrolytic reactions was not the current density at the electrode, but the potential difference there. Looked at in this light, many curious electrolytic reactions became quite easy to explain. As regards the cleaning of iron articles by means of cathodic action, he had worked out a process for doing this some years ago with the object of removing the rolling scale from rolled steel sections. The steel was used for steam turbine blades, and the rolling process covered it with a hard blue scale, which had to be removed before the machining was done. He used dilute sulphuric acid with carbon anodes, and the process worked very well, the sections coming out of the bath beautifully clean and bright.

Mr. W. CRAMP called attention to the hard coating of apparently black oxide of iron produced on tramway rails, due probably to the constant sparking and rolling occurring under the car wheels. This coating was the very thing that had been sought for so long by gunmakers and others to protect the surfaces of rifles, &c. In the Birmingham Royal Small Arms factory the process used for putting on an oxide coating is kept absolutely secret, and even then the result was poor compared to that to which he referred. He should like to ask if it were not possible to make use of a similar effect to that produced by the tram wheels to design a process for putting a coating upon other articles for general commercial purposes.

Mr. REGINALD PORTER thought the author was somewhat optimistic when he said that one had to go to America to search for electrolytic troubles due to stray currents. He had, in only the last few weeks, come across three separate places in England where trouble from networks of trams was beginning to show. In two of these cases, the damaged cables were the property of municipalities only supplying alternating current, which made it all the more aggravating to the borough engineers concerned. The higher the current density, the greater the electrolytic trouble effects. In the solid system, where the lead was well insulated except at the bridges, water was apt to creep between the bridges and the bitumen, with the result that here and there the insulation at these points broke down, and if there were stray currents, owing to the insulation of the rest of the system, high current densities were produced at these points. For this reason, solid systems must be frequently and carefully earthed. The same, of course, applied to a conduit system, in which one could not rely on the joints being watertight. An engineer had told him the other day that the first time he employed metal bridges he experienced great trouble. The reason was that he had neglected to provide other earths, as he had considered the metal bridges good enough. The earthing provided by the bridges was very poor, and he had to put matters right by carefully earthing as usual. Alternating current electrolysis might be only about 1 per cent. of the electrolysis caused by an equivalent direct current. This appeared at first sight to be negligible, but with alternating currents by no amount of careful earthing can the lead sheath be made negative. So that this form of protection was useless. Alternating current effects with lighting and supply stations only were probably not worth considering, but it would be interesting to see the effect of the increase of single-phase railway systems. Conditions were aggravated in this case by the lower frequency. Mr. Hayden had proved that by superimposing a direct current 3 per cent. to 4 per cent. of the alternating current, electrolysis could be prevented, though he was under the impression that this had not yet been tried in practice.

Dr. E. ROSENBERG (British Westinghouse Co.) said that in alternating current traction, high voltages, such as 6,000 volts, were used, and therefore the current flowing through the rails was comparatively small, so that no great electrolytic action could be expected. He was very glad to find in the Paper actual figures as to the electrolytic action of alternating current. Once he had occasion to see the effect of electrolytic corrosion in the bearing of a three-phase slip-ring crane motor with a two-phase armature, the neutral point of which was connected to the shaft. When in the metallic starter, by a chance, a point of the resistance was earthed, the current flowing through the body of the crane, and through the bearing to the shaft, wore out shaft and bearing rather quickly. He was surprised that the lubricating oil did not insulate, but found that some qualities of oil on the market had so much acid that electrolysis took place to a rather unexpected degree. He saw that Professor Gee accepted the theory that the passivity of an aluminium cell was due to a film of aluminium oxide; but he had heard also of a theory that the effect was due to the accumulation of oxygen gas. With regard to the question of stray currents in Germany, the rules of the German Institution of Electrical Engineers had not been accepted by the Societies of Gas and Water Experts, but both societies had now formed a committee to investigate the matter by experiments and researches before new rules were issued.

Professor GEE in reply said that with respect to the remarks about commercial concrete, he had started with commercial concrete, and obtained such inconsistent results that he thought it would be wiser to use standard materials. The subject in course of investigation really was the resistances of porous materials, especially in connection with electrical endosmose. One point where he found difficulty was the surface drying. This might be very rapid, causing the resistance of the whole block to appear to be extremely high, whereas the inside was wet and of low resistance. He would like to consider further about the rusting of iron due to the occluded carbon dioxide. One must remember that the carbon dioxide was probably in a dry condition. Moisture must be present to form an electrolyte. With regard to current density, Haber and Goldschmidt stated definitely that the production of passivity was a matter of current density rather than of voltage. The oxide film that Mr. Cramp has noticed seemed to be well worthy of investigation, and the action of electric heating and pressure in producing oxides may be important. One speaker said that we were perhaps too optimistic about corrosion in this country. Certainly the rapidly increasing use of electricity in lighting and traction systems in which both direct and alternating currents were used might give us trouble in the immediate future, and it might be necessary to make some modifications in the Board of Trade Regulations. With reference to alternating currents, experiments showed that it was very probable that alternating current might become rectified in the earth.

Indian Telegraph Service.—About six months ago Mr. John Newlands, Deputy Controller of the Central Telegraph Office, London, was sent out to India for the purpose of reorganising the Indian telegraph system. The employees contend that the reforms which Mr. Newlands has introduced are utterly unsuitable to Far Eastern conditions, and the attitude taken up by the telegraph operators has resulted in a complete disorganisation of the telegraph service. It is stated that 2,000 telegrams are held up at Rangoon, and cables from Europe *via* Teheran are seriously delayed from Karachi onwards.

Water Power in Japan.—A report on the possibilities of development of electrical power in Japan appears in a recent American Consular Report. Several sites in the Fiyiyama district have been surveyed, and other sources of power are near Nikko, where Lake Chuzens would form a large reservoir. In the Lake Inœwashiro district some four miles of tunnel would render upward of 50,000 h.p. available. In all, some 300,000 h.p. would be available. All these power sites are located within reasonable distances of Tokyo, the minimum distance being 80 miles, and the maximum 150 miles. It is estimated that the present requirements of Tokyo represent 48,000 h.p., and that plants needing an additional 20,000 h.p. are in process of construction. These figures do not include the electric railway from Tokyo to Yokohama, or the elevated railway which is being constructed by the Government in Tokyo.

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ELECTROCHEMISTRY AND ELECTROMETALLURGY

THAT platinum is more or less attacked by hydrochloric acid when it is made the anode in a solution of the acid is well known, but one would hardly have expected the solubility to be sufficient for the preparation of chloroplatinic acid from platinum scrap. H. C. P. Weber has, however, employed this method for obtaining the fine chloroplatinic acid (*Bulletin Bureau of Standards*, U.S.A., 1908, **4**, 365). The platinum scrap is first dissolved in aqua regia in the ordinary way, and the platinum solution so obtained reduced by means of an alkali formate or with zinc, but preferably with the former. The precipitated platinum, which is in a state of very fine division, is then washed with dilute hydrochloric acid to remove any iron. After this it is placed in the electrolysing cell, which consists of a glass tube 35 cm. long and 4 cm. in diameter. The bottom of the tube has a narrow siphon, 4 mm. in bore, sealed into it. The wide tube forms the anode compartment, and in this platinum is placed, sinking, of course, to the bottom; near to the bottom of the tube a piece of platinum wire is sealed through and comes in contact with the platinum black, and is connected with the positive side of the electric supply. The electrolyte is concentrated hydrochloric acid, as also is the cathode solution.

The cathode is of platinum, and is enclosed in a porous cell placed in the anode solution. The whole apparatus is placed in a beaker, through which cold water is circulated in order to keep it cool. A current of from 8 to 10 amperes is employed. In one experiment, which was run for 4½ hours, 64 grams of platinum were dissolved. If the height of the hydrochloric acid in the cell is properly adjusted, the heavy chloroplatinic acid siphons over as it is formed, and falls out drop by drop into a receptacle placed to catch it. The solution can then be concentrated to any desired strength, chlorine gas at the same time being passed through it to oxidise any platinous compounds which may have been formed.

The manufacture of carbon disulphide in the electric furnace has been carried out for some years now by the Pittsburg Reduction Company, who use the process of E. R. Taylor. In the *Journal* of the Franklin Institute, 1908, **165**, 141, Mr. Taylor contributes an interesting paper upon the subject. The original furnace used had a diameter of 1·2 metres, and was 7 metres high; this was found not to be sufficiently large, as it became very much overheated. It has now been found that by considerably increasing the diameter of the furnace very much better results can be obtained. The present plant had a capacity production of 14,000 lb. of carbon disulphide per 24 hours, but it is now capable of producing another 25,000 lb. in the same time. The electro-thermic process for the manufacture of carbon disulphide appears the most economical and satisfactory, but very large installations are not likely to be fitted up, because of the limited use of the finished product.

Volume XII. of the *Transactions of the American Electrochemical Society* is just to hand, and well maintains the traditions of the Society for interesting publications. The volume consists of 474 pages, which, considering that the *Transactions* are published twice in the year, says a good deal for the vitality of the Society. There is a half-tone frontispiece to the volume, which is printed with "monox ink." Monox or silicon monoxide, it will be remembered, has been recently described in these notes, and is one of the most recent triumphs of electro-chemistry (Electrical Engineering, Vol. II., 382, 878). The majority of the papers in the volume have already been noticed, but we might draw attention to the paper by O. W. Brown and R. R. Sayers on "The Treatment of Storage Battery Elements before putting them out of Commission." Before transport, storage battery plates of stationary cells are usually dried, but drying the elements, unless carefully carried out, may lead to considerable loss of efficiency and decrease in the life of the battery. The authors have made a series of investigations, in which different methods have been employed for drying the plates. The capacity of the plates was first carefully tested, they were then dried, and again set up and the capacity re-tested. In some cases formalin was added to the water in which the plates were washed; this, however, is not to be recommended, as it makes the plates difficult to dry, and the formalin adheres in a very tenacious manner to the material of the plates. Negative plates should always be freed from acid before being dried, otherwise they are apt to crack and sulphate, but it does not seem to do so much harm to positives. It seems best always to thoroughly wash for 12 to 24 hours in distilled water, and then to air dry. The addition of other substances to the wash water would appear to be always disadvantageous.

There is also an interesting paper by G. Gin upon "The Electro-metallurgy of the Rare Metals." This is a long paper of 63 pages, and deals with the metals molybdenum, tungsten, uranium, and vanadium; but the principal part of the paper is devoted to the first-named. The paper is divided into three parts: (1) the concentration and purification of the ores; (2) treatment of the concentrates for the extraction of the metals; (3) the refining of the metals. In this paper is found a very useful description of the various ores of molybdenum, with their properties and distribution. The methods of separating these ores from various other minerals and gangue with which they are mixed are then described. First there is the sieving, then the electrostatic process, the apparatus of Prof. Blake, of Kansas, being described, the principle of which is as follows.

If a solid particle is close to a body which possesses an electric charge, it tends by induction or contact to acquire the potential of this body. During charging the particle is attracted to the electrified body, and when it has attained the same potential it is repelled. The phenomenon is that of the pith ball of Coulomb. This repulsion, however, is exerted at the end of a variable time, which depends upon the capacity of the particle. A powdered mixture brought into contact with an electrified body will possess a particular time factor for each of its particles, which will determine the length of its adherence to the charged surface. For good conductors this time factor is practically zero, but for dielectrics may even reach several days. This being so, one sees that if a fine layer of the powder glides down an inclined metallic surface which has an electrostatic charge, the particles will fall off in certain zones, characteristic of each of the minerals of the ore, owing to their being electrified and repelled in the order of their electrical conductivity and capacity.

Practically the process is worked as follows:—The pulverised mineral is fed in a thin layer by the shakers on to two metallic cylinders, which form the repelling poles and are continually rotated. They are charged by a 350,000-volt current, generated by Wagner's system. By means of a brush the cylinders are continually cleared from the adhering particles. The conducting particles are by this means thrown into a central receiver from which they are removed by a screw conveyor, while the non-conducting particles fall into lateral funnels. With this Blake electro-static separator separation up to 60 per cent. of molybdenite may be made from ores containing only 3 per cent. in the first place. The separator will treat from 10 to 15 tons of ore per day, and requires 3 h.p. The concentration by oil flotation (Elmores process) is also mentioned. Chemical methods of purification are then described, and the processes for manufacturing various molybdenum compounds. Finally, a description of the electric furnace for producing molybdenum is given. The furnace, as he states, differs very little from those at present used for the manufacture of aluminium. Cast molybdenum is made in a furnace similar to a carbide furnace. Finally, the induction furnace method is described. This contribution by Gin is of great interest, and for it he was awarded the Frenzel Prize by the Council of the American Electro-chemical Society.

By a happy arrangement, the members of the Faraday Society receive the *Transactions* of the American Electro-chemical Society, and their American confrères receive the Faraday *Transactions*.

The bi-annual meeting of the American Electro-chemical Society takes place at Albany, N.Y., on April 30th. The titles of the following papers have already been announced:—"Corrosion of Iron from the Electro-chemical Standpoint," C. F. Burgess; "The Electro-chemistry of Light," W. T. Bancroft; "Conduction in Electrolytes," L. Kahlen; "Copper Anodes in Chloride Solutions," P. Dushman; "The Potential of the Nickel Electrode," E. P. Schoch; "Power for Electro-chemical Industries," J. Meyer; and "Industrial Applications of Aluminium," J. Meyer.

ELECTRICAL SCIENCE

British and American

The Helmholtz and Nernst Formulæ for the E.M.F. of a Voltaic Cell.—The well-known Helmholtz equation for the electromotive force of a cell is

$$E = \frac{H}{nF} + T\frac{dE}{dT}$$

where H is the heat of reaction or of dilution, expressed in joules, n is the valence of the cation, and F is the number of coulombs transported by a gram-equivalent of the cation. It is now fully established that the second term arises from the electromotive forces existing at the several thermo-junctions in the cell. Nernst's equation for the E.M.F. of a concentration cell, that is, a cell in which the two electrolytes are solutions of different concentration of the same salt, is

$$E = \frac{R}{nF} T \log \frac{c_2}{c_1}$$

where c_1 and c_2 are the concentrations. In the *Physical Review* of March, H. S. Carhart shows that the Nernst equation is deducible by the integration of the second term of the Helm-

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holtz equation applied to a concentration cell. The Nernst equation is therefore an expression for only that part of the E.M.F. of a concentration cell which is due to electrolytic thermo-electric force. It gives the correct value for the E.M.F. of such a cell only for infinite dilution, or when the heat of dilution is negligible. The author and F. J. Mellencamp have made a series of measurements on concentration cells, made with electrolytes where heats of dilution are known. These measurements constitute an excellent proof of the Helmholtz equation. The agreement between the calculated and observed E.M.F.'s is very close. The mode of calculation can be briefly indicated here. Suppose a cell made up with two solutions, one $ZnSO_4 \cdot 50H_2O$, and the other $ZnSO_4 \cdot 400H_2O$. The act of dilution of the former to the concentration of the latter generates 82 calories. Of course, in the cell, what actually happens is that for every gram-equivalent of metal which passes from the zinc anode into the more dilute electrolyte solution, a gram-equivalent is deposited on the kathode from the more concentrated electrolyte. As the latter operation absorbs less energy than is derived from the former, the surplus energy appears in the electrical form. In the case of the sulphates of zinc and of cadmium, the experiments showed that the E.M.F. due to heat of dilution ranges from 7 to 78 per cent. of the whole E.M.F. of the cell.

A New Magneto-Mechanical Effect.—In the same journal (*Physical Review*, March), O. W. Richardson explains his view that the angular momentum of the atoms of a para-magnetic material ought to be perceptible experimentally. It is widely believed that the resultant magnetic fields which the atoms of magnetic substances possess arises from the motion of their constituent electrons in closed orbits. In a mass of matter which is distant from any magnetic field and unmagnetised, the planes of the electronic orbits may be assumed to be facing all ways, and their summed angular momentum about any axis is zero. If a magnetic field be imposed on the specimen, some of these orbits turn, in a greater or less degree, so as to face along the field. Thus the component of angular momentum of the electrons in their orbit, along the axis of the magnetic field, changes from zero to a finite magnitude. Consider a long, thin cylindrical bar of iron suspended by a fibre passing through its axis of figure so that it is capable of vibrating about a vertical axis. When the bar is not magnetised its constituent electrons will not possess any resultant angular momentum about any axis. Now apply suddenly a vertical magnetic field. The movable orbits will set so as to leave a balance in favour of the plane perpendicular to the direction of the field. This angular momentum acquired by the revolving electrons must be balanced by an equal reaction somewhere. This might be a reaction of electro-magnetic nature on the magnetising system; but the other—and, in the author's eyes—more reasonable possibility is that the expected reaction from the electronic orbit will be effective on the rest of the atom, that is, on the part which is not revolving. In this case the reaction would be made evident by a twisting of the suspended system as a whole. The author computes that the ratio between the resultant angular momentum per unit volume and the intensity of magnetisation is the same for all substances, and is equal to twice the inverse of the ratio e/m for the negative electrons; and, also, that the torsional effect should be easily measurable experimentally. So far as his experiments have gone, there has been no observable effect, but this the author attributes to the difficulty of eliminating disturbing circumstances.

Electric Discharges through Gases.—At the Royal Institution on Saturday last Prof. J. J. Thomson delivered the fifth of the course of lectures on this subject. The lecturer first showed a series of curves showing the relation between spark-length, voltage, and gas-pressure. For a constant spark-length there was a critical pressure at which the spark passed easiest; below this pressure the necessary voltage increased rapidly; above this pressure the voltage depended on the quantity of gas through which the spark must pass—or, in other words, with constant voltage the product of pressure and spark-length must remain constant (Paschen's law). For spark-lengths comparable with the wave-length of sodium light, the voltage was proportional to the spark-length, and was equal to about 1,000,000 volts per centimetre. It had been found that for spark-lengths up to three or four wave-lengths the voltage was independent of the gas used, but above this the gas used made a difference. For instance, the voltage for a spark-length of five wave-lengths was higher for carbon dioxide than for hydrogen. For spark-lengths under six wave-lengths, the voltages were different for different metal electrodes, but above this length the voltage was the same for all electrodes. For solid and liquid dielectrics, the sparking voltage was of the order of 1,000,000 volts per centimetre, as was the case with the above short lengths in a gas. In these cases there could be no ionisation by collision, but the charged particles for carrying the current must be dragged out of the electrode by the intense field. Returning to the question of the discharge through gases at low pressures, Prof. Thomson showed how the chief fall of potential took place near the cathode. If a series of metal discs were interposed between the cathode and anode, the flow of particles was interrupted, and a dark space was formed at each cathode. Each dark space meant a high resistance, and thus the discharge passed easier through the tube without the discs, although the discs were conductors. The dark space near the cathode, the negative glow, the Faraday dark space, and the striæ were due to a particular distribution of electricity in the tube, and the time interval during which this distribution took place between the application of the electric stress and the passage of the spark was quite appreciable. If the discharge was oscillatory—for instance, that from a Leyden jar, there was no time for this distribution, and the discharge was quite different. Goldstein, using this discharge, had found a new line spectrum for the alkaline metals. This form of spectrum had not been obtained with the lighter gases. Prof. Thomson then explained the principle of the vacuum-valve, in which one electrode in an exhausted bulb is enclosed in a narrow tube. This electrode cannot be the cathode, as there is no room for the formation of the dark space. Thus the discharge will only pass through the tube if the other electrode is made the cathode.

Continental

Spectrum of the Singing Arc.—The spectrum of Duddell's singing arc, which sings by resonance, is almost indistinguishable from that of the ordinary arc. But when the singing is obtained in other ways the arc spectrum may come to show all the characteristics of a simple spark spectrum. In the *Atti dei Lincei* for February 16th Michele La Rosa describes this curious phenomenon, which is best observed when a condenser is shunted across the poles of the arc, without any sensible inductance. Not only do the carbons become indistinguishable as positive and negative, but the spectrum breaks up into numerous lines, which are identical with the nitrogen, oxygen, and carbon lines observed in the spark between carbon terminals at ordinary pressures. The electrical mechanism of this change has not yet been cleared up. A gradual restoration of the arc spectrum may be brought about by lowering the capacity of the condenser. The addition of a small inductance to the shunt circuit has the same effect as a great diminution of the capacity. The lines lose their intensity in different degrees, and the carbon bands make their appearance instead. The author intends shortly to publish a more extensive study of this phenomenon.

Mechanical Equivalent of Light.—Some interesting comparisons between the ideal and the actual efficiency of electric lamps are made by C. V. Drysdale in *Bulletin* No. 274 of the French Physical Society. The efficiency of a lamp is the ratio of the light it gives to the energy supplied. This definition suffers from the well-known imperfection due to the colour of the light emitted. Strictly speaking, lights of different colours cannot be quantitatively compared. In comparing two lights of different tints, the only scientific method is to integrate the light over the different wave-lengths, comparing photometrically only the lights of the same wave-length, and adding up the amounts so found. This has to be done over the visible spectrum. The author isolated the latter by a prismatic contrivance, which is more certainly effective than the use of screens. He then measured the radiant energy by means of a bolometer, and the light in the various parts of the spectrum by means of a spectrum photometer. The results obtained with a standard incandescent lamp show that an ideal lamp giving white light would furnish 10 c.p. per watt. This would mean that all the radiant energy would appear in the form of light evenly distributed over the spectrum. For the brightest monochromatic light (540 $\mu\mu$) the amount so furnished would be 17 c.p. per watt.

Gases from Electric Sparks.—In the *Comptes Rendus* for March 23rd, M. de Broglie gives an account of some experiments in which a stream of gas was passed through a small spark gap during a spark discharge between platinum terminals. After passing through the gap, the gas was found to contain a number of gaseous ionisation products, including heavy ions, heavy neutral particles, and a kind of metallic dust. The heavy ions have a mobility of 10 microns per second in a field of 1 volt per cm., and in this respect they closely resemble the slow ions discovered by Langevin in the brush discharge. The neutral particles are easily ionised by the action of radium or X-rays, or by bubbling through water. The metallic dust is especially plentiful when sodium, thallium, or bismuth electrodes are used. The particles are ultra-microscopic, and settle down very slowly. They exhibit distinct Brownian movements. Some of them are electrified, while others are neutral. In the case of sodium, the particles quickly grow into drops when falling through moist air, owing, no doubt, to the formation of caustic soda. These gaseous products produce no cloud in the electric arc after they have been bubbled through water. But they do if the water contains metallic salts in solution. In that case they give the flame spectra of the elements dissolved.

Municipal Exhibition at Sheffield.—At the Municipal and Public Health Exhibition, which is to be held from May 1st to the 12th, a special feature will be the demonstration of methods of measuring illumination. Papers on "Illumination" will also be read at the conference in connection with the exhibition.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published April 2nd, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

5,508. B. G. Lamme. In alternating-current traction systems in which series commutator motors are used, the motors may be operated as generators for braking purposes. According to the present invention, the series connection is broken when it is desired to obtain a braking effect, and the field windings are excited separately, either direct from tappings on the main transformer, or indirectly through an auxiliary transformer. The armature is connected to a braking resistance or solenoids actuating a mechanical braking device. Two claims, three figures.

5,652, V. A. Fynn. Improvements in single-phase compensated series commutator motors of the type in which the main motor field is excited partially by the rotor winding. The power-factor, torque, and commutation are considerably improved by the addition of an auxiliary winding, or by the addition of auxiliary brushes, in such a manner that an auxiliary field is produced along an axis at some angle to the main motor field axis. If, for example, an auxiliary winding is placed in the axis of the compensating winding, a field will be produced at right angles in direction to the main motor field, and by suitably adjusting the phase and intensity of this auxiliary field, the conditions of a two-phase motor are approached. A better utilisation of material as well as improved starting and running are obtained. The specification describes several modifications, besides various methods of exciting the auxiliary field. Twenty-eight claims, eighteen figures.

5,853, A. Steinacker and A. Plisnier. Improvements in systems of wireless telephony with undamped electric waves. The inventors have found that a Cooper Hewitt mercury vapour lamp can be substituted with advantage for the carbon-copper arc used by Poulsen and others. The waves from the oscillating circuit are influenced by means of a strong current microphone connected as a shunt across the terminals of the inductive coil. If a capacity is inserted between the coil and earth, the microphone is connected across both coil and capacity, a better effect being obtained in the latter case. An alternative method consists in influencing the arc itself by means of a strong magnetic field the exciting winding for which is in series with the microphone. Five claims, five figures.

7,933, R. D. Archibald. A petrol-electric system for motor vehicles, in which polyphase electric transmission is used. The petrol engine is coupled direct to the external rotating field system (excited by direct-current from a battery or small generator) of the generator. The internal armature, which is also capable of rotation, is wound for generating three-phase current, and the terminals of this generating winding are connected to the terminals of another three-phase winding on the armature of the motor, which armature is also connected mechanically with the armature of the generator and rotates with it. The other member of the motor is stationary, and can be short-circuited or connected to a variable resistance. There are no brushes or slip-rings, but a switch interposed between the windings of the two armatures, and rotating with them, can open the connection or short-circuit the generating winding. The transmission can be made entirely mechanical by means of a clutch which mechanically connects together the armature and field system of the generator. The engine and field system are kept constantly running. At starting the generator acts partly as motor, but also supplies current to the motor armature. A higher speed is obtained by disconnecting the motor armature and short-circuiting the generator armature. These two speeds are both efficient running speeds, but other speeds are obtained by inserting resistances in either the motor or generator circuit. One claim, two figures.

8,764, British Thomson-Houston Co. (*General Electric Co.*). An automatic starting device for use with polyphase induction motors. The primary circuit is closed by solenoid switches, one for each direction of rotation, and the resistance in the secondary circuit is gradually cut out by another solenoid switch. The connections are so arranged that the primary circuit cannot be closed until the secondary circuit is closed through the entire resistance. No-volt releases are provided to open the primary circuit on failure of supply. Three claims, two figures.

10,440, R. C. Browne. In order to render microphone telephone transmitters more sensitive and to increase the resistance of the same without increasing the amount of granular carbon, the electrodes are, according to this invention, embedded as far apart as possible in the granular carbon so that the current traverses the material in a direction transverse to the line of pressure as applied by the vibrating diaphragm. The active material is arranged in a wide, thin layer between polished walls of some non-conducting material. The ratio of the resistance of the active material to the resistance of the line is thus considerably increased, with the result that the variations in current are greater. The electrodes are so constructed that the current will be densest in that portion of the material which is compressed the most. Six claims, six figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1907 Patents

1,373, Park & Mason. Lighting of railway vehicles.
6,649, British Thomson-Houston Co. (*General Electric Co.*). Compensated commutator machines.
6,854, Schattner & Amberion. Motor switches.
6,906, Keith & Tyson. Series commutator motors.
6,920, Fuller & Fuller. Apparatus for magneto-electric ignition for internal-combustion engines.
6,943, Davy. Electric arc lamps.
7,181, British Thomson-Houston Co. (*General Electric Co.*). Motor control for towing systems.
7,737, R. Waygood & Co. and Bone. Electric lifts.
7,742, Cowper-Coles. Electric furnaces.
8,151, Rawlings & Smith. Supports for electric lamps, shades or reflectors.
10,091A, Sutcliffe. Electric telegraph apparatus.
11,166, Highfield. Generation of high-tension direct current.
11,523, Kneen & King. Tramway conduit points.
12,172, Tatlock & Horne. Fire-alarms.
13,196, British Thomson-Houston Co. (*General Electric Co.*). Electric insulators.
13,739, British Thomson-Houston Co. (*General Electric Co.*). Electric reactances.
14,876, Noeggerath. Dynamo-electric machines.
16,366, Mayo & Houlehan. Motor starters.
16,710, Bruce, Peebles & Co. and La Cour. Dynamo-electric machines.
17,695, Stone. Space telegraphy.
17,769, Morris. Lightning conductors.
18,849, Dussek & Dussek. Laying of underground conduits and conductors.
19,244, Groom. Power storage and safety device for lifts.
19,875, Nobbs & Nobbs. Electric hot water radiator.
20,670, Drault. Mercury interruptors.
20,688, Winton. Controllers for motor vehicles.
20,932, Friedheim. Electrolytic manufacture of honeycomb radiators.
21,670, Allgemeine Elektricitäts-Ges. Motor control.
25,448, Tardieu. Microphones and telephonic receivers.
26,742, Dumaire & Moonen. Sparking-plugs.
27,400, Rawlings & Smith. Box couplings.
27,945, Siemens Bros. & Co. (*Siemens & Halske Akt.-Ges.*). Tachometers.

1908 Patents

220, Nicholson. Selective electric signalling.
1,333, Nicholson. Telephonic receivers.

Complete Specifications open to Public Inspection before Acceptance.

1908 Patents

4,637, Wagner. Electrically-driven trackless train.
4,846, Girlot. Machine for welding rings.
5,318, Swan. Incandescent lamp sockets.
5,610, Allgemeine Elektricitäts-Ges. Incandescent lamps.
5,783, Howell. Incandescent electric lamps.
5,856, Gin. Electric process of singeing textile fabrics.
5,879, Gerhardt. Automatic electrical switch.

Applications for Amendment

Further particulars and instructions as to procedure in opposition to amendment will be found in the Official Journal of the Patent Office of April 1st.

5,104, of 1902. André Blondel seeks leave to amend the specification numbered as above, granted to La Société G. et P. de Mestral, for "Improvements in arc lamps and electrodes therefor." The proposed amendment consists in eliminating portions of the specification, including Claims 3 and 6 to 11, and Figures 10, 11, 13, and 14, and further to insert "we are aware of the Letters Patent No. 16,552 of 1898 granted to Hugo Bremer, and we make no claim to anything therein contained."

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. 1906	Dividend Paid. 1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ld.	10	7	7%	10¾—11⅜ xd	−⅛
Do. 4½% Cum. Pref.	10	4½	4½	10—11	
Do. 6% Cum. Second Pref.	10	6	6%	10½—11	+¼
Do. 4½% Debenture, Red.	Stock	4½	4½	100—103	
Bromley (Kent) E. L. & Power Co., Ld.	5	5⅛	2/-*	4⅜—5⅛	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	96—99	
Brompton & Kensington E. S. Co., Ld.	5	10	10%	7¼—8¼	
Do. 7% Cum. Pref.	5	7	7%	6¾—7¾	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	98—101	
Ch. Cross. W. E. & City E. S. Co.	5	5	5%	3⅜—4½	−⅛
Do. 4½% Cum. Pref.	5	4½	2¼%	4—4½	−¼
Do. 4% Deb. Red	Stock	4	4%	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½	4—4½	−⅛
Chelsea Electric Supply Co., Ltd.	5	4¼	4⅜	3¼—3⅜	
Do. 4½% Deb. Red	Stock	4½	4½	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9⅜—10⅜ xd	
Do. 6% Cum. Pref.	10	6	6%	11½—12⅝	+¼
Do. 5% Deb. Red	Stock	5	5%	123—125	+1
Do. 4½% 2nd Deb. Red	Stock	4½	4½	101—104	
City of Durham E. P. Dis. Co.	5	4	2%	3—3¾	
Do. 5% Pref.	5	5	5%	4¼—4¾	
County of London Elect. Sup. Co. Ld.	10	5	5%	7⅜—7¾ xd	
Do. 6% Cum. Pref.	10	6	6%	10¾—11¼ xd	
Do. 4½% Deb. Red	Stock	4½	4½	106—109	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	97—100	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	¼—1¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	58—63	
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4½—5 xd	
Do. 5% Cum. Pref.	5	5	5%	4⅝—5⅜ xd	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8⅝%	6¼—6¾	+¼
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E. L. Co.	10	10	10%	7⅜—8⅜	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N'tng Hill E. L. Cos. Db. Rd.	Stock	4	4%	97—101 xd	
London Electric Supply Corporation	3	4	2½%	1¼—1⅜	
Do. 6% Pref.	5	6	6%	4½—5	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6½%	5—5½	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D.	100 & 500	4½	4½%	97—100	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	9¼—10¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne El. Supply	5	8	8%	5¾—6¼	
Do. £2 Pm.	5	8	8%	5⅝—6⅛	
Do. 5% Pref. (fully paid)	5	5	5%	5⅛—5⅜	
Do. 10/- Pm.	5	5	5%	5⅛—5⅜	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7%	5¼—6¼	+⅛
Do. 4% Deb. Red.	Stock	4	4%	93—95	
St. James and Pal. Mall E. L. Co. Ld	5	10	10%	7⅜—8½	
Do. 7% Non-Cum. Pref.	5	7	7%	6¾—7	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	½—1½	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	3/-*	2⅝—3⅛	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅜—⅝	
Do. 7% Cum. Pref.	1	7	7%	1¼—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102 xd	
Urban Elec. Supply Co., Ltd.	5	5	5%	1⅜—2½ xd	
Do. 5% Cum. Pref.	5	5	5%	1⅜—2⅝ xd	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90 xd	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¼—8	
Do. 4½% Cum. Pref.	5	4½	4½%	5—5½	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	89—92	
Central London	Stock	4	3%	71—74	
Do. 4% Preferred	Stock	4	4%	82—84	
Do. Deferred	Stock	4	2%	52—55	
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Exst. & Hamp. Pr. Db.	Stock	4	4%	81—84	
City and South London Cons.	Stock	2½	4¼%	39—41	
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1893	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11 o/o	1—1½	
Gt. Northern, Piccadilly & Brompton	10	4	4%	5¼—6¼	
Do. 4% Perp. Deb.	Stock	4	4%	87—90	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1⅝%	41—42	
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½%	71—74	
Metropolitan District	Stock	nil	—	10¾—11⅛	
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Deb.	Stock	4	4%	70—75	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pr. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	40—44	
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/*	⅝—¾	
Do. 5% Cum. Pref.	1	5	5%	1⅜—1½	
Do. 4½% Deb. Red.	Stock	4½	4½%	89—94 xd	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	4—4½	
Do. 5% Perp. Deb.	Stock	5	5%	93½—96½ xd	−1
Do. 4½% 2nd Deb.	Stock	4½	4½%	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4⅜—4⅝	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	98—101	

NAME.	Amount of Share.	Dividend Paid. 1906	Dividend Paid. 1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%	%		
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	96—98 xd	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¾	—	⅜—1⅝	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	7/8—7/8 xd	
London United Trs., Ld., Cm. Pf.	10	5	5%	6—7	+½
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	85 490 xd	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/8—3/8	
Do. 5% Cum. Pref.	1	5	5%	3/8—5/8	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	95—98	−2
National Elec. Construction Co. Ltd.	1	10	2/-	1/8—1/8	−1/8
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅛—1	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	1—⅛	
Do. 3½% Mort. Deb.	£100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	nil	nil	9/16—⅝	
Do. 5% Cum. Pref.	1	5	5%	⅜—7/16	+1/16
Do. Red. Deb.	Stock	4½	4½	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4⅜—5	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	6%	⅜—1⅛	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1⅛	
Do. 6% Cum. Pref.	5	nil	—	3—3½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅜	3½%	55—58	
Do. 6% Pref. Ord.	Stock	6	6%	98—100	
Do. Def. Ord.	Stock	1⅜	1%	13¼—13¾	⅛
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	86—89 xd	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3½—3¾ xd	
Do. 10% Cum. Pref.	5	10	10%	8½—9½ xd	
Do. 4½% Debs.	50	4½	4½%	99½—103½	
Direct United States Cable Co. Ltd.	20	4¼	4⅜%	13⅜—14⅜	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	99—101	
Do. do. (Mauritius Sub.)	25	4	4%	99¼—101½	+½
Eastern Ext. Australasia & China	10	7	7/6	12⅜—12⅝	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5⅜	7%	130—135	
Do. 3½% Pref.	Stock	3½	3½%	84—87	
Do. 4% Mort. Deb.	Stock	4	4%	101—104	+1
G. N. Tel. Co. (Copenhagen)	10	20	20%	31—33	
Indo-European Telegraph Co. Ltd.	25	13	6/-	54—57	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	1/16—1/8	
National Telephone Co., Ltd., Pref.	Stock	6	6%	107—109	+½
Do. Deferred	Stock	5½	6%	108—110	
Do. 6% Cum. 1st Pref.	10	6	6%	10—12	
Do. 6% Cum. 2nd Pref.	10	6	6%	10—12	
Do. 5% 3rd Pref.	5	5	5%	5—5⅛	
Do. 3½% Deb. Red	Stock	3½	3½%	97½—99½	
Do. 4% Deb. Red.	Stock	4	4%	101¼—103½	+½
West African Telegraph Co. Ltd.	10	4	4%	10—10¼	
Western Telegraph Co., Ltd.	10	7	7%	13¼—13⅜ xd	
Do. 4% Deb.	Stock	4	4%	99—102	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	3/16—¼	
Do. 6% Cum. Pref.	1	6	6%	11/16—12/16	
Babcock & Wilcox, Ord.	1	20	10%*	3⅜—3⅝	
Do. 6% Pref.	1	6	6%*	1⅛—1⅜	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	6¼—6⅜ xd	
Do. 6% Cum. Pref.	5	6	6%	5⅝—6¼	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	91—96	+3
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—⅜	
Do. 4% Mo t. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	3/16—7/16	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	77—80	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	63—66	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10¾—11⅛	⅛
Do. 5% Cum. Pref.	5	5	5%	5⅜—5⅝	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106—108	
Consolidated Electrical Co., Ltd.	1	3	3½%	7/8—15/16	
Crompton & Co., Ltd.	3	5	5%	11⅛—11⅜	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1⅛—1⅜	
Do. 6% Cum. Pref.	1	6	6%	1—1⅛ xd	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
Edison & Swan United "A." £3 paid	5	4½	2/6	3—1	
Do. do (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87 xd	
Electric Construction Co., Ltd.	2	—	—	½—⅝	
Do. 7% Cum. Pref.	2	7	—	1⅜—1⅝	
Do. 4½ 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8½	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90 xd	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10½—11½	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5¼	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100 xd	
Tel. Const. & Maintenance Co.	12	15	17½%	31—33	
Do. 4% Deb. Bds. Red.	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres.	1	nil	1/-	1—1½	
Do. 6% Cum. Pref.	5	nil	6%	3¾—4	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

ACTON: *Electricity Losses.*—At a meeting of the Council last week, the following resolution was moved by Councillor Page: "That owing to the great loss in our electricity undertaking, the time has arrived when the Council shall refer to a special committee the best means of disposing the whole scheme to some private company, or at least the possibility of utilising the electric standards for gas and thereby reducing the loss of at least £1,200 or £1,300 per annum on street lighting." In moving this resolution Councillor Page alleged that the total loss in three years upon the undertaking had been about £6,000 a year, and he contended that it was impossible for any engineer to make a profit at 4d. per unit when the energy cost 5d. per unit before they sent it out. During the subsequent discussion a good deal of criticism was directed against the Council for having signed the agreement with the Metropolitan Electric Supply Co., for a supply in bulk, it being stated that the work costs were as high as 3·22d. per unit, and that sooner or later the question of generating their own energy must be considered. An amendment to the resolution that an expert be paid a fee of 100 guineas to report upon the undertaking was carried.

BECKENHAM: *Metallic Filament Lamps.*—The Electricity Committee has recommended that a circular be sent to wiring contractors in the district intimating that the Council reserves the right, without notice, to increase slightly the price of current should the general adoption of metallic filament lamps render this course necessary.

BELFAST: *Tramway Returns.*—The traffic returns for the year ended March 31st, 1908, show that the number of passengers carried was 45,465,204, and the gross receipts £190,766. For the year ended March 31st, 1907, the number of passengers carried was 43,144,418 and the receipts £178,659. The increase in the advertising and Post Office contracts was £675, and there has been, therefore, a total increase in receipts of £12,781.

Cavehill and Whitewell Tramways.—A deputation of residents in Belfast waited upon the Corporation last week with regard to the Cavehill and Whitewell tramways, complaining of the inadequate service upon the lines of the Cavehill and Whitewell Tramways Company. The deputation suggested that some arrangement might be come to between the Corporation and the Company to remedy the present position of affairs. The Lord Mayor replied that although the Corporation thought they had done everything in their power, they would see what could be done further.

BLACKROCK: *New Telephone Charges.*—The Council, as a protest against the new system of charging for telephone service, has decided to grant no facilities to the National Telephone Company so long as the new system of charges is enforced upon the public. This decision was taken as the result of a discussion upon an application by the company regarding the fixing of new poles.

BRADFORD: *Electricity Works Inspection.*—The members of the Council of the Bradford and District Chamber of Trades have been shown over the electricity works, and the opportunity was taken of holding a conference, at which several points of difference between the traders of Bradford and the Electricity Committee were discussed. The result was that the Chairman of the Electricity Committee and the City Electrical Engineer were able to promise certain concessions, and at the same time agree to bring some other points raised before the committee.

Tramway Receipts.—For the year ended March 31st, 1908, the receipts from passengers on the tramway system amounted to £232,013, an increase of £4,518 over the figures for the preceding year. The receipts from the parcels department amounted to £5,739, an increase of £725. The number of car-miles run was 5,331,009 against 5,167,261.

BURY: *The Proposed Electricity Works.*—In response to the expression of opinion at a public meeting recently that the Council should call a meeting of the ratepayers to discuss the proposed new electricity works before the Local Government Board inquiry concerning the loan, the Council has adopted the view of the General Purposes Committee that such a meeting is not necessary. It is stated, however, that the Electricity Committee is willing to receive a deputation on the question. With regard to the cost of the scheme, statements have been made that this will be £100,000, but the General Purposes Committee point out that it is proposed to expend in the first instance £62,000 and to obtain the necessary powers for another £10,000 expenditure on mains for large consumers when necessity arises.

CONWAY: *Damage to Telegraph Cable.*—The Surveyor has reported that while excavating a roadway on March 11th for the purpose of laying the curb of a new footpath on the approach to the Conway suspension bridge, a workman cut through a Post Office telegraph cable with his pick-axe. The man was under the impression that the cable was a disused one, and did not report the accident until the telegraph staff came on the scene in consequence of dislocation of the telegraph service. The Postmaster-General has written a somewhat strongly-worded letter to the Council, pointing out that on the present information it appears that the man at fault is liable to serious penalties under the Telegraph Act, 1878. The letter goes on to say that much difficulty was experienced in effecting the necessary repairs, and the cost of the work will be charged to the Council. The letter concludes with a request to the Corporation to take prompt and effective measures to ensure that there shall be no further interference with the telegraph cables by their employees.

CROYDON: *Tramway Parcels Traffic.*—The South Metropolitan Tramways & Lighting Co. has inaugurated a tramway parcel service upon their cars running between Tooting, Penge, Croydon, Wallington, Carshalton, Sutton, and Mitcham. The packages may be handed to the conductors at any of the recognised stopping places, or may be left with certain agents. The rates vary between 3d. for 7 lb. and 7d. for 56 lb.

DEVONPORT: *Dockyard Power and Lighting.*—It is stated that the change over from steam and gas for driving and lighting purposes to electricity has been completed.

DUMBARTON: *Tramways.*—The work in connection with linking up Glasgow with Dumbarton and Loch Lomond is being proceeded with rapidly, the track being now finished between Dumbarton and Renton.

DUNDEE: *New Tariff.*—The Town Council, acting on Mr. Richardson's recommendation, have now finally passed the new system of charging for power. The price to be charged in future will be on a sliding scale, with a maximum of 2½d., while power will be had at as low a figure as 0·45d. per unit, according to the number of units used. Mr. Richardson also recommended the Council to do away with the minimum charge for lighting and power altogether, and this has been done. A new feature in the scale of charges for next year will be the special price which is quoted for electric signs, and which is calculated to make this form of advertisement more popular in Dundee. Also a specially low rate is quoted for power to textile mills, &c., for which current can be obtained at ·5d. per unit for the units in excess of 50,000 per quarter, and at ·45d. per unit for those in excess of 200,000 units per quarter.

DUNFERMLINE: *The Electric Lighting Scheme.*—The result of the poll of ratepayers at Dunfermline on the question of the policy to be adopted in regard to the electric lighting Provisional Order was that out of a register of about 5,600 only 861 voted. Of these 422 votes were in favour of the Provisional Order being transferred to the Fife Electric Power Co., 323 for the erection of a generating station, and 116 in favour of taking a supply in bulk from the Power Co. A meeting of the Town Council was held on Thursday, when it was stated that a Liverpool firm of electrical engineers had offered to erect a generating station for the Council and give a guarantee against any financial loss. After a somewhat stormy discussion, a resolution that this company be asked for further particulars was carried.

EDINBURGH: *Electric Lighting Debt.*—A joint meeting of the sub-committee of the Electric Lighting and Treasurer's Committees of the Edinburgh Corporation have made a recommendation to the committees in question that in future the period for repayment of capital expenditure upon the electrical undertaking shall be 25 years.

Electric Lighting Reserve Fund.—The Treasurer's Committee recommends the investment of a further sum of £5,900 from the electric lighting reserve fund with the Gas Commissioners at 3½ per cent.

Street Lighting.—The Electric Lighting Committee have recommended that the lighting of Rose Street, a narrow thoroughfare, should be changed from incandescent gas to electricity, the lamps being carried across the street on wires suspended from the buildings on either side.

Electricity Works.—In consequence of complaints with regard to the alleged exceptional amount of Sunday labour in connection with the trimmers and lighting department, the Engineer has been instructed to minimise Sunday labour as much as possible.

FARNWORTH: *Electricity Extensions.*—The plans for the enlargement of the electricity works have been approved. These provide for an extension at the rear of the present engine room which will accommodate the engineers' offices, transforming station, and accumulator room. The new destructor works will be erected at the rear of the boiler house.

ILFORD: *Tramway Running Powers.*—A meeting has taken place between sub-committees of the tramways committees of East Ham and Ilford in regard to the question of tramway inter-communication between the two districts. As a result the Ilford Tramways Committee recommend that it is not desirable to make any alteration in the existing arrangements at present.

LEEDS: *Electricity Tariff.*—As a result of the deputation to the Corporation urging a reduction in the charges for electric power (Electrical Engineering, March 12th, page 414), the Electricity Committee recommend that a reduced scale be adopted based upon the number of units consumed per kw. of the consumers' maximum demand, as follows:—Less than 300 units per kw. per quarter, 1¾d. per unit; from 300 to 450, 1½d.:

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450 to 600, 1¼d.; 600 to 720, 1⅛d.; 720 to 850, 1d.; 850 to 1,000, 0·95d.; 1,000 and upwards, 0·9d. When the units consumed are 375,000 or upwards, but less than 500,000, the charge will be 0·85d., and for a consumption per quarter of 500,000 or upwards the charge will be 0·80d. This, if adopted, will take effect on April 1st, when the cost of current for cooking purposes, &c., will be at the rate of 1½d. per unit.

Tramway Receipts.—For the year ended March 31st, 1908, the total traffic receipts amounted to £336,446 compared with £323,912 for the previous year, an increase of 3·86 per cent. The mileage run was 7,694,989 car miles, compared with 7,358,185, an increase of 4·57 per cent., whilst the number of passengers carried was 75,734,085, against 73,024,853, an increase of 3·71 per cent. The receipts per car mile work out at 10·49d., a decrease of 0·07d. compared with the figure for 1906-7. The receipts per passenger in the two years were practically the same, being 1·066d. for the last year, and 1·065d. for 1906-7.

LEYTON: *Electricity Reserve Fund.*—At the last meeting of the Urban District Council the Electric Lighting Committee, in its report, stated that for the first time in the history of the undertaking a sum of money had been set aside as a reserve fund.

Electric Lighting.—The Electric Lighting Committee has considered the memorial from residents requesting the reconsideration of the charges made for the supply of electricity, and has adjourned the matter for three months. In the meantime the memorialists have been informed that by using the latest types of lamp on the market, and which can be inspected at the Council's premises, they will be enabled to largely reduce their consumption of electricity without diminishing the lighting power obtained.

Tramways.—At the last meeting of the District Council the Tramways Committee recommended that the time having arrived, in their opinion, for reconsideration as to the charge made for the electric current used for tramway purposes, such charge should be reduced from 1¼d. per unit to 1d. per unit. This recommendation, however, was referred back.

LIVERPOOL: *Tramway Pension Scheme.*—The Liverpool Corporation Tramways Committee has approved of a scheme by which the Corporation will pay towards the benefit society in connection with the undertaking an additional 2d. per man. Contributions will also be made by the men themselves, whilst the proceeds of unclaimed property left in the cars is also to be added to the fund. The annual report of the Liverpool Corporation Tramways Benefit Society shows that the total income for the year 1907 was £3,719, and the expenditure £2,764. The amount to the credit of the Society is £7,103, of which £6,800 is invested in Liverpool Corporation bonds. The total membership of the Society is now 1,823, and during 1907 £2,010 were paid in sick allowance, the average per member in receipt of such sick allowance being £2 1s.

Tramway Revenue.—At the last meeting of the Corporation, the chairman of the Tramways Committee, Sir C. Petrie, expressed the opinion that the high-water mark in regard to tramway revenue had now been reached until further extensions were made, but he saw no probability of further extensions at the present.

LONDON: *London County Council.*—At the meeting on Tuesday, Mr. Hayes Fisher, dealing with the estimates of the tramway undertaking for the ensuing financial year, said it was calculated there would be a surplus of £110,883, and deducting £10,000 for contingencies, it was proposed that the whole of the balance of £100,883 should be transferred to the Renewals Reserve Fund. If this estimate is fulfilled, the renewals reserve fund would, at the end of the year 1908-9, amount to £316,808. With regard to the results for the year to March 31st, 1908, Mr. Hayes Fisher stated that the surplus amounted to £66,547, instead of the estimate of £41,788. It was proposed to transfer the whole of the balance, together with the sum of £5,925 brought forward, to the Renewals Reserve Fund. During the coming financial year, £254,968 would be required for repayment of capital. Out of the £8,500,000 capital borrowed for tramway purposes, £1,082,000 has been repaid. While regarding the financial position of the undertaking as satisfactory, the chairman of the Finance Committee said they could not afford to entertain any question of lower fares or extensive additions to the undertaking.

The report of Mr. T. B. Cockerton upon the accounts of the London County Council for the year to March 31st, 1907, has just been received by the Council. Dealing with the tramways accounts, mention is made of the fact that whereas the three revenue accounts, namely, the southern system, northern system, and general account have been amalgamated, separate accounts are being kept of the income and expenditure of horse and electric traction respectively. For the year in question the total receipts from electric traction amounted to £829,259, and from horse traction £585,545, equal to 12·23d. and 10·15d. respectively per car mile. Of these balances £350,839, or 5·17d. per car mile was transferred to the net revenue account in respect of electric traction, whilst upon horse traction there was a deficiency of £11,352, or 0·20d. per car mile. The amount charged against revenue account for the redemption of debt was £153,155, making a total set aside on this account, since the tramways were taken over by the Council, of £603,173, in addition to £209,573, which has been provided out of the proceeds of sales. The renewals reserve fund on March 31st, 1907, stood at £141,855, of which £85,000 is invested in 3 per cent. London County consolidated stock. Mention is made by the auditor that the sum of £55,000 transferred to the reserve fund for the year 1906–7 falls short by about £52,782 of a sum calculated on the basis of 1d. per electric car mile, which is the basis tentatively approved by the Finance Committee for arriving at the amount to be transferred yearly to renewals reserve fund out of the available surplus balance. The total capital expenditure upon the undertaking was at the date in question £2,064,700. The sum charged to tramways capital account in regard to street widening was £58,039, making a total charged at March 31st, 1907, of £190,999.

Caledonian Road and Seven Sisters Road Tramways.—The Board of Trade has intimated its consent to the use of the underground conduit system of electric traction upon these lines.

Hammersmith-Putney Tramways.—The Fulham Borough Council has intimated that it is prepared to agree to the use of the overhead trolley system on these lines.

Harrow Road-Edgware Road Tramways.—The Highways Committee of the London County Council recommends that an arrangement be made with the Metropolitan Electric Tramways, Ltd., for the Metropolitan Electric Tramways Bill, 1908, to be proceeded with, so far as regards the proposed extension of the tramways in Harrow Road to Edgware Road, subject to an agreement being entered into between the Council and the company embodying the undermentioned terms, and to such clauses being inserted in the Bill as are requisite to give effect thereto:—(i.) The company, if and when the lines are authorised, to execute the street widenings provided for in the Bill, and to construct the tramways in accordance with plans and specifications to be previously submitted to, and approved by, the Council. (ii.) The Council to purchase the tramways at the expiration of six months from the date of their completion under section 44 of the Tramways Act, 1870, on the basis of paying to the company the actual expenditure incurred by it in the construction of the tramway and the execution of the street widenings, including such sum not exceeding £4,500, as may be paid by the company to the Paddington Metropolitan Borough Council in respect of the widening of Harrow Road at Pickford's corner. (iii.) The company to enter into a further agreement, the terms of which are to be approved by the Council hereafter, embodying the terms upon which the company shall have running powers over and use the proposed extension to Edgware Road. (iv.) The tramway to be withdrawn from the Bill, unless the terms set out above are agreed to by the company.

Tramway Guide.—The Highways Committee recommend the preparation and issue of a guide to the Council's tramways, consisting of (1) alphabetical list of places of interest in London, together with, in the case of those which are accessible by tramway, an indication of the route by which they may be reached; and (2) a list of the various tramway routes with route diagrams and particulars of car service, fares, &c. The suggestion is to print an edition of 100,000 copies, which shall be placed on sale at 2d. per copy. The cost is estimated at £1,000.

New Tramway Routes.—Two new tramway routes were opened on Saturday, one starting from Brixton Station and running to Victoria Station via Stockwell Road, Vauxhall Station, and Vauxhall Bridge, and the other from Greenwich to the Obelisk at Lewisham, by way of London Road.

Bermondsey.—The Borough Electricity and Street Lighting Committee's estimate for the year ending March 31st, 1909, amounts to £10,253 for street lighting, and £5,221 for the dust destructor. The increase in connections to the mains for the year ended March 31st last was equivalent to 578kw., and the motive power connected for the year was equal to 519 h.p.

Brixton-Camberwell Tramways.—The Highways Committee recommend that the provision of trolley standards for the cars intended to run upon the Brixton Road—Camberwell Green route shall be carried out by the direct employment of labour at an expenditure not exceeding £350. The cost of equipment is estimated not to exceed £25 per car.

Finsbury: Tramway Speeds.—The Borough Council has received a communication from the Board of Trade, enclosing copy of a letter received from the L.C.C. upon the subject of the speed of electric tramcars in Goswell Road, and stating that the Board see no reason to vary the speeds to be imposed by the regulation and by-law recently issued. It has been pointed out that the rate of speed allowable is 16 miles per hour in certain parts of the road.

Lewisham: Overhead v. Underground Telegraph Lines.—The Postmaster-General has forwarded to the Borough Council a notice requiring the latter authority to give consent to the placing of telegraph poles in a number of roads. The Council's Works Committee have had reports before them in relation to proceedings on similar applications to the Woolwich Borough Council, and have come to the conclusion that the Council should adhere to their previous decisions with regard to overhead wires, that the application to the Postmaster-General be refused, and that in the event of application being made to the magistrate, all necessary steps be taken for maintaining the position taken up by the Council.

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Southwark: Electricity Loans.—The Borough Council Electric Light Committee has had under consideration a letter from the Comptroller of the L.C.C. in regard to the accounts of the electric lighting undertaking. The letter points out that all loans which have been sanctioned in the past on the 42 years' system have been so sanctioned on the express condition that if any of the works, plant, or material purchased fail to be renewed during the currency of the loan, the cost of the renewals shall be provided for out of revenue, and shall not be made the subject of a further loan, inasmuch as a period of 42 years is admittedly much in excess of the usual life of plant and machinery. Provision should be made by means of a renewals or reserve fund (which the L.C.C. Finance Committee observed the Borough Council had already established, but which it suggested should be invested to create an effective reserve); that this, however, would not obviate the necessity for making provision for entire replacements, caused through ordinary wear and tear, or through obsolescence by reason of the progress of science. Further, the letter states, the Finance Committee consider the amount to be set aside for renewals should be based upon the life of the various units of plant in accordance with the periods adopted by the Council in 1906 for the repayment of loans, viz.: Land, 60 years; buildings, 50 years; mains, 30 years; plant, 20 years; house connections, 12 years; and meters, 10 years. The Borough Council Electric Light Committee point out that the District Auditor has already dealt very fully with the question at issue, and expressed concurrence in the system now obtaining, and they propose to forward a copy of his report as a reply to the L.C.C. communication.

MAIDSTONE: *Depreciation.*—The Electricity Committee, having gone carefully into the question of depreciation upon the basis of the various periods recommended by the Incorporated Municipal Electrical Association, reports that for the year ended March 31st, 1907, there should have been paid the sum of £2,710 for depreciation, whereas the amount of principal repaid was only £2,458. The Committee recommend that after March 31st, 1908, this difference should be placed to a fund called "Depreciation carried to Reserve Fund." The following percentages have been allowed for depreciation on various parts of the undertaking:—Buildings, 2½ per cent.; machinery, 5 per cent.; mains, 3 per cent.; meters, 10 per cent.; instruments, 10 per cent.; and accumulators, 10 per cent.

MIDDLESBROUGH: *Workhouse Lighting.*—The Electrical Engineer to the Corporation is to be allowed to prepare specifications for the installation at the workhouse of electric lighting.

Electric Lighting Works' Assessment.—In view of the fact that the Corporation is now taking some of its supply from the Power Company, Mr. H. M. Taylor, the Electrical Engineer, has urged the Assessment Committee to reduce the assessment upon the power-house. At present, he pointed out, the assessment is equal to 0·02d. per unit.

NOTTINGHAM: *Electric Light Charges.*—A deputation from the combined traders' associations of Nottingham waited upon the Electricity Committee of the Nottingham Corporation last week to urge a reduction of the present charges for electric supply. The resolution which led up to the deputation was passed at a meeting of the Association in January, and is as follows:—"That this meeting of the representatives of the various traders' associations in the city of Nottingham considers the present system of charging for electricity for lighting purposes most unsatisfactory, and they beg to suggest to the Electricity Committee that in future a uniform or flat rate, not exceeding 3d. per unit, be charged to all consumers, believing that this method of charging would be much more satisfactory to consumers generally."

Nottingham and Derbyshire Tramways.—A conference has been held between the General Purposes Committee and the Nottinghamshire & Derbyshire Tramways Co. with regard to the construction and working of certain tramways within the city of Nottingham, and the transfer to the Corporation of certain of the company's powers, with the result that it has been agreed that the company shall promote a Bill in Parliament with this object in view, and that the Corporation shall support it. The agreement includes the granting of running powers to the company over certain of the Corporation lines, and the tramways which it is proposed to transfer to the Corporation are those for which the company has powers to construct from Carlton, Arnold, and Beeston, joining up all the existing tramways of the Corporation. The company will also endeavour to obtain Parliamentary powers for some other lines which the Corporation will construct.

POTTERIES: *The Tramways Order.*—As the County Council has decided to oppose the Potteries and North Staffordshire Tramways (Amendment) Order, the Stoke Corporation and the other authorities concerned propose to join the County Council in presenting a petition against the Order.

RADCLIFFE: *Electricity Profit.*—The profit for the past twelve months upon the electrical undertaking amounted to between £300 and £400—equal to a penny rate.

SHIPLEY: *Electricity Charges.*—In consequence of complaints from large consumers of electricity, it has been agreed to grant special discounts to consumers for lighting purposes on accounts for over 2,000 and 3,000 units respectively.

SOUTH LANCASHIRE: *Runaway Tramcar.*—One of the cars of the South Lancashire Tramways Co. on the Bolton-Atherton route got out of control on a steep hill near Hulton Park on Thursday, and eventually left the metals and ran into a field. The driver was slightly injured.

STALYBRIDGE: *Runaway Tramcar.*—On Thursday a car belonging to the Stalybridge, Hyde, Mossley, and Dukinfield Joint Tramways Committee got out of control on a hill known as Ditcherott, near Stalybridge, and when near the bottom jumped the metals, and, breaking through a wall, fell into a brook 20 ft. below. The car was of the single-deck type, and the hill in question has a sharp turn at the bottom. Although it is only 250 yards in length, the Board of Trade regulations stipulate four compulsory stops on this incline. Nobody was seriously injured.

STOKE: *Electricity Charges.*—A recommendation by the Electricity and Destructor Committee that in future the price of electricity to consumers within the Borough be 7d. per unit for the first 60 hours per quarter of the maximum demand, and 2d. per unit afterwards, and that no customer shall be charged above an average of 5d. per unit, has been adopted. The previous charges were 7d. and 3d. respectively, without the maximum of 5d.

SWANSEA: *The Electricity Undertaking.*—The Engineer's annual report states that the number of consumers on the books is now 1,124, an increase of 166. During the year only eight consumers have discontinued taking a supply.

Free Wiring.—At the last meeting of the Electric Lighting and Tramways Committee, a discussion took place upon the question of free or assisted wiring. Col. Sinclair, the chairman, stated that he did not think it a wise policy, but a sub-committee was appointed for the purpose of thoroughly considering the matter.

TROWBRIDGE: *Electric Lighting Order.*—The Board of Trade having received an assurance from the company which holds the Trowbridge Electric Lighting Order, that negotiations are now proceeding which will lead to the undertaking being established at an early date. The question of revoking the Order has been deferred until May 31st.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ACCRINGTON.—The Corporation have decided to apply to the Local Government Board for powers to borrow £7,500 for the purchase of electric cables.

CARLISLE.—A Local Government Board inquiry was held on Thursday at the Town Hall into the application of the Corporation for sanction to borrow £5,000 for cables.

BLANDFORD.—At the last meeting of the Council, owing to the unsatisfactory manner in which the gas company is carrying out its contract, a suggestion was made that there was a very good field for a company to start an electric lighting works.

DERBY.—The Tramways Committee recommend further extensions of the tramways at an estimated cost of £5,500.

DUNDEE.—Tenders are invited for the following:—(*a*) steam, exhaust, feed water, and drain piping system, with two steam-driven feed pumps and two hotwell tanks for main generating station: (*b*) equipment of circulating water pump room, including two electrically-driven vertical-spindle centrifugal pumps, in connection with the main generating station; (*c*) circulating water-pipe system (about 1,500 feet long), in connection with the main generating station; (*d*) overhead travelling cranes for main generating station and two sub-stations. Full particulars from the City Electrical Engineer, fee £3 3s., returnable, and tenders to the Town Clerk by April 27th.

ECCLES.—Extensions to the electricity plant at an estimated cost of £4,000 are estimated.

FRASERBURGH.—At a special meeting of the Council last week, a long discussion took place upon the question of acquiring the local gas company. Several of the councillors took the opportunity of urging the claims of electric light, and when a vote was taken it was found that there was not a two-thirds majority, so that the motion was declared lost.

FROME.—The Local Government Board inquiry into the application of the Corporation to borrow £10,000 for the purpose of the electricity undertaking was resumed and concluded last week.

HASLINGDON.—Tenders are invited for overhead tramway lines with tangential suspension, telephone system, and tower wagon. Particulars from the consulting engineers, Messrs. Handcock & Dykes, 1 Victoria Street, Westminster (fee, three guineas, returnable), and tenders to the Town Clerk by April 25th.

HORNSEY.—Tenders are invited for the supply of cable, feeder pillar joint boxes, &c., in connection with a new feeder cable to Muswell Hill. Forms of tender, &c., from the Borough Electrical Engineer (fee, 10s. 6d., returnable), and tenders to the Town Clerk by April 21st.

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LONDON: *Poplar.*—The Electricity Committee invite tenders for the erection of a sub-station building at Millwall in brick, ferro-concrete, or corrugated iron. Full particulars from the Borough Electrical Engineer, fee 5s., not returnable, and tenders to the Town Clerk by April 29th.

Holborn.—The estimate prepared by a special committee of the Borough Council for the provision of furniture and fittings for the new Council chamber and offices, includes £550 for electric light fittings and lamps. The committee propose to obtain and consider prices.

MANCHESTER.—The Tramways Committee invite offers for a quantity of scrap-iron, steel, &c. Full particulars from Mr. J. M. McElroy, General Manager, and tenders to the Chairman of the Tramways Committee, 55 Piccadilly, Manchester, by April 14th.

MIDDLESBROUGH.—New cable is to be laid at an estimated cost of £2,000.

PENANG.—The Council of Georgetown invite tenders for the supply and delivery, f.o.b. British port, for (1) four single-deck open-type tramcars, (2) motors and electrical equipment for same. Full particulars from Messrs. Preece & Cardew, 2 Queen Anne's Gate, Westminster (fee, £1 1s., each section returnable), and tenders by April 15th.

ROTHERHAM.—Tenders are invited for a 500-kw. direct-current, steam-generating and surface-condensing plant. Particulars from the Town Clerk (fee, £2, returnable), and tenders by April 16th.

WALLASEY.—Tenders are invited for the supply of automatic overload and reverse current single-pole circuit-breakers. Particulars from the Engineer and Manager, and tenders to the Town Clerk by April 15th. The Council also invite tenders for the supply of stores during the ensuing twelve months, including switches and cut-outs, meters, cable, and junction boxes, and arc lamp carbons.

WORTHING.—A Local Government Board inquiry was held last week into the application by the Town Council to borrow £1,710 for the purposes of electric lighting. It was explained by Mr. J. Porter, the Electrical Engineer, that one of the principal items for which the loan was required was in connection with the scheme to reduce the cost of street lighting—namely, by the addition of incandescent lamps to the arc lamp standards, which would be automatically switched on at 11 p.m. The estimated saving from this was to be at £700 a year, or a rate equal to 1¼d. in the £. Another item of the loan is for the installation of condensing plant at the generating station.

TENDERS RECEIVED AND ACCEPTED

ADELAIDE.—Acting on behalf of the Electric Lighting & Traction Co., of Australia, Messrs. Kincaid, Waller, Manville & Dawson have placed an order with the Lancashire Dynamo & Motor Co. for a 1,200-ampere 180-volt motor-driven booster.

ASHTON-UNDER-LYNE.—The tender of Messrs. Parmiter, Hope & Sugden, for Ajax motor-starting switches, has been accepted for twelve months from April 1st.

BECKENHAM.—The tender of the Tudor Accumulator Co., at £1,521, has been accepted for a battery of accumulators, and that of the Lancashire Dynamo and Motor Co., at £851 10s., for a booster and switchgear.

BELFAST.—The tender of Messrs. Musgrave & Co., Ltd., has been accepted for gangways and iron railways at the Electricity Works.

BLACKBURN.—The following tenders for stores, among others, in connection with the electricity undertaking, have been accepted:—Watlington & Co. (London), red fibre sheet and presspahn sheet; India Rubber, Gutta Percha & Telegraph Works, Ltd., india-rubber solution; Siemens Bros. & Co., ozokerit tape, non-hygroscopic tape; Ruberoid Co. (London), P. and B. insulating tape and paint; Wells Oil Co., oils; British Insulated & Helsby Cables, Ltd., house service fuse-boxes; Metallic Seamless Tube Co., screwed tubes.

COLCHESTER.—The following tenders have been accepted for the supply of stores to the Electricity Department:—Fuse-boxes, Messrs. Lucy & Co., 2s. 4d. each; prepayment meter installations, Messrs. Joslins, Ltd.; joiners' work, G. Appleton; ironmongery and tools, Williams & Co.; oilmen's sundries, Joslins, Ltd.; castings, Stanford & Co.

In connection with the Tramways Department, the following tenders have been accepted:—Overhead equipment, Messrs. Watlington & Co.; standard pinions and armature coils, the British Westinghouse Electric & Manufacturing Co., Ltd.; trolley heads, sleeves, wheels, plugs, terminals, and thimbles, Messrs. W. Wood & Co.; remainder of car fittings, Messrs. Dick, Kerr & Co.; ironmongery, oils, and grease, Messrs. Joslins, Ltd.; castings, Messrs. Brackett & Co.; rubber and fibre material, Messrs. G. Angus & Co.

DERBY.—The tender of Messrs. Edgar Allen & Co., at £350, has been accepted for special work in conections with the renewal of one of the tramway junctions. Messrs. Allen's tender at £208 7s. for work in connection with the Nottingham Road carshed lay-out has also been accepted. Messrs. J. Smith & Co.'s tender, amounting to £270, for the supply of inspectors', drivers', and conductors' uniforms, &c., has been accepted.

GRAYS.—At the last meeting of the Council, tenders for cables were considered. The lowest offer was from the Union Electric Co., at £175, and the next lowest from Messrs. Callender's Cable & Construction Co., at £238. By four votes to three the Council decided to accept Messrs. Callender's tender.

LEYTON.—The Council has accepted the tender of Messrs. Bruce, Peebles & Co. for the supply of a 10-h.p. motor at £45 5s., and a starter and regulator at £8, for driving machines at the electricity station. The tender of Messrs. Headland & Headland has been accepted for carrying out for twelve months electric light repairs at schools.

LONDON: *London County Council.*—The Highways Committee recommend that a contract with Messrs. Walter Scott, Ltd., now in course of execution, for the supply and delivery of track rails and fastenings, be extended to include the supply of track rails, &c., required in connection with the reconstruction of the Queen's Road, Battersea, tramways, at an extra cost not exceeding £5,652.

The contract for the electrical equipment of the traverser at the central repair depôt has been placed with the British Westinghouse Electric & Manufacturing Co.

The tender of Messrs. F. W. Rowlands & Co., for 20,000 brake-wearing shoes has been accepted at £937 10s.

A contract has been sealed with W. R. Cunis, Ltd., for the removal of ashes from the Greenwich generating station.

Bermondsey.—The following tenders have been accepted:—J. Amos, £35 per ton, for the purchase of scrap cable; G. Gibbons & Son, for the supply of 560 zinc street lamp numbers; dynamometer to test the motors of consumers, W. G. Walker & Co., £12 10s., less 25 per cent. and 5 per cent. discount. The committee has decided to accept, subject to usual sanction, the following tenders for annual supplies:—Geipel & Lange, arc lamp carbons; Laing, Wharton & Cunnington, dynamo, booster, and motor brushes; Sutton & Co. (Overseal, Ashby-de-la-Zouch), conduits and troughing; Albion Clay Co., conduits; Sykes & Sugden, Ltd. (Huddersfield), straight through joint and disconnecting boxes and house service boxes; Campbell, MacMaster & Co., pavement frames and covers; Universal Electrical Manufacturing Co., meter boards; Silvertown Oil Storage Co., dynamo and cylinder oil; C. C. Wakefield & Co., forced lubrication chamber oil; Ferranti, Ltd., meters; Reason Manufacturing Co., Ltd., demand indicators; General Electric Co., Ltd., cut-outs; British Insulated & Helsby Cables, Ltd., concentric paper cable, lead-covered.

Hackney.—The Electric Lighting Committee has decided to accept the tender of Geipel & Co. for arc lamp carbons (Henrion make), at the following prices:—18 m/m positive, 44s. per 1,000 pieces; 13 m/m negative, 20/1d.; 16 m/m positive, 34s.; 11 m/m, 16/3d.

Islington.—After a satisfactory trial for over six months, the Borough Council Lighting Committee has decided to purchase from the Underfeed Stoker Co., Ltd., a mechanical stoker at £279.

St. Pancras.—The Electricity Committee has decided to accept the tender of Messrs. C. A. Parsons & Co. to supply and fix two new commutators to the armatures of the turbo-generator at £189 each.

Stepney.—The Electricity Committee has provisionally accepted the tender of Messrs. Thos. Crow & Sons, West Ham, at £70 (28s. per ton) for the supply of 50 tons of moulded pitch.

Wood Lane Station.—The Kensington and Notting Hill Electric Lighting Companies (Joint Works), Wood Lane, W., have ordered three Bennis and Miller-Bennett improved smokeless chain grate stokers for B. & W. water-tube boilers. This is a second repeat order.

RAWTENSTALL.—An order has been placed with the Lancashire Dynamo & Motor Co. for an automatic reversible booster.

SHEFFIELD.—Messrs. Marples, Leach & Co., inform us that they have been entrusted with the complete contract for the supply, delivery, and erection of 18 motors for driving the printing presses in the offices of the *Sheffield Daily Telegraph*. These motors are all specially designed for variable speeds where necessary, and are being wound for the Sheffield Corporation Supply, 200 volts, 50 periods, two-phase.

WILLESDEN.—The Board of Guardians have accepted the following tenders:—Messrs. Siemens Bros. & Co., supply of plant for workhouse electrical installation, £459; Messrs. Roger Dawson, wiring, fittings, &c., £727.

WIMBLEDON.—The Electric Lighting Committee has provisionally accepted the tender of Babcock & Wilcox, Ltd., at £4,710 for the supply and erection of two boilers at the electricity works, and that of the British Westinghouse Co., Ltd.,

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at £2,606, to supply and erect a high-tension switchboard and gallery. For annual supplies to the electricity works, the following tenders have been provisionally accepted: Engine-room stores, Pryke & Palmer; refuse destructor tools, Jas. Harvey; cables and pilot wires, Siemens Bros. & Co., Ltd.; conduits, Albion Clay Co., Ltd., and Doulton & Co., Ltd.; joint boxes and jointing materials, W. Lucy & Co. (service boxes and house cut-outs), and Callender's Cable & Construction Co., Ltd. (for remaining items in schedule); transformers, British Westinghouse Manufacturing Co., Ltd.; ordinary meters, Ferranti, Ltd.; lubricating oils, Duckham & Co.; other oils, Blumann & Stern; lamps, carbons, and accessories, Mackey's Lamp Co. (incandescent electric lamps), Pestalozzi & Co. (arc lamp carbons); General Electric Co., Ltd. (accessories); H. G. Mayer & Co. (vulcanised india-rubber cables); "Flame" arc lamp carbons, Union Electric Co.; castings, Pryke & Palmer; firebricks and fireclay, Hall & Co. (Croydon), Ltd. (eight items).

WREXHAM.—The following tenders have been accepted for the supply of stores to the Electricity Department for the year ending March 31st, 1909:—Tools and ironmongery, Thomas Hayes; rubber cable, The General Electric Co.; ordinary service cut-outs, The British Insulated and Helsby Cable Co., Ltd.; meters, Venner & Co., and Ferranti, Ltd.; arc lamp carbons, Sloan Electrical Co.; coal, Wynnstay Colliery Co., and Barton & Co.; wood troughing, S. Rogers; boiler solution, Lee Howl & Co.

COMPANIES' MEETINGS AND REPORTS

AIRDRIE & COATBRIDGE TRAMWAYS.—At the annual meeting in London last week, Mr. F. W. Chanter, who presided, stated that the small increase of £82 in their receipts for the year 1907 over those of 1906 was almost wholly accounted for by the revision of fares, which was put into force in the summer. The working expenses showed a decrease of £70, but, principally due to repairs to the track, the repairs and maintenance account showed an increase of £420. Administration and general expenses showed an increase of £59, the whole of which increase was absorbed in rates, taxes, and insurance. For the first time the balance-sheet made provision for depreciation and renewals reserve, namely, £570 for future renewals, £225 to sinking fund, and £455 for general depreciation and expenses.

AMERICAN TELEPHONE & TELEGRAPH CO.—The annual report to December 31st last shows that the company now own a total of 3,839,000 stations, and have 8,610,592 miles of wire. Only $52,921,400 has been added to the capital expenditure during the year, as compared with $79,366,949 in 1906, owing to the general unfavourable business conditions. A sum of $36,626,667 was also spent during the year on reconstruction. The net revenue for the year was $16,269,388. A sum of $10,943,644 was paid in dividends, and $3,500,000 was added to reserve, while $1,825,744 was carried to surplus.

SIR W. G. ARMSTRONG, WHITWORTH.—The annual general meeting was held at Newcastle-on-Tyne on Wednesday last week, Sir Andrew Noble, chairman, presiding. The balance-sheet shows a net profit of £682,698, out of which £50,000 has been added to reserve fund, which now stands at £800,000, and a further £50,000 to the fire insurance account. The report and accounts were adopted. Dividends of 3s. per share on the ordinary shares, free of income tax, and 4 per cent. on the preference shares, were confirmed.

EDWARDS AIR PUMP.—At the ordinary general meeting on Thursday, the report and accounts given in our last issue were adopted. Mr. C. W. Milne, the chairman, who presided, referring to the new type of contraflo condenser, stated that these have been fitted in connection with quite a number of large turbo-generator plants, including those of the London County Council and the Glasgow, Manchester, Edinburgh, Dublin, and Sheffield Corporations. There were indications that there was going to be an enormous business done with these condensers. He also mentioned that for some time past the directors have been carrying on negotiations with a patentee of a double-acting pump on the Edwards principle, which had an increased effective displacement for the same diameter, stroke and number of revolutions per minute.

ELECTRIC LIGHTING AND TRACTION COMPANY OF AUSTRALIA.—At the annual meeting on Monday, when Mr. J. B. Braithwaite presided, the report and accounts given in our last issue were adopted. The Chairman, referring to the great drawbacks under which the company had been working for several years, owing to the want of new capital, stated that it was hoped within the next few months to be able to make arrangements which would tend to place the company upon a sound financial basis. Mr. R. P. Sellon, in seconding the motion for the adoption of the report and accounts, referred to interviews with the Premier of the Australian Commonwealth and others in regard to the growing feeling in England that the trend of politics in Australia was altogether against the employment of private capital. The directors placed great reliance upon the assurance received that this was not in any way the intention of Australian statesmen and others, and that they would do their best to have any such restrictions, if they existed, removed.

MIDLAND ELECTRIC CORPORATION FOR POWER DISTRIBUTION.—The report for the year ended December 31st, 1907, shows a loss of £10,139. The meeting is to-day.

ROSSENDALE VALLEY TRAMWAYS.—At the annual general meeting on Friday Mr. A. Love, the chairman, stated that the local authorities had given notice to purchase the company's undertaking, and that negotiations were proceeding. The number of passengers carried last year were 1,963 less than in 1906. A dividend of 5 per cent. has been declared upon the ordinary shares.

ROTHESAY TRAMWAYS.—At the annual meeting held in London last week, the report and accounts given in our last issue were adopted. The Chairman stated that in spite of the increased cost of coal there had been a decrease in running expenses.

SOUTH LONDON ELECTRIC SUPPLY.—At the annual general meeting on Tuesday the report and accounts given in our last issue were adopted. Mr. J. Atherton, who presided, referring to the satisfactory progress of the business, stated that for the March quarter of 1908 the company had sold some 100,000 units more than during the corresponding period of 1907. With regard to the dust destructor, the reduction of capital in regard to this, which had been decided upon instead of writing off the loss over a period of years, would free the company's capital account of the cost of all unproductive plant, and in addition the settlement of the dispute had freed the company entirely of litigation.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION.—The sixth annual general meeting was held at Cardiff last week, Mr. W. Gascoyne Dalziel presiding. The report and accounts given in our last issue were adopted. Dealing with the unfortunate position of the company, the Chairman said that, as the shareholders had been previously told, this was due largely to the fact that the company was one of the pioneers in electrical supply for power purposes, and that many difficulties had been encountered in consequence. For instance, even after they had succeeded in inducing the large power users in the district to change over to electric power, there were frequently considerable delays, amounting at times to over a year, before the electrical plant was delivered upon the consumers' premises. In the meantime, the power company had to wait with all its plant and mains idle, which resulted in heavy losses each year, so that in 1906 the whole of its capital resources had been exhausted, and without the aid of the principal consumers it would have been impossible to continue. The inability of raising the further capital authorised by the company's Act of 1906 had led to the formation of the consumers' company for working the Treforest area and the various other arrangements in connection with the remaining generating stations. The arrangements with the Treforest Electric Consumers Co., Ltd., were now completed, and that company had taken over the working of the Treforest area as from September 1st, 1907. About £30,000 was being expended upon further plant at the Treforest station, and orders had been placed for a 3,000-kw. turbo-generator, economisers, superheaters, and other plant. Some of this had already been installed, and it was expected, at the end of another two months, that the company would be reaping the benefit of this new plant. Negotiations were still going on for the formation of a similar consumers' company to work the Cwmbran station, and it was hoped soon to bring them to a successful issue. With regard to the company's Bill sanctioning the arrangements above referred to, the Chairman mentioned that it had already passed the House of Lords (Electrical Engineering, March 26th, page 498, and April 2nd, page 533). Before concluding the Chairman expressed the directors appreciation of the friendly assistance which had been given by the large party of creditors in accepting a settlement of their claims in preference shares, as without this assistance nothing could have been done to save the company. Although these arrangements had been carried through, and were the last resource for saving the company, it would necessarily be a considerable time before the shareholders could expect any benefits from their holdings in the company, but it must be a satisfaction to them to know that the statutory powers and the two main power stations had been preserved. There were yet considerable hopes that they would attain the position anticipated for the company by its original promoters. Mr. W. Gascoyne Dalziel, Mr. W. L. Madgen, and Mr. T. Griffiths were re-elected directors.

WILLANS & ROBINSON.—At the ordinary general meeting held in London on Tuesday, Mr. Mark Robinson presiding, the report and accounts given in our last issue were adopted. The chairman stated that the fact of the profits for the half year not bearing the same relation to the volume of work done as in the past, was attributable to the unfavourable conditions of trade. As a matter of fact, the earnings of the company would allow of a greater dividend than 10 per cent. upon the

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ordinary shares, but they must be prudent, and have regard to the uncertain state of the engineering trade, and for this reason the directors had deemed it wise to set aside the remainder. With regard to Queen's Ferry works, he would say little, as negotiations for a sale were being carried on.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night, was £60 5s. to £60 15s. per ton (last week, £61 10s. to £62 per ton).

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—Notice is given of an intended dividend in the bankruptcy of Mr. U. A. Roderick, Electrical Engineer, 12 Penmaen Street, Swansea. The last day for receiving proofs is April 18th. The trustee is Mr. George David, Official Receiver's Office, 117 St. Mary's Street, Cardiff.

The creditors of the Standard Wire Co. are requested to send in particulars of their claims by May 16th. The liquidator is Mr. W. H. Armitage, Station Street Buildings, Huddersfield.

In addition to the meeting of the London creditors of Messrs. Bruce Peebles & Co. referred to in our last issue, a meeting of the Scottish creditors was also held last week in Edinburgh, when Mr. J. H. Robertson-Durham took the chair. The object of the meeting was to give the Scottish creditors the same information that had been afforded to the London creditors. At the conclusion of the meeting some local gentlemen were nominated as additional members of the creditors committee, which was appointed in London, and the full committee is now as follows: Messrs. Wishart, Scot, Cowen, Herdman, Callender, Broadhurst, Anderson, Mountain, Lamb, Gibbons and Hence.

The Electro-Medical Institute, 33 Blackfriars Street, Manchester, is to be wound up voluntarily. Mr. T. Cotton, 37 Braxennose Street, Manchester, is liquidator.

A meeting of the Medical Electro-Thermic Generator Co. will be held at the office of the liquidator, Mr. H. W. Freshwater, 7-8 Railway Approach, London Bridge, London, on Friday, May 1st, at 12.30 p.m. for the purpose of hearing an account of the winding up.

CHANGE OF ADDRESS.—We are notified that the registered office of the South Metropolitan Electric Light and Power Co. is now 183 and 185 High Street, Lewisham, S.E., where all communications should be addressed.

SIEMENS BROTHERS DYNAMO WORKS.—A new branch office has been opened at Sheffield, with Mr. E. S. Saunders in charge, in order to cope with this firm's extensive business in that district. All communications should be addressed to Foster's Buildings, 22 High Street, Sheffield.

On account of the great increase in the sales of tantalum lamps, the above firm have transferred their tantalum lamp department from White Mansion, York Street, Westminster, to their City Stores at 6 Bath Street, City Road, E.C., to which address all communications regarding tantalum lamps should be sent.

NEW PUBLICATIONS

"Principles of Direct-Current Electrical Engineering." By James R. Barr. (London: Whittaker & Co.) 10s.

"Science Abstracts": Section A, Physics; Section B, Electrical Engineering. March. (London: E. & F. N. Spon.) 1s. 6d.

"Power Gas Producers": Their Design and Application. By Phillip W. Robson. (London: Edward Arnold.) 10s. 6d.

Piccadilly "Tube" Capital.—By the Great Northern and Strand Railway Act of 1902, the Great Northern and Strand Railway Company, which had been incorporated in 1899 with a capital of £2,400,000, was amalgamated with the Brompton and Piccadilly Circus Railway Company, which had been incorporated in 1897. By the Brompton Bill, which received Royal Assent after the passing of the above Act, the name of the company was altered to "The Great Northern, Piccadilly and Brompton Railway Company." It was claimed by the Attorney-General that this company had made no statement of the increase of nominal share capital due to the capital of £2,400,000 authorised to be issued by the Great Northern and Strand Railway Company, with which the company had amalgamated, and that the company was therefore liable to pay the penalties incurred by the failure to deliver the statement required by section 113 of the Stamp Act, 1891. Mr. Justice Walton held that no new power had been granted to the amalgamated companies, and that as duty had already been paid on the powers granted to both companies, no further duty was payable. The Court of Appeal held that the nominal share capital of the company had been increased, and that it was liable to pay the penalties incurred. In the House of Lords on Friday last the company appealed against this latter decision, but the Lord Chancellor dismissed the appeal, stating that the capital of the company had evidently been increased, and that it was therefore liable to pay the penalties.

PARLIAMENTARY INTELLIGENCE

BLACKBURN CORPORATION BILL.—This Bill was before the Police and Sanitary Committee of the House of Commons last week, and was reported for third reading. Part III. of the Bill authorises the borrowing of £9,000 for new tramways, repayable in 20 years, and includes the power to purchase the Blackburn, Whalley, and Padiham Light Railway, which, when purchased, is to form part of the Corporation's tramway undertaking.

DUNDALK URBAN DISTRICT COUNCIL BILL.—This Bill was before the Unopposed Committee of the House of Commons on Thursday, and was ordered to be reported for third reading. The Bill enables the erection of a generating station for electric lighting purposes, and an amendment of the Council's borrowing powers for this purpose.

LONDON ELECTRIC POWER BILLS.—The names of a Committee of the House of Lords to consider the London Electric Power Bills are given on page 542.

NEW COMMITTEES.—A Committee of the House of Lords consisting of the following will commence the consideration of a group of Bills on May 12th, including the Great Northern, Piccadilly & Brompton Railway, the Metropolitan District Railway, and Stockport Corporation: The Marquis of Anglesey, Earl Hardwick, Lord Dunboyne, Lord Seaton, and Lord Newton (chairman).

Another committee, consisting of the following, will commence the consideration of a group of Bills on Tuesday, May 12th, including the Bristol Tramways and Keighley Corporation: Earl Carnwath, Earl Albemarle, Earl Liverpool, Viscount Hill, with Lord Ludlow as chairman.

THE NEW TELEPHONE CHARGES.—The reply of the Postmaster-General in the House of Commons last week on the subject of the new telephone charges is given in full on another page.

PROGRESS OF ELECTRICAL BILLS.—The Stockport Corporation Bill was read a second time in the House of Lords on Wednesday last week. The second reading of the West London, Barnes & Richmond Tramways Bill has been put off until May 6th. The Finchley Urban District Council Bill was read a first time in the House of Lords last week. In the House of Commons, on Monday, the London County Council (Tramways and Improvements) Bill was read a second time.

TELEGRAPH AND TELEPHONE ACCOUNTS.—In the House of Commons on Wednesday last week Mr. Harold Cox asked whether the Postmaster-General had yet completed his examination of the accounts of the Post Office telegraph and telephone departments, with a view to presenting them in a form which would show the net annual profit or less after allowing for depreciation of plant, interest upon loans, and compound interest upon payments made out of the exchequer to meet capital expenditure or loss in previous years. Mr. Sidney Buxton, in reply, reminded Mr. Cox that last autumn he appointed a committee to consider the question referred to, consisting of Mr. C. A. King, the Comptroller and Accountant-General of the Post Office, Mr. Blain, Assistant Secretary of the Treasury, and Mr. Bromley, Accountant-General of the Board of Education. The preliminary report had been received from the committee, and in the estimates for 1908-9 the two accounts had been separated. The question of preparing the accounts in order to show profit or loss on each service was now receiving the consideration of the committee.

The Gerrard Telephone Exchange.—A party of press representatives were invited to inspect the new Gerrard telephone exchange last Tuesday and general approval was expressed with the arrangements. We published a detailed description of this exchange in our issue of October 31st last, shortly after it was taken into operation. It will be remembered that it is on the standard central battery system. A feature of the switchboard arrangement is that, whilst the subscribers' lines are multipled over every six panels of the junction sections of the switchboard, they are only multipled over every nine panels of the subscribers' section. The switchboard is made up of eight-panel sections, each equipped for three operators' positions. Four-party line ringing keys are used on the subscribers' positions. A plugging up circuit of new design is another feature of the exchange. In the apparatus room the cables are brought to the vertical side of the main frame, on which side are the fuses, lightning arresters, and heat-coils.

Wireless Telegraphy.—A scheme for the signalling of Greenwich time at noon and midnight to all ships fitted with wireless apparatus was proposed at the Academy of Sciences, Paris, last week. The Eiffel Tower station at a height of 900 ft., or better, a station on the highest point of Teneriffe, was suggested as a suitable centre for transmission. A special committee has been appointed to consider the scheme. With a view of establishing communication between St. Petersburg and Vladivostock, a station is being erected by the Russian military authorities near Zlatoust, in the Government of Ufa. The place selected is the highest point of the Ural range, and another station will be erected at some point in the Altai mountain chain.

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MISCELLANEOUS CITY NOTES

ANGLO-AMERICAN TELEGRAPH CO.—After placing £5,000 to the credit of the renewal fund, the directors recommend an interim dividend for the quarter ending March 31st, 1908, of 15s. per cent. on the ordinary shares, and £1 10s. per cent. on the preferred stock less income tax.

BRUSH ELECTRICAL ENGINEERING CO.—In the Chancery Division of the High Court on Saturday, on the application of Mr. Thompson, Mr. Justice Neville made an order sanctioning the reduction of the capital of the Brush Electrical Engineering Co., Ltd., by £170,484, in respect of loss of assets in freehold and leasehold factories, patents, and goodwill, shares and debentures, held in other companies.

CUBA SUBMARINE TELEGRAPH CO.—A dividend of 6 per cent. per annum free of tax for the half-year to December 30th, 1907, is recommended.

GREAT NORTHERN TELEGRAPH CO.—Although the company's receipts for last year have decreased by about £22,000, compared with those of the previous year, the board of directors intend to propose to the general meeting to distribute the same dividend and bonus as in 1906, viz., 20 per cent. (inclusive of 5 per cent. already paid), and to carry the usual amounts to the reserve and pension funds, viz., £55,555 and £8,333 respectively, whilst the dividend equalisation fund will be increased only by the interest on the same for the year.

OLDHAM AND SADDLEWORTH DISTRICT TRAMWAYS CO.—The *Manchester Courier* states that this company will shortly issue 50,000 six per cent. £1 cumulative preference shares, the whole of the 4 per cent. debenture stock having already been subscribed. The company has been incorporated for the purpose of acquiring Parliamentary powers of the Oldham and Saddleworth District Tramways Co., dated 1905, which will form a continuous route between Oldham, Saddleworth, Springhead, Mossley, and Manchester. A supply of electrical energy will be given by the Stalybridge, Hyde, Mossley, and Dukinfield Joint Tramways Board on a sliding scale varying from 1½d. to 1d. per unit. The consulting engineers to the scheme are Sir Douglas Fox and Partners.

ORIENTAL TELEPHONE AND ELECTRIC CO.—The directors recommend a final dividend of 5 per cent. on the ordinary shares free of tax, making 8 per cent. for the year.

RIO DE JANEIRO LIGHT & POWER CO.—The Paris correspondent of the *Financial News* states that, contrary to the statements which have been made in London to the effect that the French portion of the Rio de Janeiro Light & Power Co.'s loan would be brought on the market under the auspices of the Banque de Paris et des Pays Bas, the issue will take place under the control of a private firm. The loan will shortly be offered simultaneously in London and Paris. The Paris firm, which is just now engaged in placing privately among its *clientèle* 6 per cent. bonds of the Rio Janeiro Light & Power Co. is Messrs. Gern & Rafzovitch. Where the Banque de Paris et des Pays Bas comes in is that it has previously granted, together with the Société Générale, an advance of 5,000,000f. on this issue of the Rio Janeiro Light & Power Co. Messrs. Gern & Rafzovitch, it appears, have taken over for cash 10,000,000f. worth of the new bonds, and have an option over another 20,000,000f. should the operation be successful. However, it is hardly likely that the French market is ready just now to absorb the bonds, in spite of their high yield.

NEW COMPANIES

ELECTROMOTOR EQUIPMENT.—This company was registered on March 24th, with a capital of £5,000 in £1 shares (4,500 preference), to carry on the business of electricians, mechanical and general engineers, workers of and dealers in electricity, motive power and light, manufacturers of electrical apparatus, &c. The subscribers are: O. Spatz, E. B. Haertel, H. G. Haertel, O. Reimers, W. J. B. Tippetts, P. W. B. Tippetts, and T. Meacock. No initial public issue. The number of directors is not to be less than three nor more than five; the first are G. Reimers, O. Spatz, and H. G. Haertel. Qualification, 100 shares.

FIFE SYNDICATE, LTD.—This company was registered in Edinburgh on March 31st, with a capital of £10,000 in £1 shares, to purchase, lease, or otherwise acquire, manage, and work any light or other railways, electric or other tramways, and electric lighting or power undertakings, and to take over the control of the statutory rights and powers under the Dunfermline and District Tramways Order Confirmation Act. The subscribers are:—W. Shearer, G. A. Nicolson, C. Brunton, J. C. Greig, A. Annie McFarlane,, F. E. Somerville, M. I. Hamilton. The first directors are not named.

Wireless Telephony.—Some experiments were carried out last week by Dr. Lee de Forest before the French naval and military authorities in Paris. Communication by wireless telephony was established between the station at the top of the Eiffel Tower and the stations at Melun (about 37 miles distant), Mont Valérien, and Villeneuve St. Georges. Experiments are to be carried out before the naval authorities in Italy and in this country.

APPOINTMENTS AND PERSONAL NOTES

The General Purposes Committee of the Accrington Corporation recommend that the salary of their Borough Engineer, Mr. W. J. Newton, be increased from £420 to £470 per annum, in view of the long and arduous services rendered in carrying out the electrification of the tramways and the additional duties and responsibilities involved in the supervision of the new tramways.

Mr. H. Bloodworth, who recently represented the Adams Manufacturing Co., and was formerly a buyer for Messrs. Edmundson's Electricity Corporation, will in future represent Messrs. Siemens Brothers Dynamo Works, Ltd. He has been attached to their London branch at 1 Abchurch Yard, Cannon Street, E.C.

In consequence of the resignation of Mr. F. Dickinson, the works superintendent at the St. Helens Electricity Works, the following alterations in the staff have been made:—Mr. R. R. Mayne, works superintendent, £3 5s. 4d. per week; Mr. J. W. Warr to be made responsible for the mains and service, in addition to his present duties as traction and motor superintendent, at a salary of £3 5s. 4d. pr week.

Mr. H. G. Thompson, of Swansea, has been appointed electrical engineer to the Neath Urban District Council at a salary of £200 per annum.

Lord Kelvin's Will.—An inventory of the estate of the late Lord Kelvin (says the *Times*) was lodged with the sheriff clerk at Kilmarnock yesterday. The will, which is holograph, is dated December 8th, 1905. There are three codicils attached to it. Lord Kelvin leaves his wife, Frances Anna, all his property real and personal, and his patent rights and goodwill in respect of inventions other than those which belong to Kelvin and James White (Limited), Glasgow. Lady Kelvin is appointed sole executrix. The personal estate consists of £45,027 8s 9d. in Scotland, £79,247 11s. 10d. in England, £4,650 in Ireland, and £32,998 11s. 2d. abroad—a total of £161,923 11s. 9d.; and heritage £7,150. The net estate heritable and movable on which duty has been paid is £155,053 15s., and the amount of estate duty paid is £10,944 13s.

The New Telephone Charges.—In the House of Commons, on Wednesday last week, Mr. Hudson asked the Postmaster-General whether he was prepared to make any statement as to the future policy of the Post Office on the subject of telephone rates, and especially in regard to the financial basis on which he proposed that the Post Office telephone system should be conducted. Mr. Sydney Buxton, in reply, said he was glad to have an opportunity of stating his views on the question of the future policy of the Post Office in regard to telephone rates. He considered that the Post Office telephone system should be conducted on a sound business basis, that is to say, that the revenue should be sufficient to provide for current expenditure of all kinds, for the maintenance and adequate renewal of plant, and for interest at 3 per cent. on capital expenditure, together with a moderate but not excessive margin of profit. In order to ascertain whether the rates were fixed at a level sufficient to satisfy these conditions, and to put the telephone service on a business footing, it was necessary that there should be a clear separation between the revenue and expenditure of the telephone service and the revenue and expenditure of other branches of the Post Office, especially the telegraphs. It was in this way alone that the telephone system could be made to stand on its own basis, unaffected by the profit and loss made on other Post Office services. The various branches of Post Office work were, in practice, frequently conducted in the same building, sometimes by means of the same plant and under the supervision of the same persons. The separation of the cost was consequently a matter of some difficulty. Last autumn, therefore, he appointed an expert committee, including the President of the Institute of Chartered Accountants, to investigate this question, and to advise as to the best method to be adopted for separating the accounts. The committee had not yet finished its work; but, as a first result of their investigation, the Estimates for 1908-9 had been presented to the House in such a manner as to separate the expenditure on telegraphs and telephones, and the telephone revenue would be shown separately. The new telephone rates must to some extent be regarded as experimental. Longer experience was required before it was possible to say what might be the permanent cost of operating a fully developed system, or to ascertain with any accuracy the life of the varying descriptions of telephone plant, having regard especially to probabilities of obsolescence, and the consequent necessity of replacing plant before it was worn out. Moreover, the conditions under which the Post Office service was conducted would be considerably modified when the system of the National Telephone Company was taken over by the Post Office at the beginning of 1912. Although it was not possible for him to pledge his successors, he should anticipate that the principles which he had stated as those which should determine the rates would be accepted by them, and the rates would doubtless be from time to time modified in accordance with those principles.

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PURCHASE OF HIGHGATE HILL CABLE TRAMWAYS

In a further report by the Highways Committee of the London County Council, full details are given as to the proposal to purchase the Highgate Hill cable tramways. The tramways are of narrow gauge, are worked by cable traction, and consist of about 0·71 route mile of partly double and partly single track along Highgate Hill, situated in London and Hornsey. The total length of line expressed as single track is about 1·31 miles, of which about 0·94 is in London and 0·37 in Hornsey. The Council was in a position in 1903 to serve notice to acquire compulsorily, under section 43 of the Tramways Act, 1870, the portion of the undertaking situated in London, but decided not to exercise its powers of purchase at that time. These powers of compulsory purchase will, in the ordinary course, recur in 1910. The company has introduced a Bill into Parliament in the present session (1) to authorise the company to reconstruct its tramways for electric traction on the standard gauge, (2) to postpone the date of compulsory purchase of the lines by the local authorities, of which the Council is one, under the Tramways Act, 1870, and (3) to confer on the company running powers over portions of the Council's tramways. As stated in a former report of the Highways Committee, the company has approached the Council with a view to the transfer to the Council at an early date of their undertaking by agreement, in which event the company will not proceed further with its Bill. As the result of negotiation, the company has now expressed its willingness to withdraw its Bill and to sell its whole undertaking to the Council upon terms which, in all the circumstances, the Highways Committee feel justified in recommending the Council to accept. It is proposed that the Council shall enter into a provisional agreement to purchase not only the portion of the undertaking in London, but also the small portion in Hornsey, and that the purchase price shall be £13,000. As regards the portion of the lines in Hornsey, the Hornsey Corporation is the "local authority" under the Tramways Act for the purchase of tramways. The Hornsey Corporation will not raise any objection to the arrangements proposed, provided that it is not involved in any financial responsibility in the matter. It will be necessary for an agreement to be entered into between the Council, the Hornsey Corporation and the company, to give effect to these proposals. Such agreement will have to be submitted to Parliament in the session of 1909 for confirmation, and the agreement will be conditional upon the Council obtaining such confirmation.

The London portion of the Highgate Hill tramways meet the Council's electric tramways system (Holloway Road route) at the Archway Tavern, and, says the report, the existing travelling facilities in the districts affected would be considerably improved by working the two systems in conjunction. The Committee recommend that when the Highgate Hill tramways are purchased by the Council they should be reconstructed on the standard gauge for electric traction as soon as possible in order to utilise them as a feeder line to the existing tramways.

In a report upon this proposal, the Finance Committee states that the total ultimate expenditure on capital account in connection with the reconstruction on the conduit system of the lines, when purchased, for electric traction, is roughly estimated at £53,200, made up as follows: Purchase of undertaking, including incidental expenses, £13,500; tramway construction, £20,000; cars, £3,920; cables and ducts, £2,680; street widenings, £10,700; and car-shed and sub-station accommodation, £1,402. If the overhead system were adopted this figure would be reduced by about £6,045. The gross surplus on working is estimated at £3,042 for the first year of working. Against this must be set debt charges on the capital outlay amounting in the first year to £3,836, and provision for renewals at 1d. a car mile, amounting to £608; so that the deficiency in the first year would amount to £1,441. Debt charges would decrease by about £70 a year as the debt was paid off, and the adverse balance would thus disappear in about 20 years, provided the estimate of traffic were realised. But although the direct traffic of the line appears to be small, the Highways Committee are of opinion that the induced traffic over other parts of the Council's system would be considerable; and it may therefore be assumed that the line would prove to be self-supporting in considerably less than 20 years.

International Telegraph Convention.—The annual report for 1907 of the Bureau International des Administrations Telegraphiques, shows that the revenue estimated at 64,500 francs amounted to 62,773 francs, while the expenditure at 141,577 francs was less than the estimate by 20,958 francs. Thus a sum of 78,804 francs has to be met by the administrations adhering to the Telegraph Convention, or less by 19,231 francs than the estimated deficit. There are 48 countries adhering to the Convention, and 19 telegraph and cable companies. Fifteen other companies correspond with the Bureau direct, although they are non-adherents, while five others correspond through the medium of one of the other groups of companies.

ELECTRICITY FROM PEAT

Rejection of the Dublin & Central Ireland Power Bill

The Committee of the House of Commons, presided over by Mr. Luke White, concluded its consideration of this Bill on Wednesday last week, and declared the preamble of the Bill not approved, too late for insertion in our last issue, in which we gave full particulars of the proceedings up to Tuesday. At the conclusion of the evidence of Captain Sankey, further evidence was called as to the possibility of business being done in the area, and to the want of provision for giving cheap supply in the districts surrounding Dublin and elsewhere.

Mr. E. A. Aston, representing a firm of mechanical and electrical engineers in Dublin, compared the cost of current supplied by the Corporation, which, he said, averaged 1·45d. per unit, with the proposed supply of the company, which would average ½d. per unit. In reply to the Chairman, this witness stated that if the Dublin Corporation took the whole of their supply in bulk from the company, and were to abandon their present plant, the capital cost of which was about £120,000, this debt might be reduced to £100,000 by the sale of the plant, and the sinking fund on this would be about £6,000 a year, as against £10,000 or £12,000 a year which would be saved by taking a supply in bulk.

The general point in the cross-examination of this witness was that those parties owning generating stations, in the event of their taking a supply in bulk, would have to scrap their plant and still bear the burden of the cost of distribution.

In answer to the Chairman, the witness stated that the right to supply Dublin with the consent of the Corporation was essential to the development of the scheme.

Captain H. Riall Sankey, who was recalled, gave estimates which, he said, he had prepared on the financial prospects of the company in connection with the supply of electricity. He put this at 7·6 per cent. on the ordinary shares, irrespective of the profits on the by-products.

On behalf of the opposition Mr. Seymour Bushe, K.C., addressed the Committee for the Dublin Corporation, and described the scheme as being speculative, experimental, and crude, and mentioned that many previous schemes had been put forward for exploiting the Bog of Allen, but all had been failures. The Corporation desired to be cut out of the Bill altogether, and that was all he desired.

Sir Ralph Littler, K.C., addressed the Committee on behalf of the Pembroke Urban District Council and the Alliance and Dublin Consumers' Gas Co., dwelling upon the scarcity of evidence as regards capital.

The Chairman asked for further information on the question of finance.

Mr. Freeman admitted that it would be impossible for him to say what capital would be invested in the company until it was known in what form the Bill would be passed.

After a short consultation, the Chairman stated that the Committee were unanimously of the opinion that the preamble was not proved.

The Electrical Engineers' Ball.—We understand that this function was particularly successful this year, as regards both the number of guests attending and the financial result. At a meeting held on March 31st, the committee were enabled to vote, from the available balance for the year, a sum of £75 for the Benevolent Fund of the Institution of Electrical Engineers.

Tramway Rating.—In the Appeal Court, on Monday, the Assessment Committee of the Hendon Union appealed against a rule *nisi* granted by Mr. Justice Phillimore prohibiting the justices of Middlesex from hearing an appeal by the Metropolitan Tramways, Ltd., against their assessment by the Hendon Union whilst certain magistrates, who are members of the Middlesex County Council, were on the bench. We gave full particulars of the action in our issue for March 5th, page 371, and March 12th, page 396. The appeal came before the Lord Chief Justice, Mr. Justice Ridley, and Mr. Justice Darling, and the decision of Mr. Justice Phillimore was reversed. The Lord Chief Justice, in giving judgment, thought that the view that the justices in question would be biassed, was a far-fetched one.

Telegraph Traffic.—The cable of the French Telegraph Company between Guantanamo (Cuba) and Mole St. Nicholas (Hayti) has been repaired, the interruption having lasted from February 11th to April 1st. The land-lines between Rangoon and Calcutta via Akyab are down, and this derangement, together with the strike of operators (see note on page 562), is causing serious delay on European telegrams to and from Rangoon. The Eastern Extension Australasia and China Telegraph Company are, however, now laying a submarine cable between the Cocos-Keeling Islands and Java, and this will give an extra route to India, as by agreement with the Indian Government, messages must be sent via Aden and Cocos at normal rates, if the other route is encumbered or interrupted. This arrangement also refers to telegrams to the Far East. On the 5th instant, the route via Hanekin was restored, and on the 6th instant the via Fao route, which was interrupted between Bagdad and Bassorah, was put into working order, but subsequently ceased working again.

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THE SIMPLEX TIME ELEMENT THERMAL CUT-OUT

THE accompanying illustration represents a piece of apparatus which Simplex Conduits, Ltd., have recently brought out for protecting motor-circuits and similar purposes. The appliance is actuated thermally, and is designed to have a true time element, allowing momentary rushes of current, but opening the circuit as soon as the excess of current becomes dangerous.

The device is very simple, and consists of a chamber containing a resistance above which is placed a corrugated capsule, the expansion of which causes a piston pressing directly on to it to raise and actuate the trigger of the switch. The capsule can exert a pressure of 20 to 30 lbs. without being damaged, the operation being therefore assured under any circumstances.

The apparatus, when once set, sets quicker or slower according to the magnitude of the current flowing. With normal current it absorbs only about five watts, and the heat developed in the chamber is radiated, but any overload above 10 per cent. will cause the device to act in a time inversely proportional to the overload. Any motor or arc lamp takes at starting an increased current, and especially so the alternating-current motors, and, in fact, there always is a rush of current on closing a circuit. To permit this, therefore, the fuse or magnetic cut-out have to be set so as to fuse or open the circuit with 50 per cent. up to sometimes 300 per cent. overload, the



THE "SIMPLEX" TIME ELEMENT THERMAL CUT-OUT.

direct consequence of this being that they afford very little protection. The thermal cut-out not only allows the rush of current at starting, but also prevents this or any smaller excess above the normal to flow for an undue time, and thus affords protection. If desired, an arrangement can be added so that an alarm is given as soon as the piston begins to rise, and before the cut-out opens, thus giving sufficient warning to the attendant.

Some tests of a 20-ampere cut-out have been made at the Electrical Standardising, Testing, and Training Institution. Overload currents of definite amount were passed through the cut-out, and the time taken by the cut-out to act was noted. The following table gives the results:—

Current amperes.	Overload per cent.	Time of action.
23	15	14 min. 0 sec.
25	25	4 min. 57 sec.
30	50	2 min. 0 sec.
35	75	1 min. 11 sec.
40	100	54 sec.
50	150	39 sec.

These times are stated to agree as reasonably as can be expected with the rating of the appliance, slight alterations being produced by the presence of stray currents of air. The mechanical action of the cut-out reported as quite satisfactory, the power exerted by the capsule being ample for the purpose of opening the switch. The watts taken at the switch terminals when warm were also measured and found to be 5.5.

Telegraphists' Conference.—The twenty-eighth annual conference of the Postal Telegraph Clerks' Association is being held in Glasgow this week. The business meetings commence to-day, and the annual dinner takes place on Saturday.

CATALOGUES AND PAMPHLETS RECEIVED

"CHLORIDE" ACCUMULATORS.—The latest publication of the Chloride Electrical Storage Company might be taken for a catalogue of complete steam yachts rather than accumulators, as it contains a series of most handsomely executed reproductions of photographs of steam yachts, in which the lighting is carried out by the aid of Chloride accumulators, including the King's new yacht *Victoria and Albert*, and other Royal and private vessels. Particulars are also included of the special type of cell which the company have developed for shipboard use.

ELECTRIC CLOCKS.—A pamphlet from the Standard Time Co., of 19 Queen Victoria Street, contains reprints of a number of letters in the *Times* dealing with the desirability of a standard time service, and a lecture by Mr. St. J. Winne, director of the Standard Time Co., given recently before the United Wards Club of the City of London on "The Time of a Great City," and a report of the discussion thereon, in which the advantages of electrically synchronised public clocks are pointed out.

METALLIC FILAMENT LAMPS.—A collection of leaflets from Messrs. G. M. Boddy & Co., of Newington Works, Liverpool, gives particulars of a metallic filament lamp being put on the market under the name of the "Metalik." The lamp has the usual elongated bulb and filament in several sections. The efficiency is given at 1¼ watts per c.p., and the average life as 1,000 hours. The following sizes are listed:—25 c.p., at 50 to 75 volts; 32 c.p., at 50 to 130 volts; 50 c.p., at 75 to 130 and 200 to 240 volts; and 100 c.p., at 100 to 130 and 200 to 240 volts In the latest form of lamp the filament, both in the case of high and low voltages, is so supported that the lamps may be used inclined to any angle.

POLYPHASE MOTORS.—The Union Electric Co. are issuing a very comprehensive list of polyphase motors. The motors dealt with range from ¼ to 340 h.p., and run at speeds from 1,500 r.p.m. to 375 r.p.m. for various voltages from 110 to 5,000. The types include those with squirrel-cage and wound rotors, the latter with or without brush raising gear, and the motors can be supplied as protected, enclosed ventilated, or fully enclosed machines. Several types of starters are listed.

SHADES FOR METALLIC FILAMENT LAMPS.—A circular is to hand from the Sun Electrical Co., of Charing Cross Road, illustrating some new designs of specially deep glass shades for use with tantalum and osram lamps.

SIMPLEX CONDUITS.—A complete catalogue of these conduits and accessories for use with them has been issued, written entirely in French, and with prices in francs.

SMALL TRANSFORMERS FOR METALLIC FILAMENT LAMPS.—A new list from the Union Electric Co. deals with this firm's patterns of small transformers for reducing the ordinary supply voltages to those more suitable for metallic filament lamps of moderate candle-power. These transformers were described and illustrated in ELECTRICAL ENGINEERING, March 5th, page 353. They are constructed in a great variety of ratings for various primary pressures, as usually found on supply companies' mains, and for the whole range of periodicity in use in this country. Two chief patterns are included and priced, viz., those with a single-circuit secondary and those with a multiple-circuit secondary. On the last page are given diagrams showing the method of connecting the transformers to the primary and secondary circuits, as well as details of construction and technical data.

STEAM ENGINES.—Messrs. Ruston, Proctor & Co., of Lincoln, have sent us a pamphlet giving prices of their well-known single-cylinder vertical high-speed engines, with flywheel inertia governors, in sizes ranging from 16 to 76 h.p. A blotter is being issued by the same firm embellished with illustrations of a suction-gas plant, and a horizontal cylinder gas engine of their manufacture.

STONEWARE CONDUITS.—A leaflet which has been issued by the Albion Clay Co., of 38 Victoria Street, relating to the Sykes' patent stoneware conduits with self-centring joints. It is stated that over 9,000 yards of this conduit have been laid at the Franco-British Exhibition entirely without concrete. An illustration is given of a ten-way conduit forming part of this contract in the process of being laid.

TRAMWAY ACCESSORIES.—A leaflet from Mr. F. J. Down, of 6 Crutched Friars, E.C., gives particulars of several accessories useful in tramway and railway work. A special guy anchor is included, and other articles include a lever arrangement for moving cars by hand and two forms of car ramp for replacing derailed cars on the track.

TRANSFORMERS FOR METALLIC FILAMENT LAMPS.—A new pamphlet from the Foster Arc Lamp and Engineering Co., of Wimbledon, calls attention to the advantages which can be obtained by the use, on alternating-current circuits, of small auto-transformers for enabling low voltage metallic filament lamps to be employed. Some diagrams are given showing the way in which such installations may be wired so as to obtain the full advantage of the balancer action of such transformers by dividing the installation into two or more sections from different tappings of the auto-transformer. Two examples

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are worked out, showing savings of 71½ and 66 per cent. respectively by the adoption of this system of lighting, as against ordinary carbon filament lamps.

VENTILATING FANS.—The Wilson Wolf Engineering Co., of Bradford, have issued a new complete list of ventilating fans of the "Arctic" propeller type, both in the continuous-current electrically-driven type and also for belt driving. The principal improvements in these fans were referred to in Electrical Engineering, March 26th, page 480, in connection with a preliminary catalogue of the same apparatus.

A NEW ELECTRIC TEA KETTLE

THE accompanying illustration shows a cheap form of electric kettle which the British Thomson-Houston Co. have now brought out and added to the already long list of heating



New B.T.-H. Electric Tea Ketile.

appliances which we have referred to from time to time as new apparatus has been introduced. The kettle is of copper, neatly finished to a simple design, and has a capacity of three pints. Each kettle has only one degree of heat, but can be supplied with either a 250-watt heating unit for boiling water already warm, or with a 500-watt unit for raising cold water to the boiling point in a short time.

Wireless Telegraphy in Madagascar.—A wireless telegraph station is to be constructed on the island, and a large quantity of apparatus has already been despatched from France.

Electricity Supply in Winnipeg.—The statement, published in London, that the Winnipeg City Council has voted a sum of £2,600,000 towards the purchase of the tramway and lighting plant of the city is incorrect. A motion was introduced in the Council to investigate the question, but no action was taken.

X-ray Dermatitis.—The head of the X-ray department of the London Hospital (Whitechapel), Mr. Ernest Harnack, has recently undergone three operations, consisting of the amputation of fingers of both hands. An appeal for financial help is being made on behalf of Mr. Harnack, who has a family dependent upon him.

Borough Polytechnic Institute.—The annual exhibition of students' work took place on Saturday last. Some excellent examples of technical work by evening students were on view in the large drawing office. Amongst the exhibits of an electrical nature were some model armatures illustrating the various types of windings, and in the electro-chemical laboratory a very neat little piece of apparatus, designed by Dr. F. Mollwo Perkin, head of the Chemistry Department, for the quick electrolytic analysis of salts, was on view. In this apparatus advantage is taken of the fact that by rotating the kathode the metal is deposited at a faster rate than when the kathode is stationary. An analysis which by the latter method would take three hours can, by rotating the kathode, be done in less than half an hour.

The Poulsen System of Wireless Telegraphy and Telephony.—According to the *Elektrotechnische Zeitschrift*, the ss. *United States*, on a voyage to America, kept up a reciprocal communication with the station at Cullercoats until a distance of 1,350 miles was reached. The height of the mast of the *United States* is 92 ft., and the capacity of the dynamo 3 5 kw. The Cullercoats station has a 5 kw. dynamo. It is also stated that the Lyngby station (see Electrical Engineering, March 26th, page 469) is in regular communication by wireless telephony with the Esbjerg station in south Jutland, a distance of 170 miles. The former station has a 10 kw. dynamo, the latter a 6 kw. dynamo. The telephonic reception was clear and good, and there was practically no distortion of the wave shape.

A NEW LAMP HOLDER

THE accompanying illustrations show a new form of lamp holder and cap on what is known as the "Bruston" system, which is being put on the market by Leo. Sunderland & Co., of 39 Victoria Street, S.W. It is claimed that this is the only lamp holder in which terminals of opposite polarity are entirely separated and enclosed in porcelain pits both in the holder and in the lamp when in use. By this means not only is the liability to burn out, which some badly constructed lamp holders possess, entirely avoided, but remarkably high insulation resistance is shown from terminal to terminal or between one terminal and the brass case; and this is so even after the whole has been immersed in water with the lamp alight. The construction of the holder and the special lamp cap for use with it is apparent from the sketches herewith. It will be seen that the springs are contained in the lamp cap instead of the holder itself, and

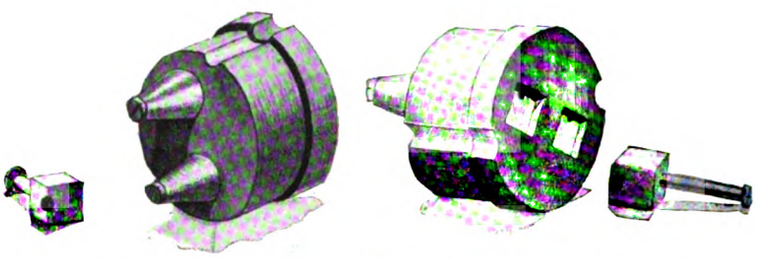


Fig. 1.—Insulator and Contact Pins of Lamp Holder, showing terminal blocks and screws separately.

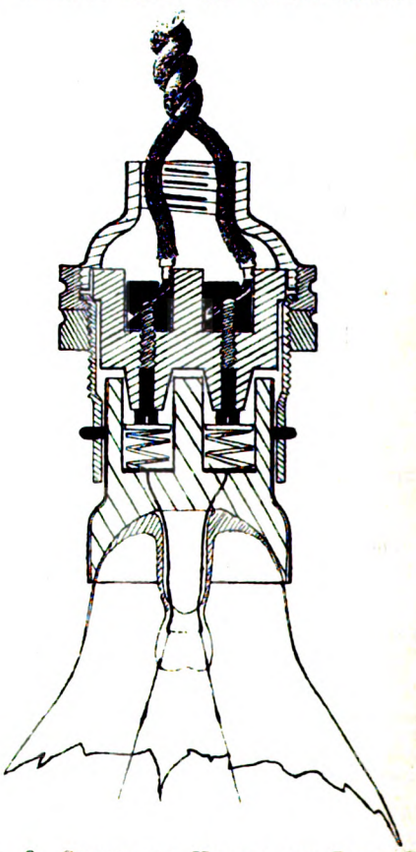


Fig. 2.—Section of Holder and Lamp Cap.

that all metal parts carrying current are embedded in porcelain or vitrite pits. The arrangement is particularly recommended for use in damp situations, as condensed moisture draining into the pits will be of little consequence, and for traction work, where the sparking caused by imperfect contact due to vibration is confined to the porcelain pits. The connections are so arranged that it is impossible for stray strands of flexible wire to cause short circuits.

Mexican Telephone Service.—According to an American Consular Report, a company is being formed for the purpose of developing long-distance and wireless telephony between Mexico City and the port of Veracruz. A concession covering a period of 50 years has been obtained. A few miles of underground work have already been laid in Veracruz. The towns in the State of Veracruz will next be connected by overhead wires, and later the wireless system will be developed.

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ELECTRICAL ENGINEERING

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Easter Holidays. The Offices of "Electrical Engineering" will be closed from 6 p.m. to-day until 9 a.m. on Tuesday, April 21st.

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SUMMARY

The scheme for a joint electrical exhibit of several firms at the Franco-British Exhibition has been abandoned. (Page 579.)

Traffic has been commenced on the single-phase system on a portion of the Lancashire lines of the Midland Railway. This is the first instance of single-phase railway traction to be put to work in England. (Page 580.)

Mr. Eustace Thomas read a Paper on Tuesday before the Manchester Local Section of the Institution of Electrical Engineers on the management of engineering workshops, in which he dealt with some of the general principles by which economy may be obtained in manufacturing works, especially as regards shop routine, lists of materials, drawings, records, &c., and the day work as compared with piece work or premium systems. (Page 580.)

A Paper on the effect of metallic filament lamps on the electricity supply industry was read by Messrs. H. W. Handcock and A. H. Dykes last Thursday at the Institution of Electrical Engineers. Figures were given as to the reduction in consumption, especially when employing auto-transformers and 25-volt Osram lamps. The authors proposed to reduce the effect on the station revenue by the introduction of a new system of charging, by which the consumer would be charged a fixed sum per annum, depending on the maximum current he requisitioned on signing his contract, and a certain charge per unit in addition. They proposed the employment of a "limit indicator," which would dim the lamps when the contract maximum was exceeded. Mr. Arthur Wright opened the discussion by deprecating such advertisements as "70 per cent. discount on your bills," instead of "three times the light for the same bill." He pointed to the enormous increase in business which would accrue through cheaper light and to the necessity of reducing the cost of service connections. At present it cost nearly as much per kw. to connect a house as to build a station. Mr. Hugo Hirst announced a Paper on the evolution of the metallic filament lamp, which he had just sent in to the Institution. Incidentally he stated that new Osram lamps could now be paired with old. He thought there was no need to resort to the panic measures suggested by the authors. Mr. Bottomley Smith did not approve of the proposed "contract demand" system of charging. Mr. W. R. Rawlings, as an electrical contractor, objected strongly to the Wright system of charging, and favoured the authors' system. Mr. F. M. Long described a system in use at Norwich, in which the consumer is charged an annual sum of 12 per cent. of the net assessment of his house *plus* 1d. per unit. The Paper was also discussed in

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Dublin on Thursday. The London discussion will be continued on April 23rd, and there will be a discussion at Glasgow on May 12th. (Page 581.)

THE extension of the Kingsway tramway subway from Aldwych to the Embankment, which forms the connecting link between the northern and southern systems of the London County Council tramways, was opened on Friday last. (Page 585.)

THE total number of units sold by the North Metropolitan Electric Power Supply Co. during the year ended December 31st, 1907, shows an increase of about 40 per cent. over the figure for the previous year. The accounts show that the average total costs, not including capital charges, were 0·865d. per unit. (Page 586.)

A VERY successful motor hiring department has been established by the Birmingham Corporation Electricity Department. Very complete arrangements are made as to testing, installation, and inspection. (Page 587.)

THE manufacture of tungsten incandescent lamp filaments, including that of the new "Z" lamp, was dealt with in a recent address by Dr. CLAYTON H. SHARP before the American Electrochemical Society. (Page 588.)

THE India Rubber, Gutta Percha, and Telegraph Works Co. have been experimenting for some time on electrical automobiles, and have now brought out a perfected "Silvertown" electric carriage for town use. The principal features of its design are the use of a four-wheel drive by two geared motors and live axles, and a controller giving as many as thirteen positions, including three electric braking notches. (Page 589.)

AN ingenious form of new arc-lamp coupling is described. (Page 591.)

A NEW metallic filament lamp, which is of British invention and British manufacture, will shortly be put upon the market. The filament consists of tungsten alloyed with other metals, and is ordinarily run at one watt per candle. 100-volt 17-c.p. and 200-volt 34-c.p. lamps will be obtainable. (Page 592.)

THE Paper on heating of ventilated and enclosed motors, read last Thursday before the Leeds Local Section of the Institution of Electrical Engineers, dealt generally with the dissipation of heat produced by motor losses and the effect upon this of different degrees of enclosure, and described some tests on an experimental machine. The author expressed the opinion that totally enclosed motors suffer from great disadvantages, but that their use can in general be avoided. Reference was made in the discussion to the enclosure of motors in large gauze cages, and the use of enclosed motors in mines. (Page 593.)

THE Paper by Mr. G. G. STONEY and Mr. A. H. LAW on high-speed electrical machinery, read on April 2nd at the London meeting of the Institution of Electrical Engineers, has been further discussed by the Newcastle Local Section. The broad principles of the designs described were less freely criticised than at the London discussion, and more attention was paid to matters of detail. (Page 595.)

THE Highways Committee of the London County Council report in favour of putting the Hammersmith-Putney tramways, which will be upon the overhead trolley system, in hand immediately. An estimate on capital account of £34,000 is approved by the Finance Committee. (Page 597.)

UNDER "Electrochemistry and Electrometallurgy" we notice methods of producing glass in the electric furnace and the various methods which have been employed for preparing calcium carbide. The interesting subject of electrolytic zinc galvanising is also discussed, and figures are given which show that the electrolytic galvanising, at any rate on paper, is considerably cheaper than the hot dipping process. (Page 597.)

LORD RAYLEIGH has been elected Chancellor of Cambridge University in succession to the late Duke of Devonshire. Under "Electrical Science," in the British and American Section, are notes on some newly-found induction coil phenomena and on the carriers of positive electricity. An account is also given of Prof. J. J. THOMSON'S concluding lecture at the Royal Institution on Saturday on "Electric Discharges through Gases." The lecturer explained the phenomena met with in the discharge through exhausted tubes, including the striation effect, and the sudden cessation of the discharge on a slight increase of resistance in the circuit. Some remarks on the electric arc, which, Prof. THOMSON said, was a case of discharge from an incandescent solid and not a discharge through a gas, concluded the lecture. The scheme for an Indian Institute of Science is progressing. In the Papers abstracted in the Continental Section, BOUQUET DE LA GRYE proposes to establish an international wireless hour signal to cover the whole globe, and BOSLER redetermines the number of electrons in an atom. (Page 597.)

AMONGST the patent specifications published on Thursday last is one by the BRITISH THOMSON-HOUSTON Co., describing a method of avoiding the use of compensating windings of any sort in the interpolar spaces of commutator motors by providing the armature with a fractional pitch winding. A commutating field is produced at the main pole-tip. A specification by J. S. HIGHFIELD relates to a modification in the high-tension continuous-current series system; the prime-mover is a single large turbo-alternator supplying current to a number of rotary-converters, the direct-current sides of which are in series. BRUCE PEEBLES & Co. and LA COUR have patented an improved method of using amortisseurs. (Page 599.)

IN consequence of the Bangor Council insisting upon increased rent for the poles of the National Telephone Co., the latter has threatened to discontinue the service in Bangor.—An action is to be taken by some of the authorities in West London against the London United Tramways, Ltd., for an injunction in respect of alleged nuisance from noise from the tramcars.—In a communication to the Edinburgh Chamber of Commerce the Postmaster-General states that but for difficulties in obtaining the consent of the Edinburgh Corporation to the execution of the underground work, the underground telegraph line from Linlithgow to Edinburgh would have been completed long ago.—The accounts of the Launceston (Tasmania) Council for the year 1907 show a net balance of £8,770.—The Finance Committee of the London County Council gives figures showing the amounts sanctioned during the financial year 1907–8, and the preceding years, for electric lighting loans.—Permission has been granted to the Newcastle Electric Supply Co. by the Tyne River Commissioners, to lay a 6,000-volt cable under the river Tyne, between Carville, Wallsend, and Hebburn.—Messrs. Kincaid, Waller, Manville and Dawson have reported to the Torquay Corporation with regard to meeting the extra demands from the Tramways Co. Two alternative schemes have been presented, one of which involves the transfer of some of the plant of the present station to another site, and the other the erection of a new station. (Pages 601–604.)

THE Aberdeen Corporation is to apply for sanction to borrow £80,000 for extensions to the electricity undertaking. Local Government Board inquiries with regard to loans for electric lighting purposes have been held at Aston (£25,213) and Canterbury (£4,000). The London County Council require 175 double-decked roof-covered car bodies with maximum traction trucks and complete electrical equipment for the overhead trolley, surface contact, and underground contact systems for the same. Applications are to be made to the Local Government Board for loans for electric lighting purposes as follows:

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—£7,942 by the Morley Corporation, £22,696 by the Wigan Corporation, and £1,700 by the Whitehaven Corporation. The British Thomson-Houston Co. is supplying a 1,500 k.v.a. exhaust steam turbine at 2,875 volts 40 cycles to the Tyneside Electrical Development Co., to be worked in connection with the Teesbridge Iron Co. (Pages 604, 605, and 583.)

The directors of the Anglo-Argentine Tramways Co. propose to make an issue of £500,000 new debentures very shortly. The accounts of the Bath Electric Tramways Co. for 1907 show a balance of £13,749, and after deducting the interest on the 4½ first mortgage stock interest and dividends on the preference shares, the balance of £24,890 is to be carried forward. At the annual meeting of the British Electric Transformer Co. last week, an amendment that the report be received but not accepted was carried, and a poll is to be taken. The accounts of the Calcutta Tramways Co. for 1907 show a revenue balance of £63,333 and a net balance of £18,979, out of which a final dividend of 2s. 6d. per share is to be paid. A scheme for dealing with the profit-sharing notes of the Underground Electric Railways Co. of London has been published. Sir George Gibb has been appointed receiver and manager in the temporary voluntary liquidation which is necessary. (Pages 606 and 608.)

The habit of grumbling, practised in moderation, is inborn in every British citizen, and is not a bad thing in its way; but when a habit is indulged in to excess, it invites either ridicule or disaster. We trust that the former and not the latter will be the result of the foolish attitude taken by some Jeremiahs in the electrical world, who foretell disaster to the supply industry because of the advent of an electric lamp three times as efficient as the one we have had hitherto. That, in some cases, the receipts from the sale of electrical energy are momentarily falling off has perhaps been unavoidable, but it is absurd to waste valuable time on lamentations when all available energy should at once be devoted to making the utmost of the inventions which have now made electric lighting far and away the cheapest of all illuminants. Doubtless the revolutionary change in the electric lighting industry which the metallic filament lamp is bringing about will necessitate a large amount of adjustment in the details of electricity supply practice. The most important of these must be the employment of cheaper methods of connecting up house services. At present, as was pointed out by Mr. Arthur Wright in the discussion on Messrs. Handcock and Dykes' Paper, there are cases in which it costs almost as much per kw. to connect up a consumer as to build the electricity works that is to supply him. Probably the old contract system of charging a fixed sum per lamp per quarter will have to be reverted to in the case of the numerous small consumers, who will be attracted by the cheaper light. This system, in the light of modern knowledge of the cost of electric supply, is not so inept as is sometimes thought, for, if it is assumed that the consumers' lamps are on during the period of peak load, the exact computation of the time they are employed on either side of the peak is less important, as the cost of supplying is then much lower. On the other hand, an introduction of any other system of charging than the flat rate or on contract would be a great mistake when it is a question of winning over the small consumer from gas by proving to him that his light will cost him less. Neither Messrs. Handcock and Dykes' "contract demand" system nor Mr. Long's "assessment tariff" should be thought of in such cases, and the maximum demand indicator should be reserved for the large and intelligent power consumer, or used only as a measuring instrument for the information of the central station engineer and manager. Now is certainly not the time to introduce new systems of charging, and the only method we dare suggest to the supply station manager for saving his profit during the next few months is to increase slightly his meter rents; but even this suggestion we put forward with some diffidence. The metallic filament lamp will be the means of lifting the electrical industry out of its present depression by an enormous extension of electric lighting all over the country. It means a large increase in the number of members of the general public who are direct customers of that industry, and any step tending to retard this increase artificially is strongly to be deprecated.

Although many excellent reasons were advanced for the electrical industry having a representative exhibit at the forthcoming Franco-British Exhibition, electrical firms have shown from the outset a disinclination to take part in it. To some extent this was due to a feeling that the exhibition at Shepherd's Bush would take rather the form of a pleasure garden than an industrial exhibition, but the main reason was that the electrical firms are reserving their energies for their own exhibition to be held in Manchester next October. By dint of great perseverance on the part of Dr. R. T. Glazebrook, last year's President of the Institution of Electrical Engineers, and Mr. C. S. Northcote, supported by the electricity supply interests in London, arrangements were practically concluded for a joint exhibit of electrical manufacturers, but we learn that at the last moment the whole scheme has fallen through, owing to unfortunate delays and the lack of interest that has been displayed from the outset. The original proposal was that there should be a regular electrical section, and circulars were sent out by the secretary of the Institution of Electrical Engineers on behalf of Dr. Glazebrook, who was to be chairman of the section. There was practically no response to this, but as it was understood that the gas interests would be very well represented indeed, it was thought that the matter should not be allowed to drop, and the electricity supply undertakers in London promised to contribute to the expenses of a joint electrical exhibit, if a sufficient number of electrical firms could be prevailed upon to take part in it. The matter proceeded very slowly, but finally some twenty firms, including many of the large ones, made formal application for space. Then difficulties arose between the committee for the joint exhibit and the organisers of the exhibition on points of detail with regard to the allotment of space, and even last week we believe the matter was not definitely settled. The result was that the majority of the larger firms who had intended to exhibit announced their intention of withdrawing, and as actually only twelve of the smaller firms were left, the supply companies decided that it would not be worth while supporting the joint exhibit financially, and the whole thing has fallen through. The large firms who have withdrawn and the electricity supply companies cannot be blamed for their action, since it is evident that owing to the intervention of the Easter holidays, no really good electrical exhibit could have been erected between the present date and the opening of the exhibition on May 1st.

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THE MANAGEMENT OF ENGINEERING WORKSHOPS

MR. EUSTACE THOMAS'S Paper, read on Tuesday at the Manchester Local Section of the Institution of Electrical Engineers, contained the impressions of the author regarding details of organisation and record-keeping in a number of manufacturing works which he had recently visited. Most of these were specialised shops, where the work was almost wholly standard, and the greater ease of running works of this nature as compared with general shops was emphasised early in the Paper.

It is generally agreed that the workman in every case should have a drawing to work to, fully dimensioned; that is, that the workman should have only manual work, and all head work should be done by the draughtsman or designer. On the same principle a complete detailed list of material should be prepared in the office, instead of the material being requisitioned from the drawing by the foreman or the workman without a list. The workman becomes a head worker, and he is usually a very inefficient and expensive one. Moreover, a list *must* be got out by some one, and if this is done in the works it will have to be thought out and written out every single time that the job repeats itself. The certain result is preventable expense and loss of time. The list should be prepared in the office even if only one article is to be made, but in such form that it may be readily available for any future work.

A still further application which is only seldom made is that there should be provided also a list of operations and list of tools, jigs, &c., in every case where a new workman might possibly be in doubt. This applies particularly in some classes of switch work.

In speaking of the duties of foremen, the author classifies these as (1) *Clerical or Administrative*, such as giving out work, seeing that there is no delay caused by waiting for material; watching the efficiency of the workmen, planning to get work executed to time, &c., &c.; and (2) *Technical*, such as the consideration of methods, tools, and jigs, for executing work, for overcoming difficulties, for reducing cost of production, &c.

The author inclined towards giving the foremen chiefly administrative work, but he must be technical enough to know if matters are not going rightly, and in such set an expert toolfitter to study the case and do what is required. The value of a certain amount of "red tape" in defining and ensuring correct routine was pointed out, although such routine is useless unless kept up by constant supervision and periodical inspection of the works by the manager. The value of brain-saving devices in the cost departments was also mentioned.

Lists of material can be made to serve several important purposes, for example:—The storekeeper marks it for material in stock or to order. The stores issue goods from it to the foreman's auxiliary stores without further requisition. The foreman can check by it all material at any stage. The drawings having been cut up into as many parts as there are pieces or groups of pieces to be made, a copy of the list is also cut up and pieces attached to the divided-up drawings for the workmen's use. On a further copy, against each item is marked the time by which it must be completed, in order that the whole of the work may go through to the date desired. Each shop foreman must have his own copy marked. A copy goes to the cost department. The work can be priced against this list in advance if required, and actual issues and returns can be checked against it. Where work is executed in different shops, it is of assistance to subdivide the list accordingly. Any assembled parts which may be used for other work are best given separate lists, as they may be manufactured for stock.

The advantages of the provision of proper type numbers to standard parts are pointed out, and it is recommended that the utmost care should be taken ensuring the return of unused material to the stores, and recording materials scrapped through fault in the material, labour wasted through fault in the material, labour wasted through faulty workmanship, material wasted through faulty workmanship, and cost of putting any jobs right if that is possible.

Shop drawings should consist of pieces of cardboard carrying that part of the drawing required for any one piece or group of pieces given out to one man only at a time. On the same card is the list of material, cut off the general list, the list of operations, and the list of tools, gauges, jigs, &c. The separate cards are numbered serially and usually kept together. Those required for a job are distributed in the auxiliary stores in the space allotted. There should be some material to each card, if all material has been collected.

The Paper then goes on to deal with day work and piece work. The following are given as some disadvantages of day work, especially in general shops:—The men slack off as soon as the foreman's vigilance relaxes at all. Some men regard it as a matter of principle to make jobs last as long as possible with a view to increasing employment. The men are quite content to wait for material. The handling of material by the foreman is always less efficient. Costing is uncertain and unsatisfactory.

Some advantages of premium or piece work are:—Each man has an interest in the work. The men press the foreman to give efficient delivery of material, and the foreman is thus placed between two fires. Each job *must* have careful consideration before being committed to a price or time which may be hard to change. Each job makes the estimation of new work easier. The foreman has more time to plan his jobs and is better able to estimate for and keep correct promises of completion. If the assemblers are on piece or premium work, they draw attention themselves to any inaccurate manufacture of parts coming to them.

The question of saving "non-cutting" time taken up in gauging, setting up, changing tools, &c., is then considered, and it is pointed out how attention to detail may considerably shorten this.

In a general shop having many small jobs in hand at once it requires a very clever foreman to give times of completion of all work in hand which he can adhere to, and yet not have too much labour employed. The author has devised a special indicator for the purpose, which gives the foreman a bird's-eye view of the work in hand, and of the capacity for work. It requires that time shall be estimated on all work in detail, whether on the day, piece, or premium systems. One or more suitable boards are laid out with horizontal grooves to represent the different men in classes according to employment, wages, &c.; some spare grooves are also allowed to each class. Vertical lines are drawn to scale to represent hours, days, and weeks. Fairly narrow strips of card are cut off for each job, of length equal to the number of hours estimated, and marked with the job number and date by which completion is required. These are then set up in the grooves, always to the left of the date marked on them. If there is more work in hand than capacity in men some cards must go into the spare grooves. The card to the left in each groove is always the job in progress at the time with that man, those to the right being arranged in the order of present urgency. They can be reshuffled later as altered circumstances may seem to require. Thus the foreman or manager can see at a glance what work is likely to be late, what is the present capacity for new work, stock work, &c., what jobs are hanging, and where it is desirable to take on or discharge men. The material labourer can also see what materials, tools, &c., are likely to be required soon, and get them ready.

Institution of Electrical Engineers.—The meeting on Thursday next, April 23rd, will be held in the Institution of Mechanical Engineers' building. Messrs. Handcock & Dykes' Paper on the effect of the metallic filament lamp on the electricity supply industry will be further discussed.

The First Overhead Single-phase Railway in England.—The experimental use of single-phase traction on the Morcambe-Heysham branch of the Midland Railway was taken into use last Monday. An overhead single-phase system at 6,000 volts is used with catenary suspension. The line is the first overhead single-phase to be put into operation in this country.

Electrotyping.—On Thursday night Mr. Sherard Cowper-Coles read a Paper, entitled "Some Notes on Electrotyping," at the London County Council School of Photo-Engraving and Lithography. The chief features dealt with were the conditions necessary for the rapid electro-deposition of copper on the moulds, and the various effects obtained by mechanical and chemical treatment.

Damage to an Electric Light Standard.—The Islington Borough Council sued the London Road Car Co., at the Clerkenwell County Court, on Friday, for £30 5s. damage to an electric light standard. It appears that on May 31st last a Union Jack motor-omnibus skidded in Highbury Grove and collided with an electric light standard on the foot-path, breaking the column. The driver of the 'bus stated that he was driving at about seven miles an hour, and that the omnibus skidded on account of the greasy condition of the road. In the end the jury found for the Borough Council for the full amount claimed.

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EFFECT OF METALLIC FILAMENT LAMPS ON THE BUSINESS OF ELECTRICITY SUPPLY

At the Institution of Electrical Engineers last Thursday, a Paper was read by Messrs. H. W. Handcock and A. H. Dykes with the title "Electric Supply Prospects and Charges as affected by Metallic Filament Lamps and Electric Heating." The authors pointed out that, with the new metallic filament lamps giving from 23 to 30 c.p. at 110 volts with a consumption of 40 watts, consumers will in some cases be able to do with fewer points and thus reduce their consumption, whilst in other cases they will merely improve their lighting without greatly reducing their consumption. So far as private consumers are concerned, the authors are of an opinion that, owing to the high price of the lamps and the fact of their being only available in comparatively large units at about 100 volts, the lamps will only be adopted at present when the consumer is sure that the total lighting bill will be reduced or, at any rate, not increased. Where a large proportion of the points are at present single lights with separate switches for each point, the saving in current by using two lamps in series would not, they think, be great enough to ensure the general adoption of metallic filament lamps at present. On the other hand, in the case of shops, halls, and factories where the lamps are mostly on all at once, even if the same total number of the lamps is used, the current consumption would be reduced by about one-third, with an increase in the illumination of 50 per cent. or more.

The authors state that when the lamps are run in series, their life depends very much on the fluctuation in voltage on the circuit, and under ordinary conditions is considerably less than when the lamps are in parallel. The 100- and 110-volt Osram lamps are said to have a useful life of 750 hours, but in calculating the cost of lamp renewals it must not be forgotten that breakages in transit are a serious item. In the case of Tantalum lamps a 750-hour life is also guaranteed, whether lamps are run in parallel or two in series; but in the latter case it is conditional on the lamps being properly paired, that if one burns out both be replaced (the partially worn-out one paired with another which is partially worn out), and that the voltage of the lamp corresponds not with the declared voltage, but with the highest voltage actually occurring on the circuit in question.

Coming to the effect of the decreased consumption on a supply station when these lamps are used, the authors point out that if, for instance, the consumption per consumer is reduced by one-third, it is not sufficient, in order to obtain the same profit, to increase the number of consumers by 50 per cent., as this only keeps the output at its former figure without allowing for the increased capital outlay on services, meter reading, and general administration.

The Paper next deals with the use of 25-volt metallic filament lamps supplied from the alternating current mains through an auto-transformer. In their own private houses the authors have made use of such an arrangement, connecting in each case an auto-transformer across the 200-volt supply main and taking off from it eight circuits of 25 volts each. This lower pressure permits the use of 25-volt metallic filament lamps of 8 and 14 British candle-power, which are cheaper in first cost, more efficient, and stronger than the 100-volt lamps. The 8 c.p. 25-volt Osram lamp is rated at 10 watts, and the 14 c.p. at 16 watts. They have tested transformers made by different makers, each wound for 8 circuits of 25 volts, and 4 or 5 amperes per circuit for use on 25-volt 50-period mains, and they have found that the no-load consumption with all lamps turned off is from 12 to 15 watts. In order to save this loss in the daytime and during the night, they have placed two-way switches on the ground and bedroom floors, by means of which the transformers are switched off the last thing at night and only turned on again on the ground floor when the lamps are required again next day, and they use carbon filament lamps in the bedrooms. They state, however, that there is now on the market more than one device which will switch the transformer off when the last lamp is turned off, and switch it on again when the first lamp is turned on. They have found that the consumption in their houses is only from one-third to one-half of what it was formerly. The smaller lamps can be used in any position, and are of ordinary size, so that they can fit any ordinary shade. Their price is 3s. instead of 4s., and an electrolier with six 8-c.p. lamps only consumes the same amount of energy as an ordinary 16 c.p. carbon filament lamp.

Some comparative tests were made by a large firm in London on a portion of their installation, consisting of fifty 8-c.p. lamps. With the carbon filament lamps the meter reading over two hours was 3·25 units, whilst with an auto-transformer and 25-volt 8-c.p. Osram lamp the reading for the same period was only 1·10 units.

This arrangement could, of course, not be used with continuous current, but 50-watt 40-c.p. 200-volt lamps are now being placed on the market.

The authors next compared the effect of the reduced consumption on the supply station with the effect of the introduction of the incandescent mantle in the case of gas lighting. They find in the Board of Trade returns that the total capital expenditure in the whole country on gas undertakings has been £124,184,000, the gross revenue £27,254,000, and the gross expenditure £20,496,000. For electrical undertakings the figures are:—Gross capital, £50,767,000; gross revenue, £6,514,000; and gross expenditure, £3,019,000. This works out to an expenditure of £4 10s. for a gasworks, or £7 10s. for an electricity works, in order to obtain the gross revenue of £1 per annum. Owing to the higher capital expenditure, there has to be a greater percentage difference between the income and expenditure in the case of the electricity works than in the case of the gasworks, as the larger capital charges have to be added to the total cost of generation. In addition to this, an electricity supply company is generally liable to be bought out at a sum representing far less than its capital expenditure after a 42 years' life, and has therefore to provide a substantial sinking fund. Another disadvantage from which the electricity undertaking suffers is that the consumer's service line, exclusive of meters, costs far more than for gas. The authors place the figures at £5 to £6 in the case of electricity, and £1 to £1 10s. in the case of gas. Moreover, if supply is required for heating, an additional expense has to be incurred for additional meters and wiring. From these figures the authors deduce that, supposing a gas and electricity company each lose 20 per cent. of their business, the gas company would have to raise its price by 6·25 per cent. in order to keep their profit at the same figure, whilst the electricity company would have to increase its price by 13·4 per cent. The opinion of gas engineers is quoted to the effect that it was the increase in gas cooking and heating which "saved" the gas companies when the gas mantle was introduced. The average annual revenue per gas consumer throughout the country works out from the Board of Trade returns at £5 8s., and the authors cite an extreme case

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in which the gas company is paying the full statutory dividend of 10 per cent., although a large proportion of the consumers have only about six lights in use, and their bills, including meter rents, did not average more than £1 16s. per annum.

The Paper next analyses the total saving in the case of a large London firm alluded to previously in the Paper, which had substituted 25-volt metallic filament lamps supplied through an auto-transformer for carbon filament lamps. They had 686 eight c.p. lamps consuming originally 36,260 units per annum, and they paid the average price of 3·47d. per unit. Their annual account came to £604 12s., of which the cost of electrical energy was £524, and the lamp renewals (1,612 lamps at 1s.) £80 12s. With the 25-volt Osram lamps only 12,500 units were consumed per annum, so that, assuming the same price of 3·47d. per unit and the same life for the lamps, the annual cost would be £422 10s. 7d., of which £180 14s. 7d. would be paid for electrical energy and £241 16s. for lamp renewals (1,612 lamps at 3s.). The lamp-makers receive in the latter case about three times as much as formerly, whilst the supply station has lost 65 per cent. of its business. As a matter of fact, the difference was not quite so great in the case in question, as the installation is supplied on a sliding scale depending solely on the quantity consumed, so that the bill for electrical energy came to £205 2s. (10,000 units at 4d. per unit, and 2,500 units at 3½d. per unit) instead of £180, and the total, including lamp renewals, was £446 18s. If the firm had been charged on the maximum demand system, the maximum demand would, of course, have been reduced in the same proportion to the total consumption, and the price per unit would have remained at 3·47d. instead of there being a slight increase.

The authors next turned to the main point of the Paper, namely, a proposal to revise the system of charging, so that the reduction in current consumed due to the use of metallic filament lamps will not affect the electricity supply business so seriously as they think is otherwise threatened. They favour a system in which it is not necessary to put in a separate meter when current is used for power, heating, &c., in addition to lighting, as this presents obvious advantages both to the supply undertaking and consumer. In the system they propose, a consumer, when he applies for a service, will state as at present the number and candle-power of the lamps he proposes to use, and the station manager will estimate from this the probable maximum demand. This the authors call the consumer's "contract demand." The consumer is to pay a fixed annual sum, depending on the amount of this "contract demand," and, in addition, a certain price per unit. The authors give the following examples as to how the prices work out in practice:—

A certain alternating-current station has a maximum load of 713 kw. on the station feeders, and the sum of the consumers' "contract demands" would probably be found to be about 990 kw., depending on the nature of the load supplied.

	£
The interest and sinking fund charges absorbed	6,203
The rest of the "preparation costs"* amounted to	4,449
Giving a total of	£10,652

This divided by 990 gives £10 15s.† as the standing charges per "contract" kilowatt demanded. The "production costs" per unit were 0·87d., say 0·95 pence, allowing a margin for profit.

The charges would therefore be £10 15s. per "contract" kilowatt demanded, and 0·95d. per unit consumed.

As an illustration take two typical houses, A and B:—

"A" has an equivalent of 60 lamps of 8 c.p., and consumes 655 units at 5½d. per unit, the present flat rate = £15.

The "contract demand" would probably be fixed at 0·9 kw., and the charges under the new system would therefore be—

	£	s.	d.
0·9 kw. at £10 15s. per kilowatt	9	13	6
655 units at 0·95d. per unit	2	11	10
Total	£12	5	4

= 4·5d. per unit.

"B" has an equivalent of 55 lamps of 8 c.p., and consumes 350 units at 5½d. per unit, the present flat rate = £8.

With the "contract demand" fixed at 0·9 kw. the charge would be—

	£	s.	d.
0·9 kw. at £10 15s. per kilowatt	9	13	6
350 units at 0·95d. per unit	1	7	8
Total	£11	1	2

= 7·58d. per unit.

The tramways take 360,000 units per annum.

Assuming 100-kw. "contract demand" the charges would be—

	£	s.	d.
100 kw. at £10 15s. per kilowatt	1,075	0	0
360,000 units at 0·95d. per unit	1,425	0	0
Total	£2,500	0	0

= 1·67d. per unit.

Take next a shop as an example:—

Lamps installed, say, 20 of 40 watts each, consuming, say, 400 units per annum.

"Contract demand," say, 0·8 kw.

The charge would be—

	£	s.	d.
0·8 "contract demand" at £10 15s. per kilowatt	8	12	0
400 units at 0·95d. per unit	1	11	8
Total	£10	3	8

= 6·11d. per unit.

As applied to a motor load, take, for example, a 10-h.p. motor giving a variable load for, say, 50 hours per week.

The charge would here be as follows:—

	£	s.	d.
"Contract demand," say, 10 kw. at £10 15s. per kilowatt	107	10	0
Say 13,500 units per annum at 0·95d. per unit	53	8	9
Total	£160	18	9

= 2·86d. per unit.

This consumer cannot be profitably charged at a lower figure, even on a flat rate, as he has the privilege of coming on at peak load. If, however, the consumer would agree not to work his motor during lighting hours, or, at all events, during the period covering peak load, but not otherwise, his rate per "contract kilowatt" demanded should be fixed as a matter of equity at, say, £5 per kilowatt.

His account would then become—

	£	s.	d.
"Contract demand," 10 kw. at £5 per kilowatt	50	0	0
13,500 units at 0·95d. per unit	53	8	9
Total	£103	8	9

which represents 1·84d. per unit instead of 2·86d.

In order that the consumer does not exceed his "contract demand," the authors propose to insert in every house a "limit indicator," the function of which is to throw a resistance into circuit when the above demand is exceeded, and thus to give the consumer an indication of the fact by reducing the brilliancy of his lamps. If the consumer has under-estimated his "contract demand," he would, it is assumed, ask to have his indicator set higher.

The authors point out that there are at present two difficulties in the application of the above system. Section 31 of the Electric Lighting (Clauses) Act provides that in the event of the undertakers charging by any special method (which must be approved by the Board of Trade), any consumer has the right, by giving one month's notice in writing, to require the undertakers to charge him by the actual amount of energy supplied to him. Moreover, in most Electric Lighting Orders the Board of Trade has fixed the maximum charge for any

* The authors define "preparation costs" as the costs which are independent of the actual output of the station, including, in the case of companies, a reasonable dividend.

† By taking 990 kw. instead of 713 kw., the maximum load on the station feeders, the consumer gets due allowance for the Diversity Factor

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amount up to 20 units at 13s. 4d., and for each unit over 20 units 8d. (In some cases the rate of 7d. is substituted for 8d.)

In concluding the reading of the Paper, Mr. Handcock read the following remarks:—

Only a few months have elapsed since this Paper was written, but much has happened meantime. Two metallic filament lamps are now being sold to every one carbon filament lamp, and many matters that were then surmise can now be tested by actual results, and a fairly close answer given to many points that our Paper raises. These results entirely confirm our views as regards the individual consumer, and they also demonstrate that the effect of metallic filaments is so complex that generalisation is impossible.

On no two stations are the effects the same; in some cases the first quarter of this year has been better than ever; in others, the normal rate of increase has not been maintained; while others again report a lower peak load than in 1907.

From the very fact that the "light-supplying capacity" of stations has been doubled or trebled at a stroke, the demand for new plant will be small until matters have readjusted themselves. As against this, the lamp-makers will reap a well-earned harvest of their labours, and installation contractors will share their prosperity. For the investor in electric light undertakings, there is the reassurance that any dislocation can only be of a purely temporary nature, as even if the consumer, who now pays 5d. per unit, for instance, were called upon to pay double that amount, his electric light would even then cost him less than it did with carbon filaments. This is a fact we must always keep before us. Provided that the situation is properly dealt with, as it doubtless will be, it is a fact that leaves room for no fear as to the future, for, after all, electric light stations must be judged, not by "units sold," but by "dividends paid."

In a short note at the end of the Paper, the author referred to a system of charging introduced by Mr. F. W. Long, City Electrical Engineer, of Norwich. Consumers have the option of taking a supply either at a flat rate of 4½d. or at what is called an "assessment tariff." Under the latter, the consumer pays a fixed charge of 12 per cent. upon the net assessment of his house and a 1d. per unit for current used. It will be seen below that Mr. Long spoke in the discussion and referred to the system at greater length.

Mr. Dykes also added some remarks. He desired particularly to emphasise two points. The first was the advisability of alteration in the present methods of charging, which had been apparent to the authors for some time, and had only been accentuated by the advent of metallic filament lamps. When a manufacturer found he could no longer supply his goods at the old prices, he must either raise his prices all round, or must rearrange them so that the greater part of the increase is borne by his most unremunerative customers. At the same time, he must try to open up new avenues for the sale of his goods. This was what the "Contract Demand" system endeavoured to carry out, by putting the increase on the short-hour consumer, and encouraging the use of current for other purposes besides lighting. The second point Mr. Dykes desired to make clear was that the authors were not pessimistic as regards the future of the electric supply business if the new conditions are properly grappled with. Take the case of a consumer now getting current at 5d. per unit and paying one shilling each for his 8-c.p. carbon lamps. If he replaced them with Osram 8-c.p. lamps at a cost of 3s., the amount he could afford to pay per unit for current, without increasing the total cost of lighting, was no less than 11·8d., or, if he used Osram 14-c.p. lamps, 14·6d. It was quite clear, therefore, that there was ample margin for the total cost of electric lighting to be considerably cheapened, and for the stations still to get a satisfactory price for their current. This fact must in the long run be in favour of the stations. The authors did not want Parliament to raise the average price above 8d. per unit. They merely wished to be able to distribute the load fairly, viz., to raise the scale at one end and lower it at the other.

DISCUSSION IN LONDON.

Mr. Arthur Wright, who was called upon by the President to open the discussion, said he thought the answer to the question as to how metallic filament lamps would affect electric supply undertakings in this country depended entirely upon the men in charge and how it was managed. If it were left entirely to the wiring contractor, he thought that for two or three years they would have quite a bad time, but if the central station men took the matter up and insisted on people having more light for the same current, instead of less bill for the same light, it would be possible to counteract the effect of the use of these lamps, and it was quite possible to do it by judicious advertising. They should abandon such advertisements as "70 per cent. discount on your bills," and advertise "Three times as much light for the same bill." Of course, one important point in connection with competition with the gas companies was the great advantage which the latter had in the way of having no restrictions, or rules, or fire rules. A very great deal of harm had been done to the electrical industry in their being too ready to make the service absurdly safe. Returning to the effect of metallic filament lamps upon the electrical industry, he said that they must not overlook the enormously increased field for business which this new discovery made possible—a type of business which had always been considered beyond the range of commercial politics. So great was this field that he did not fear that the metallic filament lamp would do the supply business any harm; on the contrary, the consumption of current would be vastly increased because of this increased field. One point, perhaps, had not been sufficiently emphasised in the Paper. Most stations could supply a greater quantity of electrical energy at a very much lower cost than the average cost they were now supplying at, or, in other words, the increment charges of extending their business were nothing like the present average cost. Taking the case of Marylebone, which, perhaps, represented to an extreme degree many other undertakings in this country, the average cost was 4½d. per unit; they could double their output for an increase of 8 per cent. in the capital. If they doubled the output, the average cost would go down to 2¼d. per unit. It was therefore obvious that they must do everything to increase the output, and nothing in the way of restricting or making the business difficult must be entertained for a single moment. Another point to which he would like to draw attention was as to why most of them felt justified in charging less for power supply than lighting, although it might occur at the peak time. It was because of the great diversity among the motors, compared with lamps; 1,000 kw. of plant in a station could handle very much more kilowatts of motors at the peak than it could of lights, because the motors were not necessarily continuously on at the peak. The worse the load factor, the more the diversity factor helped. In the East-end of London he believed Mr. Tapper had found the diversity factor among motors was something like 4, whereas among lamps it was certainly never more than 1½. It was obvious from this that a very much lower rate could be charged for power, or for any supply not dependent upon the setting of the sun. With the exception of a few pumping installations, the average motor was as intermittently used as the tramway motor. The diversity factor among motors was tremendous compared with lamps, and it was on account of that difference that the standing charges were lower. There was another disadvantage that they were suffering from, viz., the high cost of house connection. At present it cost nearly as much per kw. to connect a house as it did to build a power station, and while they were taking all the trouble to reduce the cost of power-station capital, nothing up to now had been done to reduce the equally important cost of house connections. He hoped some day it would be possible to have one service per block, and some means of overhead supply to the different tenements, or outside tubes—anything to avoid this £10 or £9 per service, which was fatal to the supply of small consumers.

Mr. Hugo Hirst (General Electric Co.) said he had just sent to the secretary of the Institution a Paper in which he dealt rather exhaustively with the evolution of metallic filament lamps of various makes under various patents, and gave tests gained from experience by various station engineers in different countries, as well as many engineers in this country; he also in this Paper had dealt with certain questions such as transformers and other points raised by Messrs. Handcock & Dykes. He rather fancied that if he had had the opportunity of reading his Paper first, the conclusions of the authors in some respects would have been different. He did not wish to go into the details of his Paper that evening, but he merely mentioned the circumstances to explain why he did not describe some of the characteristics of these lamps as might have been expected. Dealing with a few points suggested by the authors, he objected to the statement that a 40-watt tungsten lamp gave 23 to 30 c.p.; this was somewhat unjust, as that lamp gave at least 32 to 35 c.p. The authors also gave some figures with regard to the life of this lamp. In practical experience the life of metallic filament lamps had surprised all makers of carbon lamps; it was considerably higher than the life of carbon lamps, and what the authors said about series running were conditions which, in connection with the tungsten lamp, did not exist at the present time. Tungsten lamps were now made and tested with such accuracy that they could be paired easily, and, after many hours, instead of throwing both of the lamps away as the authors suggested, it was possible to put a new lamp with the old one, and they would run perfectly well. There was a little trouble at one period, but that was due to an ordinary mistake in a factory, and since then there had been no trouble in actual use. There seemed to be a grievance that the lamp-maker was making too much money out of the metallic filament lamp. As a matter of fact, the greatest losers, in the first instance, were the lamp-makers themselves, for they had to depreciate their existing carbon filament lamp works, and had to go to such a considerable expenditure in the matter of patents and experience generally that it would take many years of good prices before this risk was covered. He therefore

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thought the least central-station engineers—who would ultimately be able to benefit mostly from it—could do was to contribute somewhat to that capital expenditure if it was wanted for the benefit of the whole electrical industry, in the way of momentarily reduced takings from the supply of electrical energy. Taking the authors' figures of £6,000,000 per annum for the electric lighting industry, and £27,000,000 for the gas industry, he was quite sure that there was plenty of room for taking from the gas people another £6,000,000 or £7,000,000 by the use of metallic filament lamps, which would go entirely to the dividends of the central-station engineers. As a side issue, not without interest, he took the opportunity to betray an attempted conspiracy in this connection. When he realised twelve months ago that he was likely to control the sale of metallic filament lamps for some considerable time, he had the brilliant idea of asking 15 central-station engineers in London whether it would not be a good plan for them to take up the supply of metallic filament lamps to contractors, and the contractors, under their instructions, to introduce them in the first instance to gas consumers, so as to win them over to electric lighting, and thus to create a larger load before the present consumers could begin to reduce their load by substituting the more efficient lamps for their present ones. But the station engineers thought it was a plan for his own benefit, and the idea fell to the ground. At the same time, they need not now resort to panic measures; it might have a very detrimental effect if they were to alter things as regards electric lighting Bills by trying an experiment of the kind mentioned by the authors.

Mr. C. Bottomley Smith (Hove Electric Lighting Co.) said that without depreciating the very excellent system the authors proposed—namely the "contract demand" system, from his experience he thought it would be very unpopular from the consumer's point of view. He had had considerable experience of the minimum charge, and, having done away with that, and found the benefits of doing so, he thought the mystery of a "contract demand" and increasing consumers' account would have a very detrimental effect upon the industry. He could hardly agree with Mr. Arthur Wright as to the figure of £10 for house services; it would probably be done for much less than that. He thought the question of house service, however, was the great question that affected them if they hoped to double or triple the number of consumers so as to make up the loss of revenue of the consumers already connected.

Mr. W. R. Rawlings said it was not often that a Paper was read before the Institution of Electrical Engineers which called for a large number of electrical contractors to be present, and Mr. Wright had probably overlooked the fact that there were on this occasion a large number of contractors present when he made his statement with regard to them. More bad language was expressed over the Wright maximum demand indicator than anything else, within the contractor's hearing; if there was one thing more than another which upset the average consumer, it was the Wright indicator. In a certain installation of about 100 lamps which he (Mr. Rawlings) had fitted up, it mattered not what that consumer did, he always had to pay 7d. per unit. Another installation which had about 50 lamps was fitted by another contractor, and the consumer in that case managed to get through at about 4½d. His own consumer insisted that his installation was bad because he was paying 7d. whilst his friend was only paying 4½d. or 5d. He had never yet found a consumer who could understand the Wright maximum indicator. Another tariff system, introduced by Mr. Erskine, of the Kensington & Knightsbridge Electric Lighting Co., also gave the consumer great difficulty in understanding it; the consumer generally understood it at the end of the financial year, which was a little late. There were a number of installations in Kensington which had no less than three meters, three main switches, three double-pole fuses, and three sets of fuse boards, whilst one set of these mains, meters, and fuse boards would be sufficient to meet the whole requirements of each particular house. This triplicating of wires was only brought about by reason of the absurd system of charging. It was very nice from the contractor's point of view, but was a check on the development of the industry. Moreover, frequent inquiries were made for a kettle or food-warmer, but when the customer was told that he would have to pay 4½d. or 5d. per unit, or else have a separate set of wires and a meter, he absolutely refused to buy the piece of apparatus, and consequently the manufacturers suffered, and the contractors, who sold through them, suffered likewise. He was of opinion that the authors' system would encourage the use of such small apparatus, and he quoted from 24 specimen accounts from actual installations, which he had worked out on the author's system, and in which he found that the desirable consumer would pay less, and the bad consumer would pay more than at present. One point, however, he thought the authors had overlooked, and that was in making provision for special illumination, such as for parties and similar functions; there should be some method of charging a fee to cut out the automatic indicator on such occasions.

Mr. F. W. Long (Chief Electrical Engineer, Norwich Corporation) said that about eighteen months ago he went into the question of reductions to consumers, as he wanted to encourage the profitable consumers and also the use of radiators, &c. It occurred to him that if they could fix the standing cost in some definite way, such as on the assessment of the house, it would have many advantages. He took the consumptions of a number of houses and found that, on the average, a small private house used seven units per pound of assessment, and that this figure held equally for a larger private house. Thus it appeared that the rateable value was, on the average, a measure of the consumption, and it followed that the rateable value was also a measure of the average maximum demand of the house. He then found that if they were to charge 10 per cent. of the rateable value and one penny per unit, he would get the same income as they had hitherto. The charge actually fixed was 12 per cent. of the rateable value, and one penny per unit, and the system was put into force early in 1907, so that he had had fifteen months' experience of it. The advantages of the system were similar to those of the "contract demand" system, as only one pair of wires was necessary, there was no meter rent, and, further, a consumer knew within a little what his bills were likely to be for the year. At the beginning he had about 400 consumers on this system, but there were now about 800. At the end of twelve months he made a comparison. Taking 250 consumers and comparing them with the previous year, he found they had increased their consumption by 20 per cent., and, at the same time, the amount of revenue received from them was reduced to £328, or about 20 per cent. The average price per unit received was 3·1d. instead of 4½d. as before. He should point out that those who came first were the ones to get the greatest advantage out of the system, whilst in the case of those coming on afterwards there had not been nearly so much reduction. He found that this system gave very general satisfaction, and no one had suggested that it was not fair. People understood it, for they were used to rateable value as the basis for water, and they looked upon the system as quite reasonable. The result had been that in many cases people used the light all over the house instead of in a few rooms only. In addition, they had supplied over 100 radiators, which were a very useful load, as they were mostly used in bedrooms, and did not come very much on the peak. It was rather difficult for him to tell how much the maximum load had been affected by this system, as he had not got demand indicators in the houses. He had, however, compared the consumptions on Sunday evenings of December last year and the year before, and found that there was only about 1½ per cent. increase in the maximum load, whereas there was 8 per cent. increase in the consumption, so that it seemed he was getting a decidedly better load factor from private houses than before. He did not think the suggestion of "contract demand" was suitable for private houses as the basis of the assessment. Business premises, of course, had to be treated in a different way, and for these he had practically in a small way adopted the system suggested by the authors, viz., taking the demand of the place and charging at the rate of £10 per kw., *plus* one penny per unit. He did not think, however, that the "limit indicator" arrangement would be altogether satisfactory. The better plan was to include the maintenance of the lamps in the charge. By doing this and going round periodically they knew exactly how many lamps a consumer had. A fixed charge of one penny per unit and a variable charge per kw. gave considerable scope. They could charge £10 per kw. for ordinary lighting, but for such things as signs they could charge a lower rate, say, £5 per kw., and yet the current could all go through the same meter.

The discussion was adjourned until the 23rd inst.

Professor David Robertson (Bristol), in a written communication, suggested the following way of charging for electricity supply, as obviating the use of demand or limit indicators and special meters for different uses. A nominal load would be fixed by the consumer, as a rule with the assistance of the officials of the supply authority, and he would contract to pay a minimum sum proportional to this load each quarter, or each year. The meter would be adjusted so that it registered at the nominal rate when the consumer is taking his nominal load, at a higher rate with a larger load, and at a lower rate at lighter loads. The standing charges may be taken as proportional to the demand. The revolutions per unit should therefore follow a linear law with the load instead of being constant; the constant part would represent the running charges, and the remainder the standing charges, profit being included in one or both. With many types of meter, the writer says, there would be no difficulty in making an adjustment of this sort. In fact, he adds, they have naturally a law something like it, and have to be compensated for ordinary use. This method would take some cognisance of diversity factor, for no account would be taken of occasional heavy loads, whose diversity factor would probably be high, when determining the nominal load proper to any particular case.

DISCUSSION IN DUBLIN.

The Paper was also discussed in Dublin on Thursday.

Mr. R. N. Tweedy said that there was no doubt metallic filament lamps presented considerable economic possibilities to consumers on alternating-current circuits, although it was difficult to persuade consumers that it was possible to reduce their current bills some 60 per cent. by using them. For this the figures given by the authors would be useful. He did not think, however, that there would be any serious diminution in current

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sold owing to the extended use of the new lamps on continuous-current systems, because it was necessary to use two lamps in series, and he thought that the time was still far distant when an 8-c.p. 200 or 250-volt lamp would be introduced. Yet he was strongly against a custom, apparently springing up in Dublin, of wiring new houses on the series system, as he considered that series running would only be a temporary expedient. Seeing that three times as many candle-power could now be obtained per kilowatt as formerly, electric lighting was really in no bad way, although there might be a temporary depression. Regarding the new tariff proposed by the authors, Mr. Tweedy considered that it made for simplicity. Engineers were altogether too honest; they tried to study equity among consumers too minutely, and consequently evolved elaborate tariffs understood by no one except the person who invented them.

Mr. G. F. Pilditch (Chief Electrical Engineer, Rathmines) considered that there was really no cause for alarm on the part of station engineers. He believed that private consumers really required more light, and stated that far more complaints were received due to insufficient light than to the amount charged. When the public found they could obtain more light for the same money they would go in for it rather than reduce their accounts. He considered the proposed new system of charging excellent from the supply authorities' point of view, but not from the consumers'. Consumers talked together, and if one consumer was supplied cheaper than another there was trouble.

Mr. C. Cummins said that, speaking as a contractor, he considered the advent of the Osram lamp was the salvation of electric lighting. No doubt incandescent gas lighting had educated the public to better light, and he believed that existing customers would now extend the use of electric light on their premises. Regarding the saving effected by the use of Osram lamps, he quoted the following cases, which were all quarterly accounts for December last using Osram lamps, and for the previous December quarter using carbon lamps, in most cases the light was greater than formerly :—

	Carbon.	Osram.	Saving.
(1).	£4 10 0	£2 10 0	£2 0 0
(2).	15 0 0	6 15 0	8 15 0
(3).	42 0 0	26 6 2	15 13 10

Mr. Cummins said that he did not believe in the use of 25-volt Osram lamps in conjunction with equalising transformers, as he thought that the smallest light unit used should not be less than 25 or 32 c.p. In his experience Osram lamps were not so fragile as stated. He had not obtained good results with tantalum lamps on alternating circuits, but had not yet gained experience with the new ones recommended for use on alternating-current circuits, in which he noticed that the filament was made in wave form, evidently with a view to allowing for expansion and contraction of the filament.

Mr. J. W. Boucher (Edison-Swan Co.) thought central station engineers, in raising the pressure of supply a few years ago, made a very great mistake. Lamps supplied for the lower voltage circuits were considerably more efficient. He entirely disagreed with previous speakers; people did not want more light; in fact, he had many inquiries from users as to how the light could be shaded down. The 100-volt metallic filament lamp was too bright altogether for private house lighting, although it might be useful for shops and lighting large areas. He considered the contract demand system of charging ridiculous. If he were in the habit of buying, say, three suits of clothes per annum from his tailor and it so happened he only required two suits one year, was his tailor to charge him half-price for the remaining suit he did not get?

Mr. W. Tatlow (Messrs. Egan & Tatlow) gave some useful figures comparing costs of gas and electric lighting. With electricity at 3½d. per unit and gas at 3s. 6d. per 1,000 cu. ft., a 55-watt Osram lamp cost for current per 1,000 hours 10s. 3d., and a gas mantle, consuming 4·5 cu. ft. per hour, 15s., while with a 55-watt Osram lamp the costs were equal. Mr. Tatlow believed that now more energy would be used than formerly, because, first, lights in cellars and so forth, burning long hours, would be converted to electric, thus improving the load factor; and, secondly, private plant users would now come on to the town mains, because their plant would be inefficiently loaded, and it would be cheaper for them to take town supply than to run their own plant. He found the life of Osram lamps to be high; in fact, he had some burning for over 2,000 hours, and they still appeared to be in good condition. One advantage of the metallic filament was that it gave a good light until it expired, whereas many carbon lamps lasted thousands of hours, and later in their life gave only a feeble glimmer, although often the consumer could not be persuaded to change them. Mr. Tatlow did not consider the maximum demand system a fair one, because demand made at times other than at peak time should not be charged at the higher rate; for that reason he preferred the two-rate meter system.

Mr. A. E. Porte agreed with other speakers that the public required more light, and would pay for it. What was lost in lighting would probably be made up in the more extended use of radiators, &c. He agreed with Mr. Tatlow that the two-rate meter was the best and most equitable system of charging.

Mr. W. J. Sowter (Chief Electrical Engineer, Bray) knew of very few consumers who actually understood the maximum demand system, and those who did gave the most trouble. He did not think consumers would take kindly to the "contract demand system," and if a change were necessary he thought it would be better in many cases to revert to the old contract system without meters. Such a course would, in his opinion, be quite feasible in the case of small private house consumers, for it is just in these cases, as the authors have pointed out, that the difficulties occur in making a profit. Mr. Sowter said the great difficulty he foresaw in making up for the depreciations caused by the use of Osram lamps was that of getting people to go to the expense of wiring their houses; some cheap system of free or deferred payment wiring was necessary, and at the same time the cost of mains and services must be reduced to as low a level as possible. It would be a great mistake to raise the price of current, as now was the time to prove the cheapness and advantages of electric light compared with gas.

The Paper will also be discussed at Glasgow on May 12th.

OPENING OF THE ALDWYCH-EMBANKMENT L.C.C. TRAMWAY SUBWAY

THE formal inauguration of the extension of the tramway subway under Kingsway, from Aldwych to the Embankment, which was described in illustrated articles in Electrical Engineering March 5th, page 343, and April 9th, page 553, took place last Friday, when the linking up of the northern and southern systems of the London County Council tramways became an accomplished fact. A party of over 150 persons, including representatives of the Board of Trade and the Local Government Board, the Mayors and other officials of several of the London Boroughs, Members of Parliament, well-known engineers and tramway men, and a number of members of the Council, including Sir Alexander Kennedy and Sir Clifton Robinson, assembled at the L.C.C. Training College in Southampton Row, where they were received by Mr. R. A. Robinson, Chairman of the Council, and Mr. W. Whitaker Thomson, Vice-Chairman of the Council and Chairman of the Highways Committee. Before calling on the Chairman to proceed to the opening of the subway, Mr. Whitaker Thomson made a few remarks on the work which has been accomplished. The Council's tramway system now carried something like a million passengers a day, and the completion of the subway, the first portion of which was opened in February, 1905, would form the connecting link between the fifty miles of the northern system and the sixty-six of the southern system. He referred to some features of the construction of the subway, mentioning more particularly the problems to be faced under Wellington Street, and paid high tribute to the work of the Council's engineers and the Works Department, who had carried out the whole of the construction. In spite of such difficulties as there had been, the work had been completed within a week of the appointed time.

The party then proceeded to the Holborn subway station and boarded the five special cars which were waiting. The procession, with Mr. A. L. C. Fell, Chief Officer of Tramways, in charge of the first car, then proceeded through the subway, passing out on to the Embankment, and continued their route over Westminster Bridge to Camberwell. A return was then made, and the cars once more went through the subway and proceeded to Islington, and then back to the London Day Training College, where refreshment was partaken of.

Later in the afternoon a regular service of cars was started. Two through routes are now in operation, one from Highbury to the Tower Bridge, the fare for the whole journey being as low as 3d., and another from Highbury to Kennington.

Antwerp Docks Electric Cranes.—A Consular Report states that at the end of the present year, 1908, the installations of cranes at the Port of Antwerp will include one 120-ton electric sheer at the Kattendyk Dock, one 50-ton electric crane, and 80 electric cranes of from 1½ to 2 tons.

Blackpool & Fleetwood Tramway Co.'s Rate.—On Friday before Mr. Justice Ridley and Mr. Justice Darling, sitting as a Divisional Court in the King's Bench Division, Mr. Leslie Scott applied for a rule for an order in the nature of a mandamus that the Justices of Lancashire should issue their distress warrant for the payment of rates by the Blackpool and Fleetwood Tramway Co. Counsel said that on the application of the distress warrant to the magistrates questions of law and fact were gone into which ought only to have been gone into on appeal to Quarter Sessions. Their lordships would remember that the powers of the magistrates on an application to enforce payment of rates were very limited. Proceedings had been taken by way of a special case, but they came to nothing, and counsel now thought this was the proper procedure. Their lordships granted the rule.

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ACCOUNTS OF THE NORTH METROPOLITAN ELECTRIC POWER SUPPLY COMPANY

IN view of the very rapid increase of the business which is being done by the North Metropolitan Electric Power Supply Co., which is now one of the most advanced power companies in the country, it is of some interest to examine the published accounts of the company as an example of costs of supply on a large scale. Before proceeding to analyse the figures, the conditions under which the supply is being carried out should be briefly considered.

The company, as is well known, owns two main generating stations at Brimsdown and Willesden respectively, from which an extra high-pressure three-phase supply is given to a number of sub-stations distributed about the area of supply. By this means a bulk supply is given partly through the North Metropolitan Power Distribution Co. to several districts, including Willesden, Stoke Newington, Enfield, Edmonton, Tottenham, &c. Current is also supplied to the Metropolitan Electric Tramways and direct to several large power consumers, including the works of the Edison-Swan Co. at Ponder's End, and others. About 70 miles of E.H.T. mains are in use. Considerable further extensions are in progress.

It is unfortunately impossible to give the generating costs of the two stations independently, as they are not separated in the accounts, nor are particulars of the units generated at each station and used in conversion given.

The total number of units sold during the year ended December 31st, 1907, amounted to 11,183,316, which, compared with the figure of 7,999,367 for the previous year, shows an increase of approximately 40 per cent. Particulars of the maximum demand, however, are not included, so that it is impossible to work out the load-factor. The following table gives an analysis of the revenue account showing the costs per unit sold for the whole undertaking:—

	Total. £.	Pence per unit sold.
Generating costs—		
Coal	18,027	0·387
Oil, waste, water, stores, &c.	1,075	0·023
Salaries and wages	4,538	0·097
Repairs and maintenance	2,963	0·064
Total generating costs	**26,603**	**0·571**
Distributing costs—		
Salaries and wages	1,747	0·037
Repairs and maintenance—Mains	836	0·018
,, ,, Substations, &c.	225	0·005
,, ,, Sundries	267	0·006
Total works costs	**3,075**	**0·066**
Management expenses, &c.—		
Rent, rates and taxes	3,487	0·075
Salaries, fees and establishment charges	2,448	0·052
Law and other charges (including insurance)	639	0·014
Depreciation	4,000	0·087
Total, excluding capital charges, £40,252		**0·865**

It will be seen that the figures are considerably lower than those obtaining in the majority of undertakings.

The total receipts (including £58,749 for sale of current) amounted to £59,373. Of the balance thus given, interest on mortgage debentures, loans, &c., absorbed £6,993, and £840 was paid under agreement to the Stoke Newington Council, so that with the addition of £864 received by interest and dividends, the final net balance (including £520 from last account) was £12,672.

A summary of the capital expenditure up to December 31st, 1907, is given below:—

	£	s.	d.
To Lands, &c.	8,235	1	4
To Buildings	93,052	4	5
To Machinery	162,387	18	8
To Accumulators	6,878	6	5
To Mains	99,856	8	6
To Meters	132	7	2
To Transformers, Motors, &c.	36,563	0	8
To Electrical Instruments, &c.	956	18	4
To Public Lamps	221	0	5
To Ballast Burning	180	17	3
To Water Service	158	5	1
To Motor Car	306	7	8
To Sundry Plant	174	17	3
To Brimsdown Dock	1,494	12	5
To Furniture	521	4	0
Total Expenditure on Works	£411,119	9	7
To Cost of Special Acts and Orders	20,223	4	10
To Special Items	2,478	4	11
Total Expenditure	£433,820	19	4

Wireless Telegraphy and Telephony.—A Consular report from Christiania refers to a new system of wireless telephony invented by Professor Birkeland, of Christiania, but no technical details are given. It is stated that on one of the University buildings three masts were erected about six months ago, and the Professor has succeeded in carrying on conversations, with excellent results, with another station at Frogua, about two kiloms. distant.

The following report on the wireless telegraphy service between Trinidad and Tobago, which has now been in operation for 2½ years, appears in the *Colonial Officers' Journal* for April. The power now used is so small that there is little danger of breakdown, and the plant is in duplicate. The more powerful but less economical set is run about once a month to keep it in order. The temporary posts erected in the first instance have started to rot, and hard wood butts will have to be fixed soon if the present stations are to be permanent. Experiments were made with the Lodge-Muirhead most recent arrangement of raising the lower aerial capacity from the ground. It was evident that this is an improvement leading to less power being required, and greater freedom of interference from both atmospheric disturbances and signals from other stations. Instructions have been given to the chief wireless operator to carry this improvement out at a cost not exceeding £20, from the working estimate of this financial year. The operators have made several experimental receiving transformers, and they are now able to exchange satisfactory signals under most conditions. From trials made whilst two or more American battleships were signalling at the same time, it was evident that under ordinary conditions the station at North Post could be arranged to receive by sound two sets of signals at the same time, with wave-lengths differing 10 per cent. or even less. The sound detectors recently installed work satisfactorily. It was only after receiving with these that the writer of the report could advocate the use of wireless stations in preference to the telephone for outlying districts.

Private Telephone Lines.—The hearing was resumed on Tuesday, April 7th, of the appeal of the National Telephone Co. against the decision of Mr. Justice Swinfen Eady, with regard to the monopoly of the Postmaster-General concerning private lines. We reported the previous hearing in our issue for March 19th, p. 432. The appeal was opened on the 11th ult., and it stood over for the purpose of enabling the defendants to consider what their position would be if the Court held that upon the true construction of the licence the royalties in dispute were payable. Sir Robert Finlay, K.C., on behalf of the appellant company, now contended that though the terms of the licence were absolutely general and so wide as to include what the Attorney-General admitted to be private telegrams not requiring a licence, the Act made it abundantly clear that the licence was only taken out for those things for which a licence was required, and of which the Postmaster-General had a monopoly. His learned friends could not successfully contend that those general terms amounted to any estoppal at all. The Attorney-General, on behalf of the Postmaster-General, said the parties had always treated an "A to B" line as within the licence. If the licence were treated as the company suggested, the bargain would be one which neither of the parties intended when it was made, and there was, therefore, a strong case of estoppal. Sir R. Finlay said the company had paid royalties on A to B lines up to March, '97, but since then they had refused to pay, and that had led to litigation. If the Postmaster-General's contention with regard to fire alarms was right, every electric door bell would be an infringement of his monopoly. Their lordships reserved judgment.

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THE MOTOR HIRE DEPARTMENT OF THE BIRMINGHAM CORPORATION

IT has always been a trouble to the central station engineer that such large proportions of his plant should have to stand idle for so many hours out of the twenty-four, and although the need of a load during daylight hours has been obvious ever since the commencement of public supply stations, yet it is only within the last five years that any great improvement has appeared in the load factor of lighting stations, due to the sale of current for power purposes. The most promising class from which to expect a demand for electric power are the proprietors of small works and factories, as the larger concerns generally have their own electrical generating plant, but the smaller proprietors are usually unable or unwilling, until convinced of its advantages by trial, to afford the initial expense of installing electric motors.

To meet this difficulty a Motor Hire Department has been started by many of the supply authorities, and we are enabled, through the courtesy of Mr. Chattock, the City Electrical Engineer, to give some particulars of the Motor Hiring Department of the Birmingham Corporation. It was decided some eighteen months ago to form such a department, and although it is too early yet to give reliable figures as to the financial results, still, there is no doubt as to the department proving a success. Whereas in the autumn of 1906 there were no motors out on hire, there are at the present time a total of 280 motors, aggregating 1,800 h.p., and these figures are steadily increasing.

The department is divided into two branches, which deal with: (1) Testing; (2) installation and inspection. The former is responsible for the testing and repair of all motors and their switchgear. Every motor is thoroughly tested on its arrival from the makers before being put into stock. The tests comprise a full load run for six hours, at the end of which time temperatures are taken, and if the temperature rise exceeds 85° F., the motor is rejected. There is also a limit to the rise in speed, which must not exceed 5 per cent. at the end of the above run. The motor is further tested at 25 per cent. overload for one hour. The insulation resistance is then taken with a 500-volt megger, but the motors are not subjected to any high-voltage test. It is almost always found possible to test motors in pairs by the Hopkinson method. The pulley on the generator is a little smaller than that used on the motor, the motor is run at its normal speed, and the generator slightly above speed, the generator field being separately excited and a rheostat placed in circuit. The machine which is motoring thus approximates to normal working conditions. In the event of a Hopkinson test not being possible, an artificial water load is employed. If a motor has been in stock for more than a week or two, the practice is to run it on full load for a short period, and take the insulation resistance.

A moderate stock is kept of all sizes of motors from ½ to 50 h.p., and the stock list is sent at regular intervals to the makers of the motors for their guidance in keeping up their own stock, as they are required by their contract to deliver additional batches of motors within two days of receipt of a requisition for same. In this way the likelihood of a motor not being forthcoming on receipt of an urgent demand from the installation branch, is extremely remote.

Motors are purchased in the following way:—Tenders are asked for to a specification drawn up by the department, and advertised in the electrical papers, and tests are carried out on those motors which are in accordance with the specification and seem generally satisfactory. The Electric Supply Committee then decide upon the placing of a contract for each size of motor required in accordance with results of such tests. The original contract, which was divided between two or three firms, was made for two years, in order that continuity of the make of the motors may be obtained for as long a period as possible.

The installation branch is responsible for the erection and connecting up of the motors and starters on foundations which the customer is required to provide. The Corporation does not undertake the wiring work in connection with motors, as this is left to contractors, but it furnishes expert advice to the customer as to the size of motor required and best method of drive. All motors are regularly inspected at least once a month, but in certain cases, where conditions of drive are bad, or for other special reasons, a much more frequent inspection is made.

The system of supply in Birmingham is three-wire D.C., with a pressure of 410 volts between the outers. But in outlying districts three-phase current at 5,000 volts, and a periodicity of 25 complete cycles per second is supplied. At present the Hire Department deals only with D.C. motors. All the motors used are of the shunt-wound, semi-enclosed type. Up to 3 h.p. the motors are wound for 220 volts, but above this size the winding is for 440 volts. Each size of motor runs at a standard speed, and is provided with a standard pulley: although there are a few direct-coupled and geared motors running, yet it is desired, as far as possible, to keep to belt drives in order to simplify installation and repairs. A word should be said with regard to the switchgear employed. The practice is to terminate service mains in a combined D.P. switch and fuse in iron case, the fuses being of the cartridge type. From this point the customer is responsible for the wiring up to the motor control gear, which is supplied with the motor, and which consists of a combined D.P. switch and fuse in iron case, and a motor starter fitted with the usual no-volts and overload release, also in iron case.

Birmingham contains an unusual number of small shops and factories of all sorts, and the purposes for which motors are required are very varied. It will be of interest to mention a few examples which have come under our notice. At a certain tube works a 50-h.p. motor drives eight tube draw-benches, each capable of drawing 2in. copper tubes, and also drives a few small lathes. This motor would be too small for the work were it not fitted with a flywheel to cope with large instantaneous demands for power. A motor of 30 h.p. drives a large circular saw, a band saw, and a small planing machine. In the jewellery trade a considerable number of motors are used, the operation requiring most power being that of polishing, which is carried out by wheels locally termed "grease mops." A 10-h.p. motor is employed for the driving of nine such double-ended wheels, although the demand from one wheel may at times amount to 4 h.p. Several bakeries are electrically driven, the usual size of motor installed for dough mixers being 3 h.p.

Butchers are finding the convenience of electric driving for their meat-chopping and sausage-making machines; 5 h.p. usually suffices for this purpose. A small laundry takes 3 h.p. to drive a washing and drying machine, and one of larger size demands 10 h.p. for two washing and drying machines and three ironing machines. The majority of the motors on hire are used to drive lathes, and similar machines in small fitting and brass finishing shops, of which there are a great

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number in Birmingham, group driving being the usual method adopted.

Few serious difficulties have so far been encountered. Perhaps the chief cause of all the troubles that have occurred has been the fact that motor hirers will not treat the motors as they would if they were their own property; thus seized bearings have been found due to the oil well being quite dry, and this, in spite of the fact that printed instructions on such points as oiling and cleanliness are sent out with every motor. It is also occasionally found that the consumer in filling up the oil wells has flooded these, and oil has got into the interior of the motor. In order to prevent this happening, and also to do away with the inconvenience to the consumer, who has to purchase oil from the Corporation, and who is responsible for keeping the bearings properly oiled, it is proposed to adopt ball bearings on motors in future. These can be periodically filled with grease by the department's inspectors, and will be very much more cleanly and suitable for the purpose, besides giving slightly better efficiency.

A pamphlet is issued by the Corporation Electric Supply Department, which gives conditions as to the hire of motors, together with the scale of charges and particulars of motors supplied on hire. The pamphlet also gives directions to be observed to ensure the safe and satisfactory working of electric motors; the advantage gained by the use of motors, and the advantage of taking motors on hire terms. A draft of agreement for hire of motors is given at the end of the pamphlet. The chief provisions contained in this agreement are that:—(1) The specified rent of the motor and starting gear shall be payable quarterly in advance; (2) the hirer shall keep the motor and gear in good and clean order, save reasonable wear and tear, and shall carefully attend to the working instructions issued by the Corporation; and, further, shall not do or suffer anything to be done whereby the motor may be distrained; (3) the hirer shall make good any damage incurred through improper use, fire, accident, stress of weather, or any other unusual cause; (4) the Corporation be allowed access to the motor at all reasonable times for inspection or repair; (5) if the hirer fails to keep the conditions of the agreement the Corporation may remove the motor; (6) the hire may be determined at any time by either party giving one quarter's notice.

The annual rental charged for the various sizes of motors varies from £2 10s. for ½ h.p.-motor, up to £26 for one of 50 h.p. This rent includes the use of the motor, starting switch, main D.P. switch, and cut-outs. There is a separate schedule of charges for conveying and fixing motors, ranging from 7s. 6d. up to £1 10s. for motors of from ½ h.p. up to 50 h.p. The Corporation stipulate that oil and carbon brushes must be purchased from them at specified prices; the hirer is, however, not allowed to fit new brushes himself, but this is done by the Corporation.

The cost of electrical energy for hire purposes is on a sliding scale. For the first 300 units per quarter the charge is 2d. per unit; for any further quantity used in the same quarter up to 3,000 units, the charge is 1½d. The charge decreases with the increase in consumption until consumers of 180,000 to 250,000 units per quarter obtain their energy at 1·07d. per unit.

Considering its brief existence, the Motor Hire Department of the Birmingham Corporation may be said to have done very creditably, and when we remember Mr. Chattock's past record at Bradford, where, if we are not mistaken, he had motors on hire aggregating over 5,000 h.p., so far back as 1902, we have no hesitation whatever in prophesying a very successful future for this department.

Aron Meter. The Board of Trade has approved the Aron alternating-current prepayment motor meter.

MANUFACTURE OF METALLIC FILAMENTS

The new "Z" Lamp

DR. CLAYTON H. SHARP gave an address recently before the American Electrochemical Society, in which he dealt with the various methods of manufacture which are employed for tungsten and similar filaments. The following abstract from the *Electrical World* gives a *résumé* of the principal methods, including that employed in the new "Z" lamp.

There are certain main difficulties in producing a filament from a material like tungsten due to the fact that the tungsten is not ductile and unites readily with oxygen or carbon. Hence it is the practice to produce filaments from tungsten in the form of a very fine powder, which is held together by some sort of binder which can be removed after the filament has been squirted; this removal must leave the filament free from oxygen and carbon. A number of processes have been described. The first to appear was that of Kuzel, in which a collodial solution of tungsten is formed by making an arc between tungsten terminals under water. This solution when of the proper consistency is squirted into filaments which consist entirely of pure tungsten and water. When the water has been driven out, the tungsten particles can be sintered together by heating the filament by means of the electric current in an atmosphere containing no oxygen. In Welsbach's process, an organic binder is used to make a paste which can be squirted through a die. The binder is removed by heating in an atmosphere which will oxidise the carbon and which contains at the same time sufficient hydrogen to reduce any tungsten which may have been oxydised. For the Just-Hanaman process, a very fine filament of carbon is heated in an atmosphere of chloride of tungsten and hydrogen. This results in a deposit of tungsten upon the filament or a substitution of tungsten for carbon. The carbon must afterward be removed by some such process as indicated above. In the "Z" process, a binder of collodion is used which can be made to burn itself out entirely. It has been found possible also to use binders of paraffine, which material can be removed simply by heat; or a slow melting metallic alloy may be used as a binder, the foreign metals being driven off by heat. An account was given of the results of a manufacturer's test on 15 series tungsten lamps, in which the average candle-power did not change during 2,135 hours of burning. Of these lamps, five survived at the end of the test, and only three had actually burned out.

Institution of Electrical Engineers.—The following is the result of the ballot for new members at the Institution on Thursday:—*Associate Members:* J. H. Bolam, G. W. Cole, A. W. Mandling, H. E.. Morrow, G. D. Nelson, J. R. Norris, Lieut. A. Rice, R.N., S. Richards, C. C. Skeates. *Students:* G. J. Duckett, A. N. Haworth, V. M. Levy, C. A. Martin, T. Y. Porter, P. B. Smith.

Large Curtis Exhaust Steam Turbine—We are informed that the British Thomson-Houston Co. have received an order from the Tyneside Electrical Development Co. for an exhaust steam turbo-generator having an output of 1,500 K.V.A. at 2.875 volts 40 cycles, when running at a speed of 2,400 r.p.m. The turbine will be of the standard Curtis two-stage type, and will be direct-coupled to a three-phase 40 cycle alternator. The steam for this turbine will be supplied from the works of the Teesbridge Iron Co., at atmospheric pressure, and will be condensed by surface condensing plant supplied by the Mirrlees Watson Co. The condensed steam will be returned to the Teesbridge Co. Provision has been made so that should the turbine not be running at any time it can be isolated from the condensing plant, and the condensed steam still utilised for the boiler feed of the Teesbridge Iron Co. The turbine and the generator will be capable of an overload of 1,800 K.V.A. The plant had been so arranged that the necessity for the usual foundations are avoided, the condenser being on the same floor level as the turbine itself. The air and circulating pumps will be driven by three-phase 440-volt 40-cycle B.T.H. motors. The sluice valve between condensing plant and turbine will also be motor-operated.

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THE SILVERTOWN ELECTRIC CAR

In view of the popularity of the quiet and smooth running electric car for town work, and other purposes where a limited radius of action is of no consequence and great speed is not required, it is not surprising that a firm with the wide electrical experience of the India Rubber, Gutta Percha, and Telegraph Works



Fig. 1.—Silvertown Electric Car.

Co. should have turned their attention to this class of work. The company have been experimenting both in the laboratory and on the road for some time, and one form of "Silvertown" electric carriage was seen in the Olympia Exhibition of 1905. The result of this work has been the production of the perfected car illustrated in this article, which has been brought out as a standard type of vehicle suitable for town work.

The principal points of interest in the design are the fact that both the front and rear wheels are driven and the design of the controller. The advantages of four-wheel drive are the diminution of liability to side-slip to an appreciable extent, and the better utilisation of the weight of the vehicle for adhesion by dividing the tractive force, thus also diminishing the liability to skidding as compared with back-wheel or front-wheel drive alone. A general view of a complete Silvertown car, with a specially designed limousine body, is given in Fig. 1, and Fig. 2 is an elevation showing the arrangement of the chassis.

The frame is of pressed steel of ample depth and thickness, inswept at the front to allow of a good steering lock, and specially stiffened at the back cross-member to support the transverse spring without twisting. Each front dumb iron forms one piece with the side of the frame to which it is electrically welded. The springs are long, although fairly stiff, in order to give as much comfort as possible in travelling over rough roads, and have large eyes in which are fitted renewable grease-retaining bushes.

The two motors are mounted one on each axle casing, thus giving the four-wheel drive. They are of the four-pole type without interpoles, and are totally enclosed so as to be perfectly dust- and damp-proof, but are fitted with quickly removable covers over the commutators, rendering the inspection and adjustment of the brushes an easy matter. The totally enclosed motors, when tested in the shop with 80 volts, 25 amperes at 1,060 revolutions per minute, gave a temperature rise of 70° F. at the end of one hour's run. On 30- to 40-mile test runs on the road, with average alteration in speeds, the rise does not, of course, amount to as much, owing to the much better cooling conditions prevailing. The motors are capable of working at 50 per cent. overload for a considerable time, and for a short time at double their ordinary load without any injury, and are so arranged that should either motor get damaged, the carriage can be run on the other alone. Details of the design of the motors are shown in Fig. 3. The armatures are mounted on ball bearings, and can be easily removed. The drive is transmitted from the armature by means of spur gearing, and both the pinion and gear-wheel are case-hardened. The latter is mounted on the outside of the differential gear-box, which also runs on ball bearings. The driving shafts are of nickel steel, turned all over, and transmit the drive to the

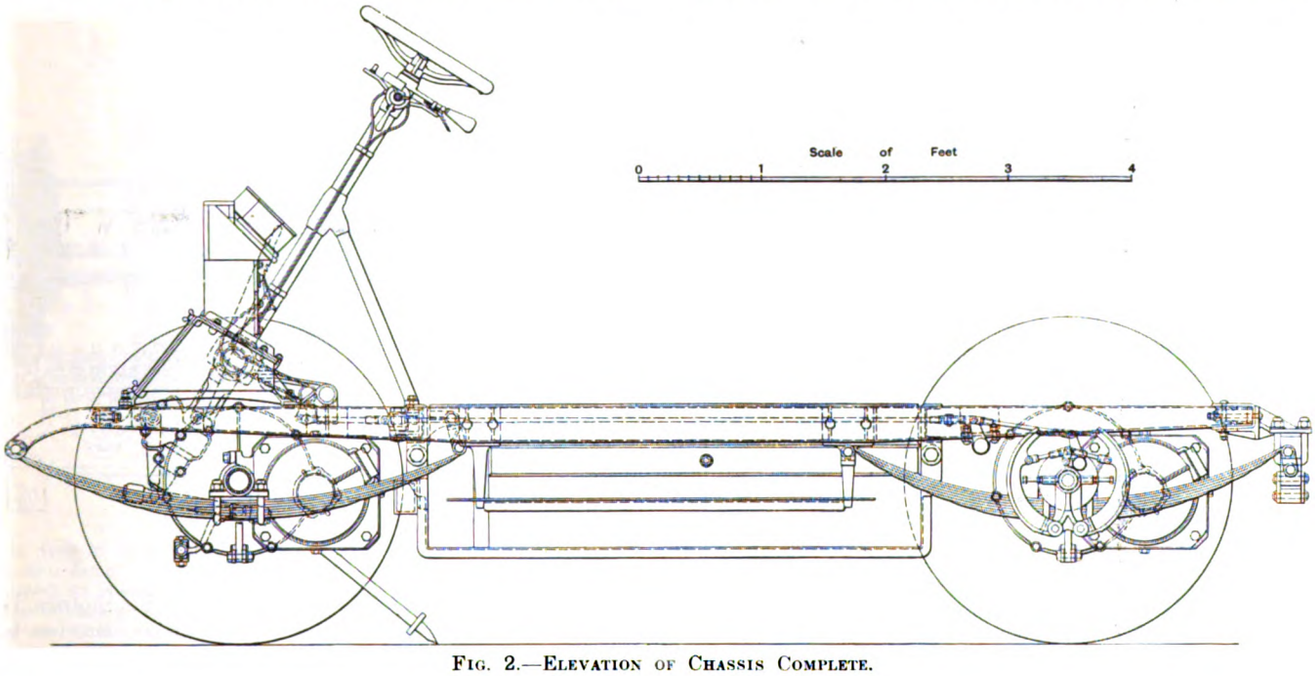


Fig. 2.—Elevation of Chassis Complete.

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hubs of the road-wheels through sliding clutches. Each road-wheel is fitted with a compound ball-bearing, containing two journal bearings and one double-thrust bearing. The whole of the running gear is completely enclosed by the axle casings.

The arrangement of the motor and gear on the front axle is similar to that of the back axle, except that a special form of universal joint is provided at each end of the driving shaft at the same centre as the steering pivot, thus allowing free steering whilst at the same time transmitting the drive. This universal joint is carefully protected by dust- and wet-proof casings.

The controller is contained in a casing at the base of the dashboard, and is operated by a lever on the steering column. Details of its construction are given in Fig. 4. It will be seen that the main drum is entirely without wood, and is built up of special shaped segments. These are made from phosphor-bronze castings, and are mounted on an ebonite-covered steel spindle; the contact brushes, which are made of wrought copper, are carefully fitted to the drum of the controller to ensure a good bearing surface. Each brush can be quickly removed for inspection. The current is not broken on the drum, but automatically by a quick-break switch with carbon contact, thus preventing burning of the segments. This switch is also independently operated by the brake pedal before any braking can take place, and is held open by a cam when the brake pedal is released until the controller handle is brought back to the neutral position. The cam is then released and the switch made again as the controller handle is moved to the notch required. It is thus impossible to restart the car inadvertently by releasing the brake pedal.

The safety plug, which the driver should always take with him if he gets off the car, as its removal prevents anyone tampering with the car, cannot be placed in position or removed unless the switch is open. The same plug has to be used, in another position, if the battery is being charged whilst on the car. The wiring is so arranged that the controller circuit is entirely cut out, so that any accidental moving of the controller handle when the charging is in progress, does not do any damage.

The controller has as many as thirteen positions in all, giving six forward speeds, four reverse speeds, and three braking positions. In the first three forward speeds or starting positions the motors are in series with varying amounts of resistance in circuit, while the resistance is cut out in the fourth or series running position. In the next position the motor armatures are placed in parallel, but the fields remain in series, and the highest speed is obtained with the motors in full parallel. The four reverse positions are similar to the series forward steps, except that the armature connections are reversed. In the first braking position the motors are in series with the armatures reversed, the battery circuit cut out, and the whole of the resistance in closed circuit, while the two more powerful braking positions are obtained by cutting out parts of the resistance. It will thus be seen that there are, in effect, three forward running steps and one reverse, as the resistance steps are only provided to produce a

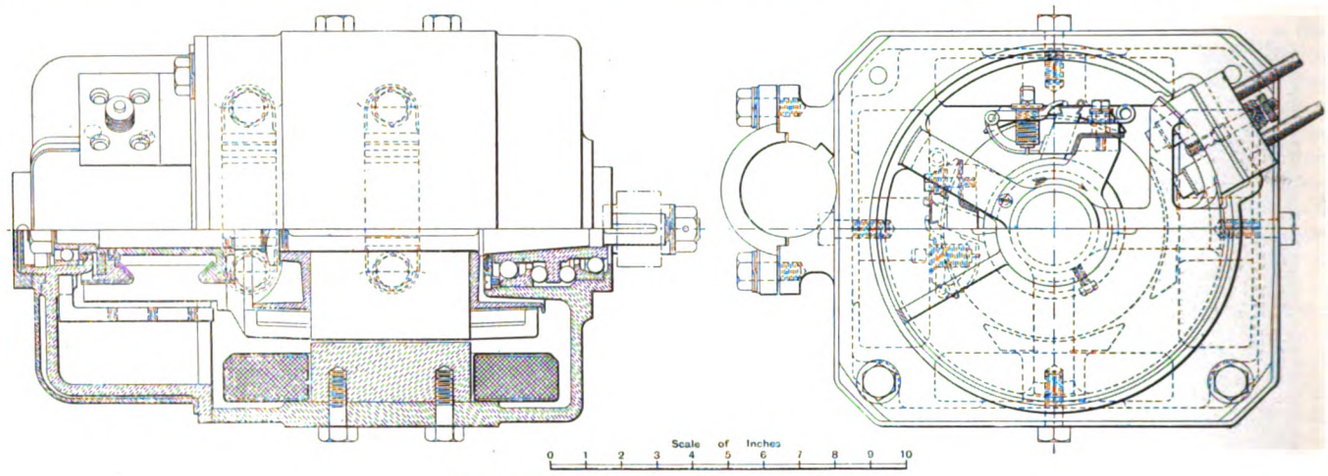


Fig. 3.—Elevation and Section of Motor.

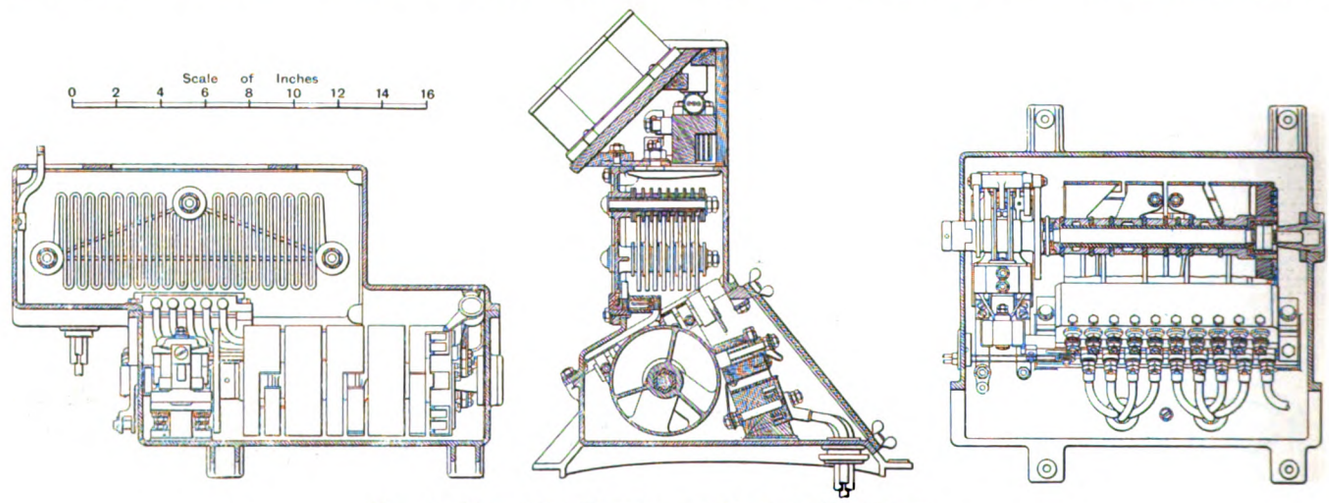


Fig. 4.—Elevation, Section, and Plan of Controller.

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graduated start, and are not intended for running on. The resistance has, however, been so designed that the first three positions can safely be used as running positions when absolutely necessary in following traffic, although this should, of course, be avoided from reasons of economy. The resistance is of the grid type, as shown in Fig. 4, in the same case as the controller. This case is easily removable from the car if required, and has mounted on the top of it a combined ammeter and voltmeter.

The only mechanical brakes are those on the rear wheels. These are of the internal expanding metal type, and are double-acting. The phosphor-bronze brake-shoes work on the inside of a steel drum, which is rigidly fixed to the hub of each rear wheel, and are well protected by an aluminium cover from all wet and dirt. The brake will hold the carriage equally well from running backward or forward. All parts of the brake gear are made adjustable, and a notched lever is fitted to hold the brake pedal in any desired position.

The steering gear, combined with the bevel wheels for actuating the controller drum, is contained in a steel case which is made dirt-proof, and is securely fixed to the frame of the car. The steering is of the irreversible type, and the connecting rod is provided with cushion springs and adjustable ball-joints to take up any shock from the road. All parts are made adjustable, the worm segment being held in eccentric bearings. The radius rods are made out of solid forgings, and are securely fixed to the pivot axles.

The battery is contained in one crate slung underneath the frame, and can be easily detached and replaced by a freshly-charged one. The battery on the particular car illustrated is composed of 44 E.P.S. cells of a capacity of about 130 ampere hours, and weighs, including crate, 14 cwt. On good roads a single charge will propel the vehicle about 40 miles without unduly discharging the battery. The total weight of the car with the form of body illustrated is 37 cwt. complete with battery.

A NEW ARC LAMP COUPLING

IN the ordinary types of arc lamp couplings fitted with strain release it is essential that the user should hoist the lamp as far as possible, and then lower back slightly on the winch, thus bringing a locking gear into action, and releasing the strain from the suspension rope. To subsequently lower the lamp it must again be hoisted higher than when originally locking same in order to release the locking catches, and it can then be lowered down. To ensure safety and ease in working it is essential that these upward and downward movements of the lamp should be definitely limited by stops in the coupling, so that the locking and release of the lamp does not depend on the skill or trustworthiness of the trimmer.

In the case of couplings which do not comply with these requirements, and in which the definite stop for the locking position is wanting, the trimmer hoists the lamp to as far as he thinks necessary, and then lowers slightly to test whether the lamp is locked, and the strain therefore on the hoisting rope released. Several attempts may be necessary before he is able to lock the lamp securely, and thus there is a great loss of time and some risk that in hoisting the lamp too high the locking device has been set to the unlocking position, and therefore the

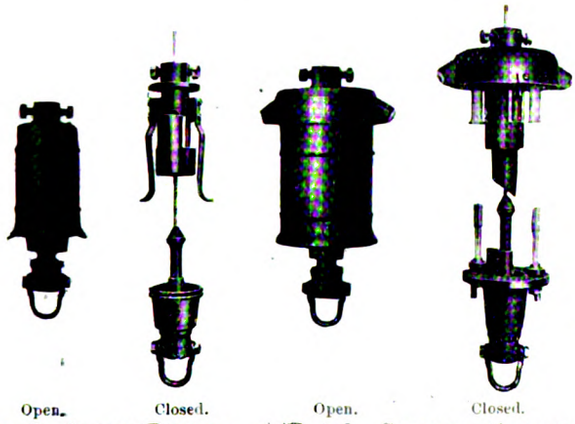


FIG. 1.—STRAIN RELEASE.

FIG. 2.—COMBINED COUPLING AND STRAIN RELEASE.

lamp is free to fall. The accompanying illustrations represent a new arc lamp coupling which the Union Electric Co. have introduced to obviate these disadvantages. It is provided with a strain releasing device in which all the movements requisite to lock or release the lamp are definitely limited by fixed stops. The lamp trimmer therefore hoists the lamp until he feels that it is against a stop, then lowers it slightly, when the lamp is securely locked, and the strain on the suspension rope released. To lower the lamp, he again hoists until he feels the stop and then lowers. The locking action is controlled by an ingenious arrangement of metal balls used in sets of two, one forming the top, and the other the bottom stop.

The mechanism can be supplied either simply as a strain release, as shown in Fig. 1, or as a combined arc lamp coupling with strain release, in which case the circuit contacts are made with massive pins, as shown in Fig 2. All these illustrations are to the same scale, so that the difference in size of the two arrangements is clearly visible. The sectional drawings in Fig. 3 show the action of the locking arrangement. The rope clamp supports a guide tube fitted with a projecting boss and a sleeve free to turn on the guide tube, and carries the two contact pins. On hoisting the lamp, the boss enters tube attached to the lamp bracket or other fixture. This tube is fitted with two longitudinal slots surrounded by a sleeve, free to move, and takes a bearing on a screw (not shown, which forms a stop). In this sleeve on each side are two depressions, which allow entry of balls and from the longitudinal slots of tube.

On hoisting up the lamp the boss enters the tube, and pushes the

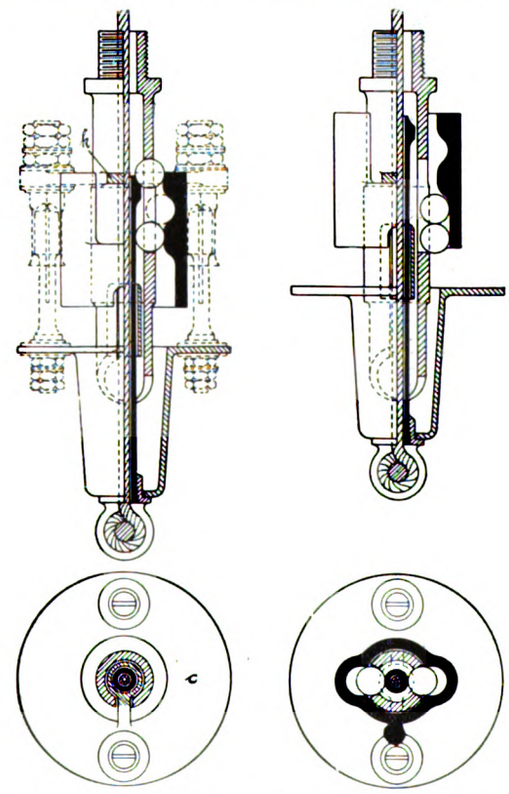


FIG. 3.—DETAIL OF COUPLING SHOWING BALL-LOCKING GEAR.

lower set of balls into the depressions, thus pushing the upper set upwards, so that, having passed the lower set, it meets the upper set, which thus form a fixed stop, as shown in the left-hand portion of the diagram. If the winch is now turned backwards, then the boss rests on the lower set of balls, and the hoisting rope is no longer under strain. The upper set also fall back into the depressions. During these movements the contact pins for the circuit have entered the corresponding bushes; to ensure correct polarity, the central tube is suitably pointed and slotted, and a guide pin on the lower sleeve engages therewith.

To release the lamp, the winch is again wound upwards, thus

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raising the boss and permitting the balls to drop into the position shown in the right-hand part of Fig. 3. In this position the sleeve is held by the friction of the circuit contacts, until on lowering by the winch the boss, passing the two balls, bears on the guide sleeve, thus bringing the weight of the lamp into action to withdraw the contact pins from the bushes, when the sleeve falls down to its original position.

The strain release without arc lamp coupling is of practically the same construction as the above description, but the friction necessary to retain the ball sleeve in its top position is in this instance produced by two flat springs acting on the sleeve.

The main advantages of this new type of coupling and strain release are that all movements which are in any way controlled by the action of the winch are definitely limited by fixed stops, and also the use of locking balls whose movement is restricted to a definite path, but uncontrolled by any mechanical connections. The whole mechanism is without joints or pins, which might lead to stickiness and consequent failure. If at any time it is necessary to take it apart, only one screw has to be withdrawn to release every part of the mechanism. All parts carrying current are insulated throughout with mica and porcelain, and the whole coupling is enclosed in an enamelled sheet metal cover, rendering it perfectly rainproof, whilst the sleeve, fitting tight against the cover, prevents dust entering into the coupling.

A NEW METALLIC FILAMENT LAMP

A NEW incandescent lamp will shortly be placed on the market, by the Bryant Trading Syndicate, Ltd., of Highbury, which is not only of British manufacture, but also of British invention. The filament is an alloy of tungsten and some other metals, and burns at from 0·8 to 1·5 watts per candle, according to the life and candle-power of the lamp. Thus the 115-volt 20-c.p. lamp runs at 0·9 watt per (Hefner) candle, and

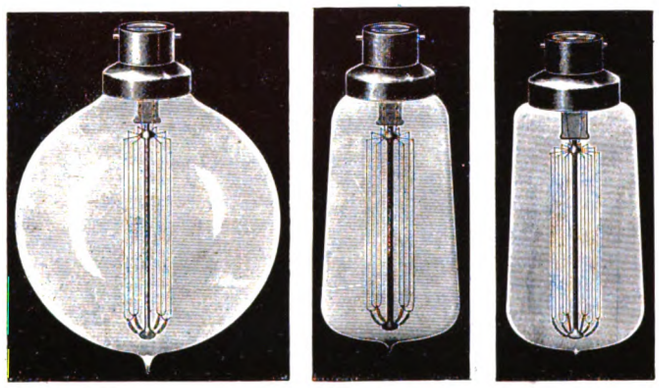


Fig. 1. Fig. 2. Fig. 3.

100 and 200-volt "Metalite" Lamps, showing Method of Supporting Filaments.

has a life of over a thousand hours. This same lamp, run on a 100-volt circuit, would, according to the pamphlet issued by the manufacturers, give 10 c.p. at an efficiency of 1·5 watts per candle. A 34-c.p. 200-volt lamp can also be obtained. This lamp is illustrated in Fig. 3. Fig. 2 shows the 17-c.p. 100-volt lamp, and Fig. 1 shows an alternative shape of the bulb. It will be seen from Fig. 3 that the 200-volt 34-c.p. lamp consists of six filaments arranged in series. An alternative design for this lamp has nine filaments, the length of each doubled filament being $2\frac{3}{8}$ in. The 100-volt lamp has four or five filaments

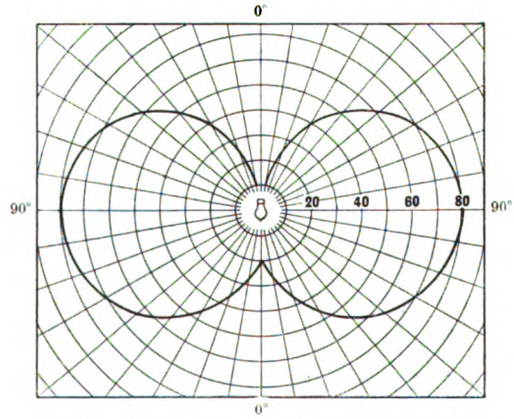


Fig. 4.—Polar Curve of "Metalite" Lamp.

in series. The filaments are cemented to the supporting wires at the top, and are also supported at the bottom by means of a zigzag spring. Where these springs come in contact with the filaments they are coated with a substance which prevents them from sticking to the filaments. The filament itself is particularly smooth, and has the appearance of a very fine steel wire. The finest filaments have a diameter of 0·0264 mm. It is claimed that the blackening of the globe is not so noticeable as with other lamps; and this, it is said, is due to the fact that no carbon-bearing paste is used in the process of making the filaments. Serious blackening does not take place unless the lamps are run at an efficiency of 0·5 or less watts per candle, when the temperature is so high that the filament commences to volatilise and the metal condenses on the surface of the glass. The lamps will burn at any angle, but it is not recommended to burn them otherwise than in a vertical hanging position. On account of the symmetrical arrangement of the filaments, the horizontal distribution of light is perfectly uniform. The distribution in a vertical plane is shown in Fig. 4, which is the polar curve for a lamp without any shade. With a suitable shade the illumination in a downward direction can, of course, be considerably increased. Fig. 5 gives the results of tests on a 90-c.p. lamp (presumably 120 volt). It will be seen that the c.p. rises to 95 and then falls to 90 again after a life of 1,000 hours. The current taken by the lamp falls steadily from 0·9 to 0·85 ampere, and the watts per candle fall to about 0·8 after about 60 hours, and rise again to slightly over one watt per candle after a life of 1,000 hours. Other tests have shown that the lamp will withstand overrunning to a considerable degree, as the resistance increases rapidly with increasing temperature. It is stated that

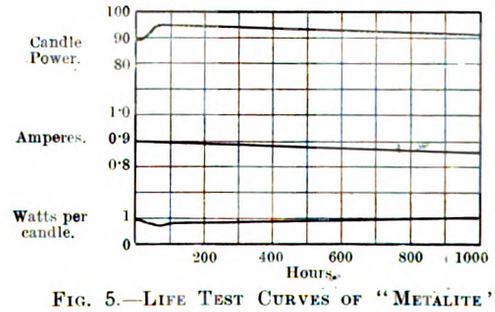


Fig. 5.—Life Test Curves of "Metalite" Lamp.

the lamps actually run better with alternating current than on direct current, and better with high than with low frequency. The lamps will be obtainable for all voltages from 1·2 volt to 250 volt, the lamps for 250 volt having candle-powers ranging from 42·5 to 188 c.p. The 10-c.p. lamp consumes 1·25 watts per candle, but the average consumption may be said to be one watt per candle. The process of manufacture is the invention of Mr. F. Harrison, who has also invented a wrapper for packing the lamps. This latter is simply a paper bag filled with wood-wool, but has proved itself so efficient that the manufacturers guarantee to replace any lamps whose filaments are broken in transit, so long as the broken lamps are returned within three days. The lamp has been named the "British Metalite."

Denmark Telegraph and Telephone Service.—Reporting upon the finances of Denmark for the year 1906-07, Mr. J. C. T. Vaughan, Secretary to His Majesty's Legation at Copenhagen, states that the telegraph service shows a slight increase over the previous years, and would not call for notice were it not that the State telephone service is included under this head. The revenue from the telegraphs was £79,375, from the telephone service £30,689, and from other sources £5,997. The total revenue was thus £116,061, and after deducting expenditure there was a surplus of £11,018, compared with £10,879 in the previous year. The individual figures for the year 1905-06 were: telegraphs, £76,963; telephone, £26,949; other revenue, £4,963. From the above it will be seen that the revenue from telephones is increasing rapidly. In Denmark, only the interprovincial, the inter-communal, and the international telephones are worked by the State, whilst the local telephones are worked by private limited companies, to which the State has granted concessions,

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HEATING OF VENTILATED AND ENCLOSED MOTORS

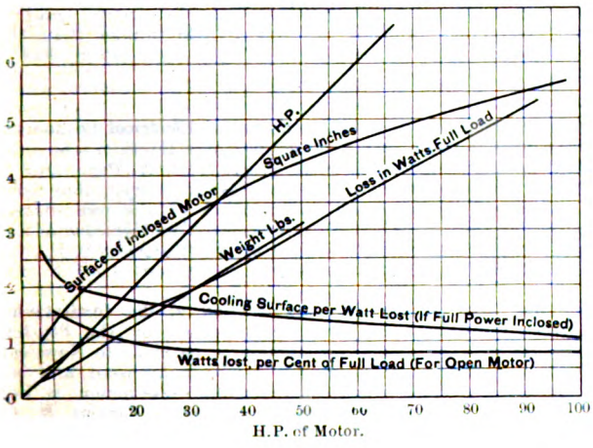
MR. WILSON HARTNELL read a Paper on the above subject last Thursday before the Leeds Local Section of the Institution of Electrical Engineers. He remarked that the evolution of the continuous-current electric motor during the last fifteen years had resulted in a gradual decrease in size for any given output, but that the heat produced in the armature and shunt winding was no greater than of old. In modern machines, the heat produced by losses in the teeth and armature discs is serious, with a dense magnetic flux in the air-gap; and can only be kept within reasonable bounds by a moderate surface speed of armature, and the heat due to the carbon brushes is considerable with low voltages. With a surface speed of 1,500 ft. per minute the loss due to friction, and the drop in volts between the carbon and copper, may easily be equal to from $1\frac{1}{2}$ to $1\frac{3}{4}$ watts per ampere per brush.

The heat thus produced can only be dissipated by heating the motor itself, by radiation, or by conduction to a flow of cool air, that is by ventilation.

The relative change of the value of these effects, for a series of motors an assumed average weight, cooling surface and loss of watts, as the size of the motor increases, may be seen from Fig. 1.

Radiation.—It will be seen that the cooling surface per watt of motor under 5 h.p. is nearly double that of motors over 50 h.p. The difference in the effectiveness of the cooling surface is far greater. For the hotter air inside the larger enclosed motor is near the top, the bottom of the motor remaining markedly cooler, and therefore the radiating surface less active. Also the magnet case may be three or four times as thick in the larger motor, rendering the escape of heat of the metal proportionately less.

When an enclosed motor is required of more than, say, 3 h.p., the usual means of obtaining the requisite cooling surface is to take a motor of larger size and reduce the output, the armature current being reduced—and therefore the armature reaction—and also the flux density in the air space and ampere turns in



Scale Vertical.

For cooling surface, multiply by			1
,, horse-power	,,	,,	10
,, loss per cent.	,,	,,	10
,, weight in lbs.	,,	,,	100
,, surface area,	,,	,,	1000
,, loss in watts,	,,	,,	1000

Fig. 1.—Averaged Particulars of a Set of Motors.

the poles. This reduces the heat due to losses in the copper, and still more the heat due to core losses. This, however, makes a costly motor for continuous working, even for moderate powers. A more economical arrangement for an enclosed motor is to place an open motor that may be fully loaded under a thin sheet-iron cover with ample inspection doors.

Ventilation.—The cubic feet of air required to keep the temperature rise below 72° is probably not less than the quantity tabulated, viz., about 9 cub. ft. per horse-power per minute for the smaller motors under 10 h.p., and about 5 cub. ft. per horse-power per minute for motors over 30 h.p. Experience shows that large open motors working to their full load can, by the aid of ventilation and radiation, be kept within the limits of 72°. But when wholly enclosed they can only be kept cool by forced draught. From rough estimation it seems that at least double the quantity of air per minute is then required.

Electric motors, viewed in regard to their means of cooling, may be divided into eight classes. (1) Entirely open, having their bearings usually on a bed plate which carries the magnets. Suitable for large motors, say, over 100 h.p. (2) Protected open, the bearings carried by open covers at each end of the magnet case. This is the ordinary modern motor, say, from 100 h.p. to 2 h.p. (3) Enclosed ventilated. The same as No. 2, but with the openings covered by wire net or perforated metal. These are used in factories where the open motor is assumed to be less safe. If the mesh be not less than 4 per inch the ventilation is not much interfered with, but if the mesh be

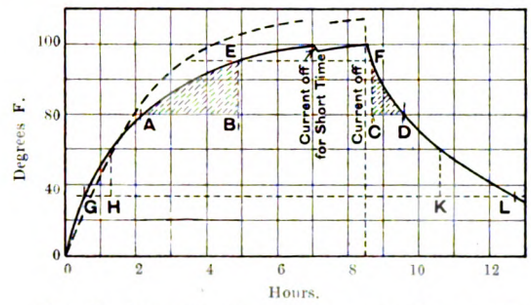


Fig. 2.—Heating and Cooling of a Magnet Coil.

much less not only is the ventilation much impeded, but the wire-work is apt to become choked with dust and fluff, and the safety of the motor endangered. (4) Same as No. 2 or No. 3, but with a forced ventilation by means of a fan on the armature and a diaphragm or its equivalent to divide the fan suction from the delivery. This is necessary in an exceptionally warm place. (5) Totally enclosed. These are required for special purposes, and usually necessitate a considerable reduction in the output. (6) Covered motors. The same as No. 2 fully loaded, but covered by a roomy thin sheet-iron case, practically dust-proof, with openings for oiling and inspecting the brushes, the pulley standing outside the case. (7) Open covered motors. The same as No. 6, but with a smaller cover made wholly or in parts of fine wire netting. The large area of wire-work prevents the tendency of any draught to cause the fine mesh to get clogged, and the motor fully loaded would be as cool as if unenclosed. This is specially adapted to textile mills where floating fluff is found. (8) Totally enclosed, but with forced ventilation like No. 4. This is necessary (*a*) when the motor is working in fumes very injurious to the motor, fresh air being sucked into the motor from a pure source through a pipe and discharged near the motor; (*b*) when the motor may be surrounded by inflammable gases, as sometimes in mines, the same air being circulated again and again through the motor and a cooling arrangement. Total enclosure with forced ventilation has been used to cool very large dynamos, cool air being drawn from outside the dynamo house and hot air discharged also outside.

From tests made to show the reduced power permissible, if a motor be totally enclosed and continuously loaded, it may be said that below 3 h.p. the loss of power may be inconsiderable; but a 20-h.p. open motor, when totally enclosed, is but little more than equal in power to a 10-h.p. open motor. A 50-h.p. open motor could only give 21 h.p. with a permissible temperature of commutator. To obtain the minimum temperature with the reduced output the winding had been specially arranged. In short, whilst the power of a modern open motor is chiefly a function of its magnetic flux, when totally enclosed the power becomes a function of the area of its casing, considerably influenced, however, by its environment, that is, by the exchange of radiated heat with its surroundings, or the motion of the surrounding air.

The author then proceeds to describe some experiments with a 60-h.p. motor running at 1,000 revs. The iron losses were measured by driving the armature by another motor, and noting the increase of power taken when the fields were excited. The tests were repeated with an unwound armature with similar results. The armature discs were then removed, bored, and fixed on a gun-metal bush—the end plates for supporting the end winding were turned thinner, and the cylindrical part for supporting ends of the windings were made shorter and thinner. The end plates were also separated from the stampings by paper discs. This made a slight improvement after two hours' run with air at 60° F., the rise of temperature in the slots was 54 and in the centre of the core 66. Finally the armature was rebuilt with Messrs. Sankey's Stalloy stampings

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and tested unwound, but with the slots filled with wood and the magnets excited. The rise of temperature in two hours was 8° F. less than before, showing a slight advantage over ordinary stampings. The armature was wound and a fan fitted to the end of the armature to circulate the air inside. It was then tested as a totally enclosed motor, with a load of 58 h.p. for three hours, with the following results:—Rise of commutator, 111°; field coils, 88°. It was again tested totally enclosed for eight hours, but with a stop of eight to ten minutes every hour (after the first four hours) to take temperatures. Load, 59 h.p. The final temperature rises were (air at 70° F.): commutator 170, armature 149, field coils 125, air inside 105. There was not much increase of temperature after the first four hours, but the temperatures then were impracticable. The fan was then removed and the motor ran at 59 h.p. as an open motor for eight hours, with the ventilating slots on the periphery of the end covers also opened; the final temperature rise with the air at 62° to 69° was: commutator 58°, field coils, 48°, armature 68° F.

A 50-h.p. motor totally enclosed at about 450 revs. per minute keeps reasonably cool with 20·5 h.p. This power probably would be the working limit at standard speed. The cooling surface of the totally enclosed motor per watt lost should be, apparently, not less than 3½ to 4 sq. in.; but this depends on outside ventilation. On long tests the temperatures have often been known to go down after three or four hours, due apparently to draughts caused through opening doors.

The convex curve (Fig. 2) shows the gradual rise to a maximum temperature of an overloaded field coil of a dynamo (without an armature) and the concave curve the shorter interval of time to reduce the higher temperature after the current is cut off. Thus in this curve, if any line *ABCD* be drawn, *AB* represents the time required to rise to a particular temperature *BE* (measured outside the coil) and *CD* the time to cool. For the higher temperature which illustrates practical work *CD* is small compared with *AB*. The dotted line shows the average internal temperature calculated from the reduced current as the temperature rose. The coil was fully exposed to the air, and it was noticed that the temperature between the coil and the magnet ring was the same as outside the magnet ring near the pole. In enclosed motors the outside of the case may at times be 20° F. cooler than the magnet coils inside. This advantageous cooling with intermittent loads can only be obtained when there is a considerable difference of temperature between that of the air and the highest permissible of the motor. If the air be very warm, so that this difference is comparatively small, the motor gets hot in less time than it cools. It will be seen on Fig. 2 that *GH* is less than *KL*.

It may be noticed that there is no such thing as a gas-tight motor, even if the shaft worked through a stuffing box. The expulsion of, say, 15 per cent. of the enclosed atmosphere when it was heated, and the entry of the same amount of gaseous air from the outside on cooling, would cause the average condition of the atmosphere outside and inside soon to be similar. To enclose a motor tightly to keep out noxious gases is a delusion. In an explosive atmosphere they must be totally enclosed and strong enough to withstand an internal explosion.

Experience with open motors exposed to various noxious chemical fumes shows that although the motor's appearance may be spoiled and soldered joints affected, yet the motors last so long that it is better to let them wear out and buy new ones rather than put up with the troubles from enclosing them. In the author's opinion the reasons given for totally enclosing any but very small motors (Class 5) are usually mistakes. In the case of insurance risk they tend to defeat the object in view. In nearly every place where power is required for manufacturing, open motors may be used and easily protected against the real or supposed dangers of its particular environment. Enclosed motors with a current of air forced through them either by means of a fan or chimney may be considered as open motors so far as heating is concerned. The conclusion is that totally enclosed motors (Class 5) are under great disadvantages, and in general their use can be avoided.

DISCUSSION.

Mr. Harding Churton (Leeds), in opening the discussion, prefaced his remarks by saying he had not had an opportunity of carefully considering the Paper, and then proceeded to read some elaborated notes on experiments made by himself on alternating-current motors, which he contrasted with the results obtained by Mr. Hartnell on direct-current motors. He failed to arrive at an agreement, and asked for further information respecting the tables given in the Paper.

Mr. F. T. Chapman (Leeds), referring to the question of cooling totally enclosed motors in mines, said attempts had been made to get over the heating difficulty by enclosing the motor in a case of fine wire gauze on the principle of the Davy lamp. Experiments in the workshop have given satisfactory results.

Mr. W. B. Woodhouse (Yorkshire Electric Power Co.) was of the opinion that the conclusions arrived at in the Paper could have been predicted, as they were the same as occur with a transformer. The effect of windage in reducing the temperature does not take place in an enclosed motor. Machines of the open type which depend on natural ventilation of the armature can be correctly designed, but they would not be satisfactory as enclosed motors. Designs including a system of forced ventilation were the best for large enclosed machines. He referred to an installation in a spinning mill, where the motors were fixed over an air duct which was in direct communication with the outside. The air, after passing through the motors, was discharged into the room. This plan gave satisfactory results. Mr. Hartnell's system of using large sheet-iron covers, with ample inspection doors, for open type motors he considered a good plan. One of the advantages of using alternating-current motors in factories was that fire insurance offices only demanded a covering of wire netting, whereas direct-current machines had to be entirely enclosed.

Prof. G. D. Aspinall Parr (The University, Leeds) wished to know if the Stalloy stampings referred to were the same thickness as the stampings they replaced. He was under the impression that Stalloy was a great improvement on the ordinary metal used for armature discs, but the author's experiments did not appear to confirm this.

Mr. A. J. Cridge (Sheffield Corporation) considered the Paper an eminently practical one, and hoped it would be followed by another on the same lines, but dealing with alternating-current motors. Referring to protecting motors with a sheet-iron case, he said it was not applicable to alternating-current motors, owing to induction in the cover itself, which heated it up.

Mr. W. F. Mylan (Sheffield) agreed with the author that it was impossible to make gas-tight motors, and the proper course to adopt was to make them strong enough to withstand internal explosion. He also was of the opinion that as a general rule there was no necessity for totally enclosing motors, and that so far as insurance risks were concerned they defeated the object in view. A fruitful source of trouble was the lack of proper attention resulting from being covered up.

Mr. H. C. Jenkins (Sheffield), referring to the use of motors in mines, said the present tendency of users was to adopt open type machines wherever possible, and in gassy mines electromotors should not be used at all, the risks being too great.

Mr. Hartnell, in a somewhat discursive reply, said the Stalloy stampings referred to were a little thinner than those they replaced. In his experience forced ventilation was the best way of ventilating a motor.

Leeds Local Section of the Institution of Electrical Engineers.—At the general meeting last Thursday Mr. H. E. Yerbury was elected as chairman, in place of Prof. G. D. A. Parr, and Mr. Rogerson vice-chairman, in place of Mr. Yerbury. The following gentlemen were elected as members of the committee:—Messrs. W. Emmott, W. B. Woodhouse, J. W. Hame, and J. M. Smyth, in place of J. W. Beauchamp, W. Hartnell, S. D. Schofield, and H. H. Wright.

Summer Tour of the Students' Section of the Institution of Electrical Engineers.—It has been proposed by the Students' Committee that the annual visit this year be made to Newcastle-on-Tyne and district. The matter has been discussed, and some preliminary arrangements have been made. Permission is being asked to see the following works:—Messrs. Parsons & Co. Heaton; Messrs. Armstrong, Whitworth & Co., Ltd., Elswick; Messrs. J. & H. Holmes; the Newcastle Power Co.'s power station and system; the Castner-Kellner Alkali Co.; the Consett Iron Works; Messrs. Swan, Hunter & Wigham, Richardson (shipyard); Messrs. Hood Haggies, Wire Rope Works, Gateshead; Messrs. Clark Chapman, Ltd., Gateshead; and an electrically-operated coal mine. The visit will take place from July 6th to July 11th, and the party from London will travel by train on Monday, July 6th, breaking up on the following Saturday. Further particulars may be obtained from Mr. W. B. Thompson, Students' Hon. Secretary.

Rent of a Cable.—In the Chancery Division of the High Court on Thursday Mr. Justice Warrington tried an action brought by the South Eastern Railway Co. and Managing Committee of the South Eastern and Chatham and Dover Railway against the National Telephone Co., claiming a declaration that defendants were not at liberty to construct, use, or maintain a cable upon a bridge at Tonbridge Station except upon payment of an annual rental of £30, and with the consent of plaintiffs. The question was whether or not defendants were bound by a contract they entered into, by which they obtained a licence from the South Eastern Railway to place a cable with the roadway of the road passing over the bridge vested in the South Eastern Railway, or whether they were entitled to say now that the South Eastern Railway had no power to grant a licence. His lordship held that defendants were not authorised to construct the cable without the consent of the railway company, and the plaintiffs were entitled to a declaration, the defendants to pay the costs.

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HIGH-SPEED ELECTRICAL MACHINERY

Newcastle Discussion

THE Paper by Mr. Gerald G. Stoney and Mr. A. H. Law, which was read on Thursday, April 2nd, at the London meeting of the Institution of Electrical Engineers, was further discussed by the Newcastle Local Section on April 6th. The Paper, which was given at considerable length in our last issue (page 543), together with a report of the discussion in London, contained an account of the development and present state of the designs of high-speed generators manufactured by Messrs. C. A. Parsons & Co. Particulars and drawings of machines for both continuous and alternating currents were given, including designs of historical interest as well as those illustrating the firm's latest practice The most notable features of the continuous-current machines are the retention of the bipolar form up to large sizes, the preference shown for smooth as against slotted cores, the avoidance of carbon brushes, and the employment of compensating windings without commutating poles. The alternators are more in accordance with prevailing practice elsewhere. The rotors are of the salient pole type, and a curious method of enclosing the field windings is adopted. The Paper concluded with a description of an ingenious arrangement for giving a compounding effect to alternators.

The Discussion was opened by Mr. J. Holmes, who considered that in the description of Mr. Parsons' 1884 patent hardly sufficient justice was done to that gentleman. There was really here the first indication of the barrel winding which in after years came into such prominent use. Referring to the 1885 experiment upon compensating winding, he would not altogether agree with the Paper's verdict that the fault was entirely due to insufficient ampere turns. He thought it might also be due to ineffective design for the purpose. In 1889 he was personally looking into this problem, and designed a form of compensating winding, which was applied to one of the machines sold by his firm, and gave perfectly satisfactory results. The arrangement is shown diagramatically in the figure in which the directions of current in the armature under the field, and direction of rotation was shown by Dr. Thompson's convention of "points and crosses." In order to neutralise the cross-exciting tendency of the vertical band of armature conductors he got the idea of placing a slot in the pole faces and filling it with ampere turns, giving an equal and opposite cross-flux. As it was mechanically difficult to make a single coil of this winding vertically, he placed coils on the side of the limbs, as shown, and found he had not only got a neutralising effect of cross turns, but could so shift the flux of lines through each pole-face that it was automatically

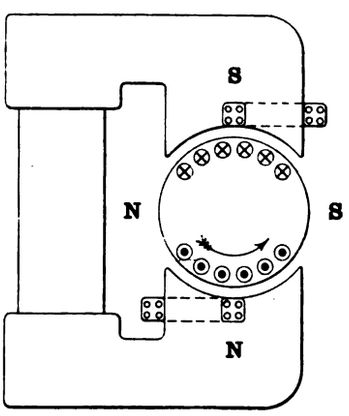


Diagram Illustrating Mr. J. Holmes' Remarks.

strengthened and weakened under the leading and lagging pole-tip in the precise way that was necessary to gain good sparkless commutation. If some such principle could have been applied instead of the arrangement shown in Fig. 1, perhaps the result would have been better. The design of armature in 1889, involving insulated discs at the end of the armature, reminded him of the Edison "Jumbo" dynamo, which had the same arrangement. The mention of the fact that in some of Messrs. Parsons' recent armatures of large size the conductors have been laid in slight grooves in the core reminded him that he himself had used a similar arrangement—having had, in fact, a patent for the same thing, which he had not upheld. The mention of brass-wire brushes was interesting, as lately carbon brushes, such as the Morganite brush, had been used, while the Westinghouse Co. had, he believed, in a recent machine used the radial surface of the commutator, placing the brushes sideways with the idea of avoiding jumping. The Morganite Co. had also introduced a special pneumatic-pressure brush-holder which, he had heard, was satisfactory on high speeds. The point mentioned as to the necessity of fixing the end windings of high-speed machines as firmly as possible was one of great importance. Even on slow-speed machines he had seen cases of violent distortion owing to insufficient security at these parts. The Paper mentioned the static balancing of armatures on knife edges. At one works which he saw recently the knife edge was superseded by a surface six inches wide, carefully planed up and kept level, the idea being that in a knife edge the surface of contact was so small tnat the weight of a heavy armature resting on it would cause the metal at that point to dent and sink in, prohibiting the armature from rolling well.

Mr. Turnbull, as an old Parsons man, referred rather humorously to some of the early difficulties. With reference to the compounding device mentioned near the end of the Paper, he believed that Messrs. Hookham many years ago used similar compensation windings on continuous-current apparatus. He would like to know the effect on the commutation of the exciter of the alternating fluxes superimposed on its ordinary flux. With reference to Morganite brushes, he had had some rather unsatisfactory experiences with some of an early pattern, but he believed that the Morganite Co. had since that time very greatly improved their brushes.

Mr. Davidson said that the compounding of the exciter mentioned in the Paper had been applied to about seven machines by Messrs. Parsons, ranging from 200 kw. to 750 kw., and no trouble had been experienced with the commutation. point concerning the working of these leakage paths was that the iron of the magnet must be saturated, and also the air-gap of the exciter is abnormally large. In ordinary machines it would be about $\frac{3}{8}$ in.; in this it was about $\frac{3}{4}$ in. Although the current in one phase may at an instant tend to assist the flux of the magnets through the bridge piece, the sum result of the superimposed alternating flux is to effect a gain of approximately half the leakage. In the first machine fitted this way the increase of exciter voltage when load came on the main machine was about 15 per cent. In a recent machine this rise could be brought up to 60 or 70 per cent. The practical effect is therefore that an alternator may have a very bad drop which can be compensated by increasing exciter voltage. To show how perfect the action was, one machine giving 500 kw. at 500 volts was connected up intermittently with a non-inductive resistance of full capacity, which was switched on and off. A glow lamp connected to the machine and placed in a dark room gave no perceptible flicker at these alterations of load.

Mr. Longman asked Mr. Stoney to give his impression of the performance of the Morganite brush with pneumatic brush gear, as the expense of heavy current brushes was heavy throughout a year. What result would the radial commutator have on life of brushes and commutator? Was there much sideplay in a turbine, and would this affect radial commutators at all? A displacement of 1/100 in. would effect sparking. With regard to the compensating device, would the fact that there was leakage round the top side of the exciter poles and not round the bottom affect the commutation? He had noticed, in some high-speed machines, that one bearing was always insulated, this being at one end of the shaft. There were several volts across that bearing and earth of alternating voltage. Was it of the same frequency as that of the machines, and to what action was it due?

Mr. R. H. Barbour wished to have one or two difficulties in the electrical and mechanical details of construction cleared up. He would like to know whether, for keeping the commutators quite true, the steel rings were found sufficient. In the use of carbon brushes the slightest irregularity—perhaps too small to be detected by a lead pencil—would set the brushes in disorder. It would be interesting to have details of the wear of brass brushes on copper commutators, as there might be some cutting. The Paper, in dealing with compensating windings, made no mention of placing separate poles between the ordinary poles and putting a winding on these. It mentions the method of varying effective resistance, but refers to the inductive effect on such an arrangement. It has, however, been found to answer properly if, instead of the usual non-inductive resistance being placed in shunt, the adjustment is made by means of a shunt having induction. He had noticed that the shaft shown in the latest machine illustrated was discontinuous. With the use of such shafts, was it not difficult to make the machine run true and balanced? The principle involved in the exciter, whose voltage is augmented by a flux due to alternating currents, is somewhat similar to the self-exciting alternator, where three-phase currents pass through a two-part commutator and are transformed to unidirectional currents for the field. The operation of this machine is satisfactory.

Mr. F. O. Hunt, in reference to the use of steel for binding

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wire, asked if manganese steel had ever been tried. It had a negligible magnetic effect. Why should there be difficulty in running self-excited compensated dynamos in parallel? He was disappointed that the Paper had not dealt more fully with the question of flashing over. The question of balancing was interesting. He believed that in some American shops the knife edge test was not solely relied on, but an actual running balance was experimentally found.

Mr. LAW, in reply, mentioned that in the early days of experimental compensation windings on the lines shown by Fig. 1, Mr. Parsons had tried the effect of using not one hole only, but three, through the poles, in which to place his windings, thus foreshadowing still more closely modern practice. The carbon brush question was not mentioned in the Paper, as they were quite certain that it would crop up in the discussion, and they wanted to reserve to themselves the last word on the subject. This was that dynamos running at high speeds had given good results with carbon brushes. The high surface speed on the commutator was likely to lead to undue heating of the commutator. As time went on the surface would get rough, but this could be cured by a little polishing occasionally. Messrs. Parsons have now about half-a-dozen dynamos under construction with carbon brushes. At the same time they were not at present making carbon brushes their standard design. They preferred to make the commutators, even when fitted with metal brushes, of ample size to receive carbon brushes should at any time sufficiently good designs of brush and brush-holder appear on the market to warrant the change. Two of the oldest makers of high-speed electrical plant, Messrs. Brown Boveri and Messrs. Parsons, used metal brushes. Messrs. Brown Boveri have carbon brushes in front of the metal ones in order, as they expressly say, to lubricate the surface of the commutator. They had had no experience with the Westinghouse type of commutator. There would necessarily be a higher surface speed at the outside diameter. For a 300 to 500-kw. Parsons dynamo the surface speed of the commutator would be about 3,000 to 5,000 ft. per minute. With the Westinghouse type he imagined that the surface speed might go up to 11,000 ft. per minute, which would not be unsafe, but more difficult to deal with. The end play might also be a difficult matter to negotiate, as a flexible coupling limits end play to about 1/16 in. either way. So far as his knowledge of Morganite brushes went, they were ingenious and gave good results, but he failed to see why springs could not be equally well used. Mr. Holmes had referred to the importance of end connections, even on slow-speed machines. On high-speed machines, where the number of poles were few, the span of the end connections was correspondingly wide and trouble was more likely to ensue. The six-inch wide balancing surfaces had already been tried and found successful. They should, however, be hinged so that they may give a fair bearing on the shaft even when slight deflection occurs along the length of the shaft due to the weight of the armature. Mr. Turnbull referred rather humorously to the bursting of commutators. So far as he (Mr. Low) remembered, only one commutator had burst in the last eight years. With reference to the leakage-path device, it was at first thought necessary to distribute the flux equally at the top and bottom limbs, but a consideration of the old horse-shoe type of bipolar dynamo would show that distortion of the field in this way had very little effect on commutating properties. In answer to Mr. Chamen, he explained that a closed circuit for the alternating-current flux was better than an open one, though the latter could be used if the pole-faces were laminated. As Mr. Davidson pointed out, bad drops could be corrected by this device, though this could not be pushed too far on account of the possibility of the machine encountering heavy inductive loads. The leakage-path device had three paths, one in each phase, but it was possible to secure results with one phase leakage-path only, leaving the two other phases idle. Also it was possible to use a current transformer giving a single-phase current from three three-phase currents. With reference to the insulated end bearing, it was difficult to tell the frequency at present, though it was supposed to be that of the machines. Experiments would shortly be made with an oscillograph to test this. Its presence was due to the action of the dynamo as a unipolar machine as regards its stator, bedplate, bearings, shaft, and armature. A question had been asked as to the life of commutators of high-speed dynamos. An 1,800-kw. dynamo at Manchester had its commutator guaranteed for two years. As the result of gauging after considerable running, its probable life was determined at 10 to 12 years, before compensating winding was introduced. Now its probable life was much increased. Referring to the effect of interpoles, it was difficult to adjust the shunt inductive resistance for variations of voltage such as from 460 to 500 volts (lighting to traction voltage). Moreover, inductive shunts looked likely to be big and expensive. Discontinuous shafts were an interesting study. In large machines, such as those at Carville, the body of the shaft was made of high permeability steel of 30 tons tensile strength, while the ends had 40 tons tensile strength, but were of different physical properties. In reply to Mr. Hunt, manganese steel has the difficulty that it is so refractory as to be impossible to draw into wire. With regard to flashing over, he claimed that this evil was practically absent from two-pole dynamos. Regarding running balance, the revolving parts were at Messrs. Parsons run up much above speed in a sort of armour-plated house.

HAMMERSMITH-PUTNEY TRAMWAYS

THE Highways Committee of the London County Council has prepared a report with regard to the tramways from near Hammersmith Broadway, *via* Queen Street, Fulham Palace Road, High Street, Fulham, and across Putney Bridge to a point in Lower Richmond Road. The length of this route is about 2⅛ miles, and the Council's Act of 1902 prohibits the use of any system of overhead electric traction on the tramways. The extension of these lines from Hammersmith to Harlesden is being constructed on the overhead trolley system of electric traction, and, with a view to the construction in the near future of a through route from Putney to Harlesden on this system of traction, authority is being sought by the Council in the present session of Parliament for an amendment of the Act of 1902 so as to enable the overhead trolley system of electric traction to be used on the Hammersmith to Putney tramways. The greater portion of the route is situated in Fulham, and the Fulham Metropolitan Borough Council has agreed to the proposed adoption of the overhead trolley system.

The construction of the tramways in question is included in the programme of tramway works for 1908-9. The Highways Committee consider the construction of them to be a matter of considerable importance from the traffic point of view. The lines will join the Council's other lines, and will also be closely adjacent to those of the London United Tramways (1901), Ltd., at Hammersmith, and when the arrangements already approved by the Council for the widening of Hammersmith Broadway are carried out, it will be possible to run through services of cars from Putney to Harlesden. The Council has already approved estimates amounting in all to £20,320 in respect of preliminary works in connection with the construction of these tramways. These preliminary works have been put in hand, and include the diversion of gas and water mains along the route, and alterations of the south-western approach to Putney Bridge in order to provide improved terminal facilities for the tramways. Various street widenings along the route were authorised by the London County Council (Tramways and Improvements) Act, 1902. The execution of these widenings are now practically completed. It is necessary, however, in order to complete the purchase of certain property of the Ecclesiastical Commissioners for the street widenings, that the Council should pass a definite resolution to proceed with the construction of the tramways.

The electric power for working the tramways will be obtained from the Greenwich generating-station. No further buildings will be required, as arrangements have been made in connection with the Hammersmith to Harlesden tramways for the erection at Hammersmith of a portion of the car-shed which is to be established there, and also of a temporary sub-station, and these buildings will serve the Hammersmith to Putney tramways. The length of the tramways will be equivalent to about 4¼ miles of single track, and the total estimated cost of the construction and equipment of the lines on the overhead trolley system of electric traction, exclusive of buildings, and of the preliminary works mentioned above, is as follows:—Trackwork, &c., including special work, and £7,800 for rails, £34,100: overhead equipment, £5,650; cable-ducts, &c., £3,500; cables and feeder pillars, £3,000; rolling-stock, £5,700; sub-station plant and equipment, £2,500; total, £54,450. In view of the urgency of the matter the Committee suggest that the operation of the standing order which relates to proposals involving capital expenditure exceeding £5,000, should be suspended so as to enable this recommendation to be dealt with by the Council before the Easter recess.

The Committee therefore recommend that, subject to Parliamentary authority being obtained by the Council in the session of 1908 for the use of the overhead trolley system of electric traction on the tramways in question, the estimate of expenditure on capital account of £34,700, submitted by the Finance Committee, be approved in respect of the construction and equipment of the tramways on that system, namely, trackwork, &c., excluding rails, £26,300; overhead equipment, £5,650; feeder pillars, £250; sub-station plant and equipment, £2,500; total, £34,700.

The Finance Committee, having considered in its financial bearings the above estimate, submit the same as chargeable to capital (short period) account. When the question of the construction of this line was last before the Finance Committee, in December, 1906, it was estimated that the working would result in an adverse balance in the first year of £3,005 on the basis of a 4-minute service, or £995 on the basis of a 3-minute service, before providing for renewals. If 1d. per car mile be accepted as the standard for renewals, provision on this basis would increase these adverse balances to £4,221 and £2,668 respectively. These estimates were based on the assumption that the line would be reconstructed on the conduit system, and the substitution of the overhead trolley system, as is now proposed, would reduce the estimated adverse balances to £2,761 and £1,118 respectively for the first year, which would decrease by about £127 and £132 a year as the debt is paid off. It must be borne in mind, however, that the tramways account is at present bearing debt charges to the extent of over £2,000 a year in respect of street widenings and other works already carried out on this route.

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ELECTROCHEMISTRY AND ELECTROMETALLURGY

THE *Revue d'Électrochimie et d'Électrometallurgie* of March has an article upon the fusion and production of glass in the electric furnace. The article, which deals with the subject from the first experiments by Reich in 1881, is practically an historical survey of the various methods which have been tried. There are a good many difficulties in the employment of electrical energy for the fusion or making of glass. One difficulty is the very local heating which is apt to be produced by the electric arc. In most of the furnaces described, the mixture of sand, lime, soda, &c. which is employed for the manufacture of glass is caused to pass from a distributor through a series of arcs into a crucible placed below, the arcs being so arranged that after passing the last one the product is completely fused. Or it is caused to pass cascade-wise down a series of steps, and as it passes each step it is radiantly or directly heated by an arc. As a rule, after reaching the crucible it is kept in the molten condition by means of gas or other firing. One of the most interesting furnaces described is that of Brown, where the crucible is embedded in broken carbon, on each side of which electrodes are placed. When the current is passed, we thus have a resistance furnace produced, and the crucible is in the midst of the furnace. The article is to be continued.

In the same number, *loc. cit.*, there is also an article by Minet upon a new electric arc furnace. He thinks it necessary to give first of all a long description of various furnaces from that of Siemens, 1878, and then various forms of furnace experimented with by himself and others, perhaps in the next number—the article is to be continued—we shall arrive at the new furnace.

There is also an interesting article upon the preparation of aluminium carbide by C. Matignon. Moissan first obtained this substance by heating a mixture of aluminium and carbon in a carbon crucible by means of an electric furnace. Mallet heated aluminium and carbon to a temperature of 1,700°, but apparently was not able to convert it into the carbide. On the other hand, Frank repeated this work and obtained a carbide which on being added to water gave off a mixture of acetylene and hydrogen; it was probable, therefore, that the presence of impurities had led to the formation of calcium carbide. The carbide obtained by Moissan gave, when treated with water, methane

$$Al_4C_3+6H_2O=2Al_2O_3+3CH_4.$$

In 1901 Berthelot determined the heat of formation at 244·8 calories. From this high heat of formation he believed it should be possible to produce the carbide without it being necessary to employ the great heat of the electric furnace. By mixing 70 or 140 parts of aluminium with 24 parts of sugar carbon and oil of terebene, and heating the mixture in a Perrot furnace for 20 minutes, the carbide of aluminium was obtained, which, upon the addition of water, gave off 95 to 96 per cent. of methane.

The reaction can also be caused to take place by Goldschmid's method—that is, by mixing carbon and aluminium together and starting the reaction by means of a fuse Reaction between aluminium and benzene hexachloride can also be caused to take place by heating to 225°; the reaction is very vigorous, and takes place as follows:—

$$10Al+C_6Cl_6=2AlCl_3+2Al_4C_3.$$

"The Deposition of Zinc for Protecting Iron and Steel Surfaces," by S. Cowper Coles, is the title of a reprint from the *Transactions* of the Glasgow Technical College Scientific Society. In it the various processes of galvanising are described, beginning with that of dipping the articles into molten zinc. The author then describes the process of cold or electrolytic galvanising, and gives figures which go to show that this process is much more economical than the hot dipping process. By the old process the cost is given as 0·5688d., and with soluble zinc anodes as 0·3658d. per square foot. Of course, there are advantages and disadvantages in both methods. If the article is to be electrolytically galvanised, it requires a much more thorough and careful preparation than if it is to be galvanised by the molten process. Furthermore, in the galvanising of tanks, &c., any slight leaks which may be left by faulty joins are filled in by the hot process, but not by the cold process. On the other hand, articles plated by the cold, wet process will take on a very fine polish, and the coating is very even. The sheradising process is then described. In this process it will be remembered that metals can be galvanised by placing them in a box, covering them with zinc dust, and heating to a temperature of 330 to 400° C.; this is about 100° below the melting-point of zinc. After taking out the metal, it is found to be evenly covered with zinc. If the metal is cut it is noticed that the zinc has alloyed with the object to quite a considerable depth. Articles so treated will also take on a very fine polish. Another very interesting result which can be obtained is galvanising in relief. If the parts which it is desired should not be galvanised are coated with a stopping off composition, and then placed in contact with the heated zinc dust, the zinc is only deposited upon the parts which have been left exposed, so that by this means any desired form of pattern can be galvanised upon a metal. Finally, the Cowperising process was mentioned. In this the article to be galvanised is placed in a chamber into which a mixture of zinc vapour and hydrogen gas is led; by this means very brilliant effects can be obtained.

ELECTRICAL SCIENCE

British and American

The Chancellorship of Cambridge University.—Lord Rayleigh has been elected as the new Chancellor of Cambridge University in succession to the late Duke of Devonshire. Lord Rayleigh's Cambridge career commenced at Trinity College in 1861, and he became Senior Wrangler of 1865 and first Smith's prizeman. In 1879, when, on account of his well-known work in Physical Science, he had already been a Fellow of the Royal Society for six years, he succeeded the great Clerk Maxwell at the Cavendish Laboratory, Cambridge, as Professor of Experimental Physics, and during his five years' tenure of this position, he conducted classical experiments on the evaluation of the fundamental electrical units. He was for some years Secretary of the Royal Society and Professor of Natural Philosophy at the Royal Institution. His later scientific work, including his connection with Sir William Ramsay in the discovery of argon, is too well known to need recapitulation.

Short Spark Phenomena.—At last Friday's meeting of the Physical Society, W. Duddell exhibited an interesting experiment on the secondary current of induction coils. The induction coil was one of about six-inch spark length, and its primary current was taken from 100-volt mains through a resistance of about 30 ohms, and through a mercury break. In the secondary circuit were an adjustable spark gap and a thermal ammeter in series. The thermal ammeter read, of course, the root mean square of the current through it. Now the author showed that if the adjustable spark gap had its poles screwed up into metallic contact, the current through the thermal ammeter was a certain small figure; but if the gap was opened slightly, say to one-tenth of a millimetre, then a mean square current of many times the original value was registered. If the gap length was gradually increased, the reading increased till at a spark length of about one millimetre it was a maximum. As the spark length was further increased the reading diminished till at a spark length of five millimetres the mean square current became of the same order as it was when the spark length was zero. With further increase of spark length the thermal ammeter reading increased. The author showed also that rather unexpected phenomena occur when a galvanometer is used in place of the thermal ammeter. A galvanometer measures, of course, the mean current. When the spark terminals are in contact the deflection is zero. When the gap is a very small one the galvanometer deflection is considerable, and is in the same direction as that given by a single *make* of the primary current. As the length of the spark gap is increased the deflection grows to a maximum and then diminishes to zero. Further increase of the spark length causes the deflection to take place in the direction of the deflection given by a single *break* in the primary current. Of all these phenomena the author gave very slight explanation. The facts unfolded are nevertheless of interest, not only because they are somewhat paradoxical, but also because they may conceivably be of service in the testing of the secondary winding of an induction coil. In the discussion, A. Russell suggested that the explanation of the thermal ammeter experiments might lie in the well-known fact that in a circuit traversed by electrical oscillations, the impedance, and therefore the current, is a function of the inductance, the capacity, and the frequency, such that if the capacity and the frequency vary in opposite ways the function has a maximum and a minimum. In the case of the experiment just shown, the spark gap is, in effect, a condenser of small capacity and the circuit containing the gap has a determinate frequency. If the gap is lengthened the capacity is diminished, and the frequency increased, and thus the maximum and minimum of the experiment can be accounted for. S. Skinner called attention to some old experiments of J. J. Thomson on the electrolysis of steam, which seemed to have some bearing on the matter. The steam was electrolysed by the current from an induction coil, which, usually, as is well known, gives a unidirectional discharge; but in these experiments cited the electrolysis varied greatly with the length of the spark gap. With short sparks the hydrogen appeared at the negative ter-

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minal, with sparks of medium length the hydrogen appeared at the positive electrode, and with long sparks the hydrogen appeared at the negative electrode.

The Carriers of Positive Electricity.—At the Royal Institution, last Friday evening's discourse was delivered by Prof. J. J. Thomson. The lecturer dealt principally with the problem of the nature of positive electricity. Though the disembodied negative unit of electricity is familiar enough to physicists, the ultimate particle of positive electricity has never been separated from masses of the size of the atoms or molecules of ordinary matter. Thus the particle of positive electricity has always been weighed associated with matter, the hermit has never been got out of his cell, though both persuasion and provocation have been applied in various ways. The lecturer summarised some of the main properties of positive rays, and then proceeded to show that in vacuum tubes the positive rays seem often to be issuing from regions they ought never to have appeared in. This was shown very emphatically by a helium tube containing a cathode made of two parallel triangular plates fixed close together. From such a cathode both negative rays (cathode rays) and positive rays (canal rays) can be seen simultaneously proceeding, for they are easily distinguishable in helium. Since the motion the rays possess is due solely to the action of the electric field in the tube on the carried charges, this experiment would seem to show that the "positive" carriers may sometimes be laden with negative charges. Here the lecturer stated his view that uncharged "positive" carriers may often be found in a vacuum tube; they may, because uncharged, reach the cathode in their wanderings, and these, becoming negatively charged, be repelled away from the cathode as so-called positive rays. The one characteristic of the positive carriers which is their real distinction is their large mass. By passing ionised gases between two very close parallel gauze strips kept at constant potential difference, the lecturer has succeeded in projecting the heavy particles in the gas with definite momenta along a tube and across a magnetic field. The field deflects the particles more or less according as their mass is smaller or greater. In this way using magnetic fields rising to 6,000 lines per square centimetre, he has succeeded in measuring the mass, and the relative number, of the positive carriers in air and in hydrogen. The conclusion he has reached is that about the same number of carriers in each gas have the mass of the hydrogen atom, another batch of carriers, also equal in the two gases, have the mass of the hydrogen molecule, while there are also batches of heavier objects not yet fully investigated.

Sir William Ramsay's Lecture in Vienna.—A lecture on radioactive gases was given last Saturday evening by Sir William Ramsay before the Electrotechnical Institute of Vienna. According to the *Daily Telegraph's* correspondent, almost all the Ministers, the entire staff of the British Embassy, and everyone enjoying a reputation in scientific circles in Vienna, were present.

Electric Discharges through Gases.—At the Royal Institution on Saturday last Prof. J. J. Thomson delivered the sixth and last lecture of the course on this subject. Most of the time was devoted to an explanation of the phenomena observed in an ordinary vacuum tube. If a section across the path of the discharge is considered, the current passing through that section is the same wherever the section is taken. Any variation in the number of carriers or particles must therefore be accompanied by a corresponding increase in the velocity and the electric force. The negative particles produced at the cathode by the impact of the positive particles got fewer in number as they proceeded along the tube, as they were driven to the walls of the tube. The velocity must therefore increase, and in the region of the negative glow the velocity was so great that fresh negative ions were produced by collision with the molecules, and the number of particles being increased, the velocity decreased. Where the electric force and the velocity were high, luminosity was produced. The number of particles would soon decrease, and the velocity would increase. Another luminous (high velocity) region would be produced, and again after the collisions a (low velocity) dark region. This was repeated along the tube, and produced the so-called striae. The narrower the tube, the more rapid the diffusion of particles, and the nearer the striae. A magnetic field also increased the loss of particles by driving them to the walls, and the striae were drawn nearer together. The total negative charge due to these negative particles was, the lecturer said, neutralised by an almost equal positive charge on the positive particles. At the surface of the anode, where the positive particles came from, there was a sudden drop of about 20 volts. Prof. Thomson then explained how it was that the luminous discharge ceased suddenly on a slight increase of the resistance in the circuit, and did not gradually die out. The curve expressing the relation between the current and P.D. for an exhausted tube was complex; that portion of it corresponding to the luminous discharge was convex to the (current) abscissa. A diminution in current then meant an increased P.D. Thus, if at the critical point the resistance in series with the tube were slightly increased, the necessary P.D., owing to the decreased current, would be larger than that available at the terminals of the tube, and the discharge would suddenly cease. Prof. Thomson then concluded the lecture with a few remarks on the electric arc. This, he said, was hardly a case of discharge through gases, but was a case of the discharge from incandescent solids. If a negative electrode were made red rot, it gave off a stream of negative particles whether it were surrounded with gas or not. The cathode of the ordinary arc was kept hot by the bombardment of positive particles from the anode. The cathode must be kept at a very high temperature, and so the cathode must be made of a substance which is a bad conductor of heat. The burning of the carbon cathode increased the temperature, and if this was hindered, as, for example, in the enclosed arc, the arc was more difficult to form owing to the decrease in the number of negative particles thrown off by the cathode. The lecturer then summed up the subject by saying that the two fundamental principles were (1) the motion of the charged particles, and (2) the production of fresh particles by collision. By applying these principles all the phenomena of electric discharges could be explained.

The Indian Institute of Science.—It is announced in *The Times* that the scheme for an Indian Institute of Science, which it is proposed to found by the munificence of the late Mr. Jamsetji Nasserwanj Tata, a prominent merchant and millowner of Bombay, is rapidly taking shape. A provisional committee has been appointed by Lord Minto, and building operations are to commence at once at the site which was given by Mr. Tata at Bangalore. The Government and the Maharajah of Mysore have contributed largely towards the cost. The chief work of the institute will be the establishment of departments of pure and applied science, and students who have passed through the Indian Universities will be trained so that they may apply science to the Indian arts and industries. The nearness of the great Cauvery power works, from which a supply of electricity at high tension will be obtained, has led to the decision to open a Department of Electrical Technology, and it is possible that a department of electro-metallurgy may also be established.

Continental

Longitude by Wireless Telegraphy.—In the *Comptes Rendus* of March 30th we find details of Bouquet de la Grye's proposals for an international hour signal by wireless. Chronometers and occultations are to be supplemented by a daily hour marked by a wireless wave capable of being received all round the world. The Eiffel Tower station has a range of 1,300 miles, and would cover the busiest portions of the Atlantic. For a world-wave, something bigger would be necessary. The Peak of Teneriffe has been proposed. It is 3,710 m. high, with an average gradient of $13\frac{1}{2}°$. The possibility of such a service has been acknowledged by Becquerel, Chairman of the Wireless Commission instituted by the French Government, and by Admiral Gaschard, who is in charge of the wireless service to Morocco. The latter does not, however, think that Teneriffe is necessary. A sea strand 6 km. long, such as is available at Guetn'dar, Senegambia, in the region of the trade winds, would be more convenient and quite effective. A beginning might be made with a service from the Eiffel Tower. The world-signal would have to be despatched at midnight, in order to get the maximum range of transmission along the dark half of the globe. The proposals have been referred to the Astronomical, Geographical, and Physical sections of the Academy, together with MM. Darboux, Poincaré, and Cailletet.

Number of Electrons in an Atom.—An interesting attempt to estimate the number of electrons contained in an atom is made by J. Bosler in the *Comptes Rendus* for March 30th. His result, derived from considerations of the energy displayed in radioactivity, goes to confirm Thomson's result that the number is of the order of the number expressing the atomic weight. According to Curie, a gramme of radium gives out 100 calories per hour. Rutherford estimates the mean life of radium at 1,300 years. This gives us an idea of the total energy available for dissipation, and due to the potential energy of the electrons and the positive elements (probably helium atoms) contained within the radium atom. The potential energy contained in a gramme of any substance may be put down as proportional to $N(ne)^2/a$, where e is the charge of an electron, N the number of atoms in the gramme, n the number of electrons in the atom, and a the radius of the atom. The latter probably varies with the atomic weight, and may be three times as great in radium as in hydrogen. Thus we get another estimate of the electrical energy in a gramme of radium. It is $2\frac{2}{3} \times n^2 \times 10^{13}$. The figure derived from the observed radioactivity and life period is 3×10^{16} ergs. Equating the two values, we find that n must lie somewhere below 10. The determination is, of course, very rough, but it should render a number of 1,700 electrons in the hydrogen atom very doubtful.

The British Association.—An advance programme of some of the arrangements for the forthcoming meeting of the British Association in Dublin has been issued. The meeting will commence on September 2nd with the Presidential address of Prof. F. Darwin, F.R.S., and the reception-room, which will be at Trinity College, Dublin, will be open the day before. The concluding meeting is fixed for September 9th. As already announced in Electrical Engineering, Mr. Dugald Clerk, F.R.S., will be president of the Engineering Section.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published April 9th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

1,373, C. A. Park and C. L. Mason. A device for use with the "Stone" system of train lighting, in which the dynamo is driven by a belt which slips if the speed is excessive. If the belt does not slip, the current may become excessive. The present device consists of a series solenoid operated switch which, if the current exceeds a certain predetermined amount, inserts a resistance in the main armature circuit. The resistance is again short-circuited on the current being reduced in value. Two claims, four figures.

6,649, British Thomson-Houston Co. (*General Electric Co.*). A method of providing machines of the compensated commutator type with a commutating field, without the use of interpoles, and particularly suitable for alternating-current compensated series motors in which there is not room for interpoles. The armature of the machine is wound with a fractional pitch approximately equal to or a little less than the width of the pole-face. The current in the coils of the slots opposite the interpolar space then neutralise each other, and it is only necessary to compensate along the pole-face, for which purpose a compensating winding is distributed along the pole-face. Furthermore, the short-circuited coils are just approaching or leaving the pole-tips, and so a commutating field of proper amount and phase can be produced at the pole-tips. A special shunt winding at the pole-tips can be provided, or that portion of the compensating winding situated at the pole-tips can be shunted with a non-inductive resistance, this causing the field at the pole-tip to have the necessary lag behind the main compensating field. Four claims, six figures.

7,181, British Thomson-Houston Co. (*General Electric Co.*). A system of control for electric winches for towing barges and other purposes. The winch, which is situated on the tug, is controlled by an electric motor, the motor being supplied with current from a generator, also on the tug. A device, consisting of two solenoids, one controlled by the current through the motor, and the other controlled by the variation in the effective length of the hawser acting on a screw and nut variable resistance switch, so controls the torque of the motor that the pull is increased when the distance between the ships increases and is decreased as the distance between the ships decreases. Thus, if the tug slows down, the hawser is reeled in to take up the slack, and if the tug suddenly increases in speed, the hawser is automatically lengthened to avoid shock, and then gradually wound in. Six claims, two figures.

11,166, J. S. Highfield. In high-tension direct-current systems it has been the usual practice to use a number of direct-current generators (each coupled to its prime-mover) in series. It is necessary to insulate each generator from earth, and consequently the generators have been supported on insulating bases, and coupled by means of insulating couplings to their respective prime-movers. To avoid the use of these insulating couplings, the prime-mover, which, according to this invention, may be a large unit, is coupled to an alternator. The alternator supplies current to a constant current transformer, the secondary of which is divided up into a number of equal sections. Each of these sections supplies current to a rotary converter and the direct-current sides of the rotary converters are connected in series. The rotary converters only need be insulated from earth, and no insulating couplings are required. When the demand on the station is small, one or more of the converters can be short-circuited, and this will not affect the current, as the transformer is designed for constant current. Instead of a single transformer, several in parallel can be used. Two claims, one figure.

11,523, W. Kneen and H. C. King. This specification relates to the points used in the conduit system for tramways, particularly where facing points are employed, and describes a mechanism for setting the slot points simultaneously with the operation of the rail points. This consists of push-rods, each of which is adapted to be maintained in operative engagement during the forward or setting stroke until it is moved sufficiently to set the point, when it is disengaged by a cam, so that its further motion is lost. Each rod on its rearward stroke resets itself ready for the next forward stroke, and moves back sufficiently to allow the plough to complete the movement of the tongue. Four claims, six figures.

16,710, Bruce, Peebles & Co. and La Cour. In machines the pole-shoes of which are fitted with amortisseurs of the usual type (*i.e.*, copper rods through the pole-shoes, the rods being parallel to the axis of the machine and being short-circuited by heavy end connections), the shoes may become unduly heated owing to currents generated in the amortisseurs by the local fluctuations of the magnetic flux in the pole-shoes, these fluctuations being caused by the irregularity of the slotted armature surface. If the copper rods are put in the shoes at an angle to the axis of the machine, these fluctuations do not induce current in the bars. The action of the amortisseurs in damping variations in the magnitude of the total flux is not impaired by this arrangement. Two claims, three figures.

20,372, V. Scholz. In the process of manufacturing metal filaments for incandescent lamps, from colloidal metals (see B.P. No. 28,154, of 1904, granted to Dr. H. Kuzel), the plastic threads are reconverted into a crystalline state by heating them to a white heat in a neutral or reducing gas. To prevent the filaments from becoming distorted while undergoing this treatment, they can be put under strain by hanging a small weight from the filament, or by causing a reaction between the current in the filament and a suitably placed magnetic field, or the above-mentioned weight can be acted upon magnetically. One claim, no figure.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1906 Patents

29,086, Lodge. Exciting Ruhmkorff coils.
29,398, Hewitt Apparatus for recording the time of signals on railways.

1907 Patents

1,596, Park & Mason. Electrically-operated switches.
6,932, Foster & Spoor. Electric igniting apparatus.
7,555, Handcock, Dykes & Smith. Electrical wiring.
7,556, Handcock, Dykes, & Smith. Boxes for electrical wiring.
7,557, Handcock, Dykes, & Smith. Boxes for electric wiring.
7,563, Friedheim. Electro-deposition of metal on hollow articles.
7,926, Hatfield & Lewis. Electric arc lamps.
8,020, British Thomson-Houston Co. (*General Electric Co.*). Systems of motor control.
8,388, British Thomson-Houston Co. (*General Electric Co.*). Systems of lighting by arc lamps.
8,629, Human. Utilisation of electrical energy in the case of intermittent loads.
8,860, Balachowsky & Caire. Driving wheels for electrically-propelled vehicles.
9,270, Cummins. Automatic electro-magnetic sanding gear.
10,931, Campbell. Electric incandescent lamp bulbs.
10,972, Porzellanfabrik Kahla, Filiale Hermsdorf Klosterlausnitz. Insulators.
12,913, Irving. Reciprocating electric motors.
13,342, Richardson & Vaughan. Electrical production of ozone.
13,403, Boult (*Soc. Anonima di Construzioni Meccaniche, Freni a Ricupero Cantino F. A. R.*). Starting devices for motors.
16,865, Brookes (*Asbestos Wood Co.*). Insulating materials.
16,968, Martin. Electrical resistance.
17,304, Summerscales & Pearson. Automatic switch point for overhead conveyors.
17,548, Milton. Inductor generators for ignition.
17,704, Marzi. Loud speaking telephone apparatus.
18,480, Schmidt. Electroplating metals.
19,101, Rawson & Sager. Electrical water-heater.
21,104, Fletcher. Magazine fuses for electric circuits.
24,983, Fidelmann. Pocket lighting appliances.
25,126, Cowper-Coles. Electro-deposition of metals.

1908 Patents

468, Siemens Bros. Dynamo Works (*Siemens Schuckertwerke Ges.*). Maximum demand meters.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patent

24,802, Timar & Von Dreger. Apparatus for transforming electric currents.

1908 Patents

6,228, Grob. Method of producing a constant booster voltage with variable speed.
6,323, Steinert & Stein. Electro-magnetic treatment.
6,432, Kinsella & Hodgetts. Electrical alarms for tramcars.
6,453, Jirotka. Production of ozone.

Expiring Patents

No patents of electrical interest expire during the current week.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. * = Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ltd.	10	7	7%	10¾—11¾	
Do. 4½% Cum. Pref.	10	4½	4½%	10—11	
Do. 6% Cum. Second Pref.	10	6	6%	10¼—11	
Do. 4½% Debenture, Red.	Stock	4½	4½%	100—103	
Bromley (Kent) E.L.& Power Co., Ltd.	5	5½	5½%	4½—5 xd	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	96—99	
Brompton & Kensington E. S. Co., Ltd.	5	10	10%	7¼—8¼	
Do. 7% Cum. Pref.	5	7	7%	6¾—7¾	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	98—101	
Ch. Cross, W. E. & City E. S. Co.	5	5	5%	3⅝—4⅛	
Do. 4½% Cum. Pref.	5	4½	2¼%	4⅛—4⅜	+⅛
Do. 4% Deb. Red	Stock	4	4%	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	4—4½	
Chelsea Electric Supply Co., Ltd.	5	4½	4½%	3¼—3⅝	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9⅝—10⅝	
Do. 6% Cum. Pref.	10	6	6%	11¼—12¾	+¼
Do. 5% Deb. Red	Stock	5	5%	123—126	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	101—104	
Cty of Durham E. P. Dis. Co.	5	4	2%	3—3⅜	
Do. 5% Pref.	5	5	5%	4¼—4½	
County of London Elect. Sup. Co. Ltd.	10	5	5%	7⅜—8¼	+⅜
Do. 6% Cum. Pref.	10	6	6%	10¾—11¼	
Do. 4½% Deb. Red	Stock	4½	4½%	107—110	+1
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	98—101	+1
Ednunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	¼—1¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	58—63	
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4¼—5	
Do. 5% Cum. Pref.	5	5	5%	4⅝—5⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8¼%	6¼—6⅜	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	10%	7¾—8⅜	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N'tng Hill E.L. Cos. Db. Rd.	Stock	4	4%	97—101	
London Electric Supply Corporation	3	4	2¼%	1—1⅛	−⅛
Do. 6% Pref.	5	6	6%	4½—5	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6½%	4⅜—5¼	−¼
Do. 4½% Cum. Pref.	5	4½	4½%	4¼—5¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D.	100 & 500	4½	4½%	96—99	−1
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	9¼—10½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	8%	5⅞—6¼	
Do. £2 Pm.	5	8	8%	5¾—6⅛	
Do. 5% Pref. (fully paid)	5	5	5%	5⅛—5⅜	
Do. 10/- Pm.	5	5	5%	5⅛—5⅜	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7%	5⅞—6⅜	+⅛
Do. 4% Deb. Red.	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7¼—8¼	−¼
Do. 7% Non-Cum. Pref.	5	7	7%	6¼—7	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅜—1⅜	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4%	2⅜—2⅞ xd	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅜—⅝	
Do. 7% Cum. Pref.	1	7	7%	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5%	1⅜—2⅛	
Do. 5% Cum. Pref.	5	5	5%	1⅞—2⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¼—8	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5¼	−¼
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	89—92	
Central London	Stock	4	3%	75—78	+4
Do. 4% Preferred	Stock	4	4%	83—85	+1
Do. Deferred	Stock	4	2%	54—57	+2
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	81—84	
City and South London Cons.	Stock	2⅜	4¼%	39—41	
Do. 4% Perp. Deb	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1895	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11½%	¾—1¼	−¼
Gt. Northern, Piccadilly & Brompton	10	4	4%	6—7	+½
Do. 4% Perp. Deb.	Stock	4	4%	87—90	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	4%	43—44	+2
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½%	72—75	+1
Metropolitan District	Stock	nil	—	11¼—12¼	+1
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Deb.	Stock	4	4%	no price	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3⅛%	44—48	
Underground Elec. Railways Co. of London 5% Profit Sha. Sec. Notes	Various	5	5%	39—43	−1
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅜—⅝	−⅛
Do. 5% Cum. Pref.	1	5	5%	⅞—1⅛	
Do. 4½% Deb. Red.	Stock	4½	4½%	89—94	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93 96	
British Electric Traction Co., Ltd.	10	—	—	1⅛—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	4—4½	
Do. 5% Perp. Deb.	Stock	5	5%	92—95	−1½
Do. 4½% 2nd Deb.	Stock	4½	4½%	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4½—5	+⅛
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	98—101	

NAME.	Amount of Share.	Dividend Paid. * = Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%			
Dublin United Trams Co.	10	6	6%*	12½—13¼	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	96—98	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	⅞—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	⅝—⅞	
London United Trs., Ld., Cm. Pf.	10	5	5%	6—7	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	85—90	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—⅛	
Do. 5% Cum. Pref.	1	5	5%	⅜—½	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	95—98	
National Elec. Construction Co. Ltd.	1	10	2/-	⅞—1⅛	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅛—¼	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—½	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9¾d*	¼—⅜	
Do. 5% Cum. Pref.	1	5	5%	½—¾	
Do. 4½% Deb. Red	Stock	4½	4½%	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4⅜—5¼	+⅛
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6%	¾—1⅛	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E.Trs. 1st Mt. Db. Rd.	100	5	5%	73—7⅝	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1¼	
Do. 6% Cum. Pref.	5	nil	—	3—3½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅜	15/-*	55—58 xd	
Do. 6% Pref. Crd.	Stock	6	30/-*	98½—100½xd	+½
Do. Def. Ord.	Stock	1¾	1%	13¾—14½	+⅛
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	−2
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3½—3¾	
Do. 10% Cum. Pref.	10	10%	8½—9¼		−¼
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4½	4/-*	13½—14	−⅛
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	99—101	
Do. do. (Mauritius Sub.)	25	4	4%	100—102	+½
Eastern Ext. Australasia & China	10	7	7/6	12¾—13⅜	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5⅜	7%	130—135	
Do. 3½% Pref.	Stock	3½	3½%	84—87	
Do. 4% Mort. Deb.	Stock	4	4%	101—104	
G. N. Tel. Co. (Copenhagen)	10	20	20%	31½—33½	+½
Indo-European Telegraph Co. Ltd.	25	13	65/-	55—5⅝	+1
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅞—1⅛	−⅛
National Telephone Co., Ltd, Pref.	Stock	6	6%	107—109	
Do. Deferred	Stock	5½	6%	108—110	
Do. 6% Cum. 1st Pref.	10	6	6%	10—12	
Do. 6% Cum. 2nd Pref.	10	6	6%	10—12	
Do. 5% 3rd Pref.	5	5	5%	5¼—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	98—100	+½
Do. 4% Deb. Red.	Stock	4	4%	101½—103½	
West African Telegraph Co. Ltd.	10	4	4%	10—10¼	
Western Telegraph Co., Ltd.	10	7	7%	13¼—13¾	
Do. 4% Deb.	Stock	4	4%	99—102	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	6%	¾—⅞	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅝—3¾	
Do. 6% Pref.	1	6	7½d	1⅛—1⅜	
British Insulated & Helsby Cables, Ltd.	5	10	10% & bonus	6¼—6⅝	−⅛
Do. 6% Cum. Pref.	5	6	6%	5⅝—6¼	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	93—98	+2
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅜—⅝	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—½	
Do. 6% Pref.	2	nil	—	⅛—⅜	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	75—80	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	60—65	−1
Callender's Cable and Const. Co., Ltd.	5	15	15/-	10¾—11¼	
Do. 5% Cum. Pref.	5	5	5%	5¼—5⅝	−⅛
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106½—108½	+½
Consolidated Electrical Co., Ltd.	1	3	3½%	⅞—⅞	
Crompton & Co., Ltd.	3	5	5%	1¼—1⅜	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1¼—1⅜	
Do. 6% Cum. Pref.	1	6	6%	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
Edison & Swan United "A." £3 paid	5	4½	2/6	¾—1	
Do. do. (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	¼—½	
Do. 7% Cum. Pref.	2	7	—	1½—1¾	
Do. 4% 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7¾—8¼	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10½—11½	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5⅜	+⅛
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	31—33	
Do. 4% Deb. Bds. Red.	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	5%	1—1⅛ xd	
Do. 6% Cum. Pref.	5	nil	6%	3⅜—3¾ xd	−⅛
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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CATALOGUES AND PAMPHLETS RECEIVED

CURRENT TRANSFORMERS.—Two new price sheets, which form additions to Messrs. Ferranti's complete catalogue, have been issued dealing with current transformers for use with measuring instrument, and for operating relays, &c. One of these is the H open type for switchboard purpose. The cores are made up of best quality transformer-iron stampings, and the windings are insulated with mica and impregnated linen cloth or porcelain. With wound primaries, *i.e.*, sizes below 200 amperes, the primary winding is insulated and the core and secondary can be earthed. When the primary consists of a straight bar through the core—200 amps. to 500 amps.—then the secondary is the insulated winding and the core must be insulated from earth. The other leaflet gives particulars of a portable current transformer contained in a neat stained hard-wood box, provided with strong carrying strap and rubber buffer feet. Bolts are provided to enable the conductor to be bolted to the primary. These transformers have 800 ampere turns at full load, and are wound with especial care to avoid magnetic leakage. Their ratio is unaffected within wide limits of resistance in the secondary circuit. They are specially recommended for all indicating instruments, and will work several instruments in series, such as, for example, a wattmeter and an ammeter.

DIE FINISHED CASTINGS.—A leaflet from the Gratze Patents & Engineering Syndicate, Ltd. describes special castings of high finish which this firm manufacture. These castings are made in steel moulds under hydraulic pressure and in various alloys, which can be made to stand up to 14 to 16 tons tensile strain per square inch. The finish is excellent, so much so that screw threads can be easily moulded thereon and holes cast in the pieces so that practically no machining is required.

SIMPLEX CONDUITS.—A leaflet has been issued by Simplex Conduits, Ltd., containing translations into French, German, and Russian of a speech made by Mr. A. Lester Taylor, Chief Electrical Engineer to the Liverpool, London & Globe and the Royal Insurance Offices, at the opening of the new premises of Simplex Conduits, Ltd., in which he is reported to have said that conduit wiring with suitable accessories was the best and safest system it was practicable to adopt.

Kent Collieries Electrical Plant.—In the Official Referee's Court on Friday, Messrs. Ernest Scott & Mountain, Ltd., sued the Kent Collieries, Ltd., for £3,249, the balance of £5,780, cost of machinery and plant supplied, besides money paid by the plaintiffs by way of wages to men lent to the defendant company. The defendants denied liability, pleaded that the plant supplied was not in accordance with the contract, and on that ground they counterclaimed. Mr. C. A. Russell, K.C., appeared for the plaintiffs, and Mr. Bousfield, K.C., for the defendants. The plaintiffs contracted with the defendants for the supply of an electrical plant and driving engine at a cost of £5,780, and in addition £550 balance of the cost of a vertical spindle pump. There was another claim for £847, wages of men lent to the defendants. Other claims were for £105 for goods supplied, and £46 16s. 10d. for stripping and cleaning one of the pumps. The specification to which the plant had to work was to raise 1,000 gallons of water per minute against a head of 640 feet of water at 1,440 revolutions. All the allegations that the plant did not come up to specification the plaintiffs denied. The plaintiffs further said that it was contemplated that they were supplying engines and motors which would be worked continually or for an unlimited period, and that if the generators got overheated and broke down they did so because they were not used fairly or reasonably. The defendants, they said, absolutely worked one of the pumps to death, and it was now in a ruined condition. They further contended that the contract provided for the payment of the whole amount, irrespective of whether the machinery was tested or not.

Mr. Hodgkin, the Assistant Managing Director of the plaintiffs' company, said that he had advised the erection of duplicate plant in the first place, as the one set could not do the work continuously; or, failing the two sets, a stock of spare parts was of the utmost importance. The pumps were worked for a week or ten days down in the shaft, but were left all night without current passing through the motor windings. While cooling, moist air was drawn into the windings, and this had caused the trouble. The fusing of the coils, due to this, was, however, no indication that the motors were not according to the contract. Later, another pump was supplied to the defendants on loan. The first and second instalments of the account were paid, but defendants said that the third instalment was not due until their electrical expert had given his certificate. With regard to the temperature rise of the motors, one test showed that when the machinery was working 15 h.p. below the full load of 100 h.p. the temperature rose to 75° C. in one hour and to 101° C. after five hours, whereas the contract stipulated a maximum rise of 70° C. After another five and a half hours' test below full load the temperature was nearly 120° C. Mr. Hodgkin did not think 120° C. too high a temperature for enclosed motors insulated with cotton. The motor in question was insulated with asbestos. The specification said clearly that the plaintiffs should have nothing to do with the pumps after they were handed over to the defendants, and witness claimed that they were handed over before they were started working continuously. The pumps were returned in a very bad condition, the efficiency had fallen from 75 to 25 per cent., which meant that both generators and motors would have to sustain a much heavier load for the same amount of water raised. Mr. W. C. Mountain, Director of plaintiff company, said that he was quite satisfied that the plant was capable of doing the work specified if it were properly looked after. It was absolutely necessary that there should be a relief pump in work of that character, as the motors should have been overhauled every 24 hours, which overhauling would take a man from one to one and a half hours. Mr. Mountain said that, with regard to the testing, it was the defendants' duty to call upon the plaintiffs to make a test of the plant before their expert. Such a test was arranged for, but was never held. The plant had been started up, owing to the impatience of the defendants' directors, before the motor coils had been dried out. The motors were perfectly dry before being installed in the shaft, and were tested at plaintiffs' works with 10,000-volt alternating current. He denied that the machines were insulated in the first place with damp cotton. The insulation was not impregnated, as the machines were too large to allow of this. The process of impregnation, said Mr. Mountain, was only applicable to small machines. Varnished cotton insulation (which was used for one motor) was not absolutely impervious to damp. With regard to temperature, Mr. Mountain thought that 150° C. was not too high for an asbestos winding. Mr. John Morley, foreman engineer for the plaintiffs, gave corroborative evidence, and the hearing was then adjourned until the 29th inst.

LOCAL NOTES

ABERDEEN: *Parliamentary Expenses.*—An account has been presented of the Parliamentary expenses in connection with the Corporation Electricity Act of 1907 and the Corporation Order Confirmation Act, 1907. The expenses with regard to the former amounted to £2,122, and for the latter £1,278. The payment of these is to be spread over five years.

AUSTRALIA: *Sydney: Lighting Accounts.*—The electric lighting undertaking shows a loss of £1,308 for the year 1907. For 1906 the loss was £9,552.

BANGOR: *Telephone Wayleaves.*—In consequence of having received an intimation from the Urban District Council that an increased rent must be paid for their poles, the National Telephone Co. have refused to accede to the proposed terms, and intimate that, if the Council insists, it will be necessary for the company to discontinue its service in Bangor. The matter has been referred to the Finance Committee of the Council.

BERMUDA: *Electric Supply.*—The Bermuda Electric Light, Power, and Traction Co. announces that it will be in a position to supply electric current on May 1st.

BRIGHTON: *Electric Lighting Charges.*—A change is to be made in the electric lighting tariff now in vogue. Consumers upon the maximum demand system of 7d. for the first hour and 1d. afterwards will in future be charged 6d. and 2d. respectively. The flat rate of 4d. will remain. It is stated that there will also be an increase in the charge for street lighting.

Southwick Electricity Works.—The Works Committee of the Shoreham Harbour Trustees dissents from the view of the Corporation that the works carried out near the Southwick Electricity Station are sufficient for the protection of the foreshore of the harbour at that spot. The Harbour Master's report on the subject reads as follows: "With reference to the portion of the foreshore fronting the Electricity Works, I find that the work which has been done by the Corporation of Brighton consists of a line of piling and planking about 130 ft. long lying parallel with the foreshore and through the crown of the beach. The western end of the work is about 20 ft. short of the western boundary of the Corporation's land, but I am informed that the work will be extended to that point. The work consists of 7 in. by 7 in. piles 8 ft. 6 in. long, driven about 6 ft. into the beach, 9 ft. 6 in. apart from centre to centre, and planked on the sea side 3 ft. down from the top with 3 in. by 9 in. planks. This work, although being sufficient to merely support the material which is being deposited on the north side of it for filling-in purposes, is not, in my opinion, sufficient to withstand the force of sea which would reach it during a southerly gale at high spring tide. There are, however, indications that the beach is again accumulating at this part of the foreshore."

BURNLEY: *Electric Power Charges.*—The Corporation announce this week a reduction in the price of electricity. Electrical energy for power and heating purposes will be reduced to 1½d. per unit for the first 39 hours per quarter, calculated on

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the consumer's maximum demand, and a 1d. per unit afterwards during the same quarter. Moreover, quarterly accounts will be subject to a 5 per cent. discount for prompt payment.

BURSLEM: *Electricity Accounts.*—The accounts of the Electricity Department for the year ending December 31st, 1907, show an income of £3,261, and expenditure £1,223. Of this gross profit, interest on loans absorbs £1,002, and sinking fund £800, leaving a net profit of £202. Expenditure on capital account during the year was £5,918, making a total capital expenditure of £52,397.

CANADA: *Telephone Purchase.*—A Bill has been introduced into the Ontario Legislature providing that, where the majority of subscribers in a district petition for the establishment or extension of a telephone system, the municipality can issue debentures for ten years to cover the cost of the work, and to levy a special rate to pay the annual instalments of principal and interest. Any deficiency may be made up out of the rates.

CHICHESTER: *Electric Lighting.*—A site has been secured at Stockbridge by the Chichester Electric Lighting Co. for its works.

COWDENBEATH: *Electric Lighting.*—The Manager of the Fife Electric Power Co. has had a conference with the Town Council with regard to the supply of electricity to the borough, and a report is to be drawn up by the company and presented to the Council at an early date.

DERBY: *New Power Station.*—The new electricity works of the Derby Corporation, which were described and illustrated in Electrical Engineering, Vol. II., 979, were formally opened last week by the Mayor, who started one of the new steam turbines, and Alderman Butterworth, Chairman of the Electricity Committee, who started the second turbine.

DURHAM: *Electricity in Coal Mines.*—A start has been made with the work of the New Winning East Pit, Lumley Colliery, near Chester-le-Street. It is stated that this will be the only coal mine in the world which will be worked entirely by electricity—all winding, pumping, hauling, screening, coal cutting, and lighting being carried out electrically.

EALING: *Noisy Tramcars.*—In connection with the action which the Council proposes to institute against the London United Tramways, Ltd., for an injunction in respect of alleged nuisance caused by the noise of the tramcars, the Chiswick Urban District Council has agreed to contribute a sum not exceeding £60 towards the cost of the action.

EDINBURGH: *Underground Telegraph Wires.*—The Secretary of the Chamber of Commerce has received a communication from the Postmaster-General in response to inquiries as to the progress of underground cable work in Scotland during 1907. The letter from the Postmaster-General points out that it is hoped within a few weeks' time to complete the line from Glasgow to Falkirk. The underground line from Linlithgow to Edinburgh, the letter states, would have been completed long since but for the difficulties which have been experienced in obtaining from the Corporation of Edinburgh the necessary consents to the execution of the underground work required in the streets of Edinburgh. An arrangement may probably be arrived at, but as this involves the use of existing ducts, so small that the size of the cable has had to be reduced, it may be necessary to duplicate the work later on.

Leith Tramways.—An amicable arrangement has been come to with regard to the points of difference between the Edinburgh Corporation and the Leith Town Council in regard to the proposed extension of the Leith tramways to Granton.

FLEETWOOD: *Transfer of Electrical Undertaking.*—An agreement has been come to between the Council and the Fleetwood & District Electric Light & Power Co. for the purchase of the undertaking of the latter at £16,000 for the works, and £2,500 for the site.

GLASGOW: *Assessment of Telephone Wires.*—A dispute has arisen between the Postmaster-General and the Glasgow Corporation with regard to the amount of the assessment upon the telephone undertaking acquired from the Corporation. Prior to the taking over of the undertaking by the Postmaster-General, the Telephone Department paid assessment amounting to £1,690, but the Post Office now raise objection to the amount. The Police Finance Committee of the Corporation recommend that a representation be made to the Treasury in order to secure payment.

HAMPTON WICK: *Noisy Tramcars.*—At the last meeting of the Council, the Highways Committee reported the receipt of a letter from the Commissioner of Police, stating that the result of careful inquiry showed the source of the noise from the tramcars was to be found not in the cars (which were kept in good condition), but in the track, which was very defective, so much so that in places the wheels came in contact with the wood blocks or stone setts. A copy of the Commissioners' letter as to the noise of the trams is to be sent to the Board of Trade, and the Borough Surveyor is to report to the committee on the subject in due course.

HANDSWORTH: *Tramway Purchase.*—The Board of Trade has been asked to appoint a referee to determine the price to be paid by the Council for the tramway company's undertaking in Handsworth. If an agreement cannot be come to upon the terms of the subsequent lease, the referee is to consider this matter also

HANWELL: *Transfer of Electric Lighting Order.*—The Metropolitan Electric Supply Co. intimates its willingness to take over the Council's electric lighting order for £550. The consulting engineer to the Council recommends that the company should also pay the interest on the money borrowed for the purposes of obtaining the order, viz., about £40, and he is in communication with the company upon this point.

INCE: *Electric Lighting Order.*—An agreement has been come to between the District Council and the Wigan Corporation with regard to carrying out the terms of the Council's Electric Lighting Order.

LAUNCESTON (TASMANIA): *Electricity Accounts.*—The report of the City Electrical Engineer for the year 1907 states that the expenditure on capital account during the year amounted to £3,353. Of this amount £648 was part of balance due to the contractors for three-phase plant, £944 for meters, construction work on mains, consumers' connections, &c., the balance being for general stores and private wiring, after allowing for repayments to the department for work done. The total expenditure to December 31st, 1907, is £164,196, including £2,825 value of stock on hand. The number of consumers is 3,175. An expenditure of £11,663 on consumers' meters has been incurred. A sum of £30,000 has been spent on the change over from single-phase to three-phase working. The report points out that when single-phase was wholly in use, the earnings from power were only £537. During 1907 the revenue from this source was £1,835, an increase of £1,298; leaving, after deducting increased maintenance charges, a net increase of £1,201. The total revenue for the year was £16,286, as against £14,934 for 1906. The increase in revenue from lighting is 2·86 per cent. over last year; the increase in revenue from power is 67·43 per cent., and from heating 20·05 per cent. The expenditure for the year shows an increase of £910. The revenue from street lighting was £2,434 for 357,878 units, equal to 1·633d. per unit. In 1895 the city was lighted by 274 gas lamps at £5 7s. 6d. each per annum = £1,473 15s. There are now 432 incandescent lamps and 175 arc lamps. The balance carried to net revenue account is £8,770, an increase of £375. Interest and contributions to sinking funds have increased by £135, leaving an actual surplus on the year's working of £1,557. The sinking and reserve funds now amount to £23,518. The gross profits since the commencement of the undertaking have been £66,070. During the year under review the units generated were 1,722,380; units used at power station, 17,000; units lost in transmission, 127,820; units supplied from sub-station, 1,577,560; units accounted for, 1,330,140; units lost in mains, transformers, meters, &c., 247,420. The total costs have decreased by 0·211d., or 12·7 per unit sold. The maximum load was 680 kw. Several new types of lamps have been obtained and tested during the year. The best of these are the "Osram" and the "Tungsten." Unfortunately at the present the filament of the former, being of a fragile nature, does not carry well in transit; the "Tungsten" filament, however, seems to be of a tougher nature, and the results on opening up the shipments are more satisfactory in this respect. The Corporation have obtained a few of these lamps, and they are available to the public at cost price, or are supplied free on the usual basis of lamp renewals to an equivalent in money value. The tests made so far show that the lamp maintains its original candle-power to within a few per cent. after about 1,000 hours' burning.

LIVERPOOL: *Motor Generators.*—At the last meeting of the Liverpool City Council a question was asked as to why the tender of the British Westinghouse Electric and Manufacturing Co. for the supply of a 500-kw. and 200-kw. motor generators was accepted. Sir C. Petrie, Chairman of the Tramways Committee, stated that the tender in question was the lowest, and in view of the fact that the Westinghouse turbines at the Lister Grove station had been working satisfactorily the Committee felt justified in accepting the tender.

LONDON: *London County Council. Highgate Hill Tramways.*—At the meeting on Tuesday the Council agreed to purchase for £13,000 the Highgate Hill cable tramways. About £26,000 is to be spent on electrifying the line (see Electrical Engineering, April 9, p. 574).

Hammersmith-Putney Tramways.—The report of the Highways Committee given on p. 596 was adopted.

Electric Lighting Loans.—The Finance Committee have submitted a statement to the Council showing the amount sanctioned during the financial year 1907–8 and the three preceding years. The following are the items in respect of electric lighting:—1904–5, £749,109; 1905–6, £319,119; 1906–7, £282,760; 1907–8, £272,518. The amount for the year 1904–5 does not include anything in respect of the loan of £1,415,000 made to the St. Marylebone Borough Council on July 26th, 1904, for the purchase of part of the undertaking of the Metropolitan Electric Supply Co., Ltd., as the Act authorising the Borough Council to make the purchase dispensed with the sanction of the London County Council to the borrowing.

Lea Bridge, Leyton and Walthamstow Tramways.—The London County Council propose to hold a special meeting soon after Easter to discuss the question of purchasing, by agreement, the portion of the Lea Bridge, Leyton and Walthamstow Tramways Co.'s undertaking in the Lea Bridge Road.

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Great Northern, Piccadilly & Brompton Railway.—The Council has approved a plan of the exits and entrances at the street level of the station to be erected on the Great Northern, Piccadilly & Brompton Railway at South Kensington (Pelham Street). As these plans differ somewhat from the original ones submitted by the company, the Council has accepted a sum of £500 towards the cost of effecting a street widening opposite the station, rendered necessary by the construction of the exits and entrances nearer the footway than was originally contemplated.

Franco-British Exhibition.—The Council has approved the plan of the exits and entrances at the street level of the Central London Railway Co.'s proposed station at Wood Lane, Hammersmith, which is intended to serve the Franco-British Exhibition. The frontage of the station will be set back 15 ft. from the edge of the kerb, and three entrances and two exits will be provided.

Fulham: Electrical Development.—A canvasser for power and lighting purposes is to be appointed at a salary of £2 per week and commission.

Hammersmith: Tramways.—The Law and Parliamentary Committee, being of opinion that a double tramway line over Hammersmith Bridge would be dangerous, has decided to oppose the West London, Barnes and Richmond Tramways Bill. The same committee has decided that notice be served upon the London United Tramways, Ltd., requiring them to forthwith make good the defective joints in the tramway rails, and to take up and relay with new wood blocks the paving inside the tramway rails throughout the whole length of Goldhawk Road and Uxbridge Road in the borough.

Marylebone: Electric Lighting Loan.—The Council has decided to take up a loan of £31,306 for electric lighting purposes at 4 per cent. from the London County Council, repayable in 30 years.

St. Pancras: Stock Checking.—Negotiations have been entered into with several firms of valuers, with the result that an offer has been accepted from Messrs. Bromhead & Co., 33 Cannon Street, E.C., to make a thorough and detailed schedule of the stores in hands for balance-sheet purposes, and to check and price same, and supply the inventory as required for 35 guineas on the understanding that if engaged for more than one year they will only charge 25 guineas next year, so as to bring their fee to 30 guineas per annum, at which rate they are prepared to do the work in subsequent years.

Street Lamps.—The Chief Electrical Engineer having received from the Borough Engineer an inquiry as to the probable cost of shifting all the arc lamps in the Tottenham Court Road from the centre of the roadway to the pavement, in view of the asphalting of the thoroughfare, the former reports that the proposal would involve five additional lamps. There would be, he said, considerable difficulty to be surmounted, inasmuch as pretty nearly throughout the Tottenham Court-road the cellars come very near the surface, and consequently the small space left is choked with electric, telegraph, telephone, gas, water, and hydraulic mains. The estimated cost of increasing the length of the circuits from the centre of the road to the side, in every case shifting the existing posts and supplying and erecting five new lamps and columns, is £350, and, in addition to this capital expenditure, there would be a permanent revenue charge for the maintenance of the five lamps of about £87 per annum. The electricity committee strongly disapprove of the proposed alteration of centre lighting to side lighting, on the ground that experience proves that the centre lighting is more advantageous from an illumination point of view.

Westminster: Street Boxes.—The City Council Works Committee have had before them the views of the Westminster Electric Supply Corporation with reference to the committee's consent to the laying of mains and boxes in four thoroughfares, subject, *inter alia*, to the proposed boxes being ventilated by combined ventilating covers instead of by separate gratings. The company stated that very great care is taken to render the boxes watertight, that ventilation is essential, and the difficulty is to combine this with keeping the boxes clean and dry; that hitherto they have used small ventilating boxes connected to the main boxes by a pipe; that the little boxes with a grating on top are placed as close to the house front as possible, and after rain all that is necessary is to lift the grating and dry them, an operation which takes a few minutes only. After negotiations, the Council's Works Committee has decided to agree to the use of separate pits of the existing pattern for ventilating street boxes, provided each pit be placed as close as possible to the box itself, and, wherever practicable, over the line of the company's wires.

LONGTON: *Street Lighting.*—It has been decided to replace 41 gas lamps by 18 arc lamps for the street lighting. The capital cost will be £385, and the annual charges in respect of current, trimming, cleaning, attendance, &c., £504. The lamps will be run in two circuits of nine lamps each, and every alternate lamp is to be switched off at 11.15 p.m.

MANCHESTER: *Tramways Undertaking.*—The estimates of income from the tramways undertaking from the present financial year is £813,662. Capital expenditure for the year is estimated at £78,000, mainly on new cars, sheds, &c.

NEWCASTLE: *Cables under the Tyne.*—An application from the Newcastle Electric Supply Co. for permission to lay a 6,000-volt, three-core, lead-covered cable across the bed and foreshore of the Tyne between Carville, Wallsend, and Hebburn has been granted, but owing to the uncertainty of the date when the tunnel works will be completed, permission has also been granted to regard the works as a temporary works on the condition that the company exhibits a board indicating where the electric cables are on either bank of the river.

NEWPORT, MON.: *Tramway Depreciation.*—The Electricity and Tramways Committee recommend that before any surplus on tramway revenue account is applied in relief of rates, a sum averaging £3,000 per annum should be paid into the tramways reserve fund.

NUNEATON: *Street Lighting.*—In connection with the renewal of the Gas Co.'s contract for street lighting, the Electricity Committee endeavoured to secure the substitution of electricity for gas, but the Council decided that it would be unwise to make the change at present, owing to electricity being still "in its infancy," and new lamps being continually brought out.

OXFORD: *The Tramway Question.*—At the last meeting of the Corporation Councillor Hastings moved a resolution calling for a detailed statement of the whole of the legal and professional charges incurred in the purchase of the horse tramway system, the special arbitration case, and the contract for the construction and electrification of the new tramways. The Council went into committee on the question, and it was ultimately stated that the resolution was lost.

PEMBROKE: *Electric Supply Charges.*—The Electrical Engineer has been instructed to prepare a report upon a revision of the present system of charging for electrical energy for cooking and heating purposes.

PENZANCE: *The Electric Lighting Order.*—The Penzance & District Electric Supply Co. has been notified by the Board of Trade that the consideration of the question of revoking the company's order has been deferred to October 31st.

ROTHERHAM: *Tramway Receipts.*—The receipts from the tramway undertaking for the year ended March 31st, 1908, amount to £31,678, as against £26,916 for the previous year.

SHEFFIELD: *Tramway Extensions.*—According to the *Sheffield Telegraph*, a number of important tramway extensions are to be completed during the coming summer months. Work is at present proceeding upon the Hillsborough-Malin Bridge section, the permanent way of which is expected to be completed soon after Easter. Later on the Eccleshall extension will be put in hand.

TORQUAY: *Tramway Supply.*—With regard to the application of the Tramway Company for an increased maximum supply for working the tramways, Messrs. Kincaid, Waller, Manville & Dawson have reported to the Council as to the ways and means for complying with this request. The generating station at present does not permit of the addition of further plant, and the report recommends that the power-house should be wholly, or partially, removed to a larger site adjoining the dust-destructor works. This would involve the use of a cooling tower, as the site in question would prevent the use of sea-water for condensing purposes. Two alternative schemes have been presented, one of which involves the complete transfer of the plant and housing it in new buildings, and the second provides for the transfer of a portion of the plant, leaving the remainder as at present. The respective estimates are £29,390 and £16,000. At the last meeting of the Corporation the matter was referred to the Electric Lighting Committee for a report. There was a good deal of criticism of the reports of the consulting engineers, some members of the Council apparently being convinced that it is possible to instal the additional plant necessary on the present site. The estimates of the consulting engineers are based upon the consumption of 1,107,364 units by the tramway company during 1908, of which 659,065 units would be for traction purposes, and the remainder for lighting.

WATFORD: *The Electrical Engineer.*—The Council has decided to give the electrical engineer, Mr. J. R. Weston, notice terminating his engagement in consequence of his having engaged a temporary draughtsman without the sanction either of the Electricity Committee or the Council.

WEALDSTONE: *Electric Lighting.*—Under the Wealdstone Electric Lighting Provisional Order, 1906, the North Metropolitan Electric Power Distribution Co., Ltd., is bound to lay mains in the compulsory area within two years from July 20th, 1906. At the last meeting of the Council the Finance Committee drew attention to the fact that no work has yet been commenced by the company, nor were the committee aware that any were contemplated. It was ultimately decided that the Council could not interfere until the time has expired.

WEST HAM: *New Chain Grate Stokers.*—The Electrical Engineer having reported that it was necessary to proceed with the erection of two of the five chain grate stokers at the generating station, included in his estimate of £51,600, the Committee have decided in favour of his being empowered to proceed with this work at an estimated cost of £700.

Tramways.—The Town Clerk has reported to the Committee that a writ has been issued against the Corporation at the instance of Mr. F. Osman, the contractor for the construction of the tramways, for the recovery of £615 under an agreement for laying metallic returns from the Canning Town station to the end of the double track in Barking Road, and also for damages for breach of the contract entered into with the Corporation as to the laying of certain tramways in West

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Ham, and for delay on the part of the Corporation in permitting him to commence the work. After careful consideration, the Committee, desiring to avoid litigation, have settled the claim, subject to the Council's confirmation, at £2,000, and a sum not exceeding £50 for costs.

WESTON-SUPER-MARE: *Street Lighting.*—The Local Electric Supply Co. has been granted permission to carry out some experimental electric lighting on the sea front.

WILLESDEN: *Harrow Road-Paddington Tramways.*—Subject to the Metropolitan Electric Tramways, Ltd., agreeing to do their utmost to expedite the widenings remaining to be carried out in connection with the Harrow Road and Paddington tramways, a three months' extension of time from May 6th, 1908, is to be granted them for performing the condition of a bond. This bond was entered into in December, 1906, in the sum of £25,000, to be paid to the Council in the event of certain widenings not being satisfactorily completed within a period of 18 months from November 6th, 1906, or within such extended period not exceeding six calender months, as, having regard to causes beyond the control of the company, should be necessary for such completion. The Council has decided not to further oppose the Metropolitan Electric Tramways Bill, 1908.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ABERDEEN.—The Electricity Committee recommend that application be made for sanction to borrow £80,000 for extensions to the electricity undertaking, out of which sum the purchase of the Cults electricity undertaking will be made. The recommendation was adopted at the last meeting of the Corporation.

AMSTERDAM.—A concession has been granted to the Amsterdam and North Holland Electric Tramways Co. for a tramway from Amsterdam to Krommenie and two branch lines from Zaandyk to Wyk aan Zee, and from Wormerveer to Purmerend. The total length of the lines will be about 28 miles, and the work has to be completed within two years.

ARRAN.—The Marquis of Graham has instructed Messrs. Stevenson & McGuffie to draw up specifications for an electric light and power installation at his two residences and the estate offices in Arran. A water power scheme is in contemplation, using pelton wheels and a transmission line of about 12 miles in length will be involved.

ASTON.—Mr. R. H. Bicknell held an inquiry last week into the application by the Council to borrow £25,213 for the electricity undertaking. The capital expenditure upon the undertaking to date amounts to £134,466. Part of the loan now sought is in connection with the supply in Erdington, for which powers were obtained last session. It is estimated that the maximum demand during the next winter will amount to 2,156 kilowatts, whereas the plant capacity is only 1,708 kws.

CANTERBURY.—A local Government Board inquiry was held last week into an application by the Corporation to borrow £4,000 for electric lighting extensions.

DUNDEE.—Tenders are invited for the following:—(*a*) steam, exhaust, feed water, and drain piping system, with two steam-driven feed pumps and two hotwell tanks for main generating station; (*b*) equipment of circulating water pump room, including two electrically-driven vertical-spindle centrifugal pumps, in connection with the main generating station; (*c*) circulating water-pipe system (about 1,500 feet long), in connection with the main generating station; (*d*) overhead travelling cranes for main generating station and two sub-stations. Full particulars from the City Electrical Engineer, fee £3 3s., returnable, and tenders to the Town Clerk by April 27th.

GOVAN.—Tenders are invited for the supply of the following stores for the year ending May 15th, 1909: Oil, waste, and engine-room stores; cables; cable accessories; bitumen and compound for joint boxes; electricity meters; house service fuse boxes; wrought-iron tubes and fittings; cast-iron pipes; arc lamp carbons; coal; joint boxes; motors; motor starters and D.P. switches. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by April 27th.

HASLINGDON.—Tenders are invited for overhead tramway lines with tangential suspension, telephone system, and tower wagon. Particulars from the consulting engineers, Messrs. Handcock & Dykes, 1 Victoria Street, Westminster (fee, three guineas, returnable), and tenders to the Town Clerk by April 25th.

HORNSEY.—Tenders are invited for the supply of cable, feeder pillar joint boxes, &c., in connection with a new feeder cable to Muswell Hill. Forms of tender, &c., from the Borough Electrical Engineer (fee, 10s. 6d., returnable), and tenders to the Town Clerk by April 21st.

ITALY.—The *Bulletin* of the French Chamber of Commerce at Milan, for March, announces that the Rome municipality intend to instal a generating works having a capacity of 7,000 h.p.

LANCASHIRE.—Messrs. Pearson & Knowles Coal & Iron Co., Ltd., contemplate an expenditure of about £40,000 upon an electrical installation and new screening plant at their Maypole Colliery, Abram, near Wigan.

LONDON: *London County Council.*—Tenders are invited for the wiring and fitting for electric lighting of a tramway car shed at Mare Street, Hackney. Particulars from the Clerk, fee £2 2s., returnable, and tenders by May 12th. (See an official advertisement.)

Tenders are invited for the supply and delivery of (*a*) 175 double-deck, roof-covered, electric car-bodies; (*b*) 175 pairs of maximum traction swing bolster trucks; (*c*) 175 complete electrical equipments for operation upon the overhead trolley, surface contact, and underground conduit systems of electric traction. Full particulars from the Clerk to the Council (fee £2 2s. returnable), and tenders by May 9th.

The Highways Committee recommend that an expenditure on capital account not exceeding £31,000 be sanctioned for the execution of the road work and platelaying, exclusive of the supply of rails and special track work, on the conduit system, of the existing horse tramways from Lavender Hill via Queen's Road, Battersea, to Chelsea Bridge.

Hammersmith.—The Electricity and Lighting Committee have had under consideration the question of converting the system of lighting the streets in the borough from gas to electric lighting, in which the necessary low-tension mains have already been laid for private supply. Sixty-eight streets are affected by the proposal, and the Engineer has submitted a report showing that in these streets electricity giving a greater candle-power could profitably be substituted for the present gas supply at the same rate of charge, viz., £3 1s. per lamp per annum. No capital expenditure will be incurred in laying mains, as the suggested scheme provides for the use of the existing low-tension mains only, and it is proposed to purchase the present gas columns. The Committee proposes to take over the streets along which low-tension mains are laid, and supply a 44 candle-power electric lamp in substitution for the 30 candle-power gas lamp.

Hampstead.—The Borough Council is to lay a main for the supply of electric current to private consumers at an estimated cost of £41. The Electrical Engineer has been authorised to obtain meters and other stores at an estimated cost of £48 11s. 9d.

Poplar.—The Electricity Committee invite tenders for the erection of a sub-station building at Millwall in brick, ferro-concrete, or corrugated iron. Full particulars from the Borough Electrical Engineer, fee 5s., not returnable, and tenders to the Town Clerk by April 29th.

MORLEY.—For the purpose of providing additional plant in connection with the tramways an application is to be made to the Local Government Board for sanction to borrow £7,942. A further sum of £5,000 is to be borrowed for new cables.

SPAIN.—The *Gaceta de Madrid* of March 18th notifies that the Compania General de Tranvias has applied for a concession for an electric tramway in Barcelona, and that a period of one month is allowed for the presentation at the Direccion General de Obras Publicas, Madrid, of competitive propositions.

TONBRIDGE.—The Council invite tenders for the supply and erection of the following plant: Section A.—One 150-kw. high-speed steam generating set with ejector condenser. Section B.—Steam feed pump, 700 gallons per hour. Centrifugal Motor-driven pump, 20,000 gallons per hour. Steam, exhaust, feed, and water piping. Section C.—Two switchboard panels, milking booster and switchgear, cables and connections. Specifications, &c., from the Electrical Engineer (fee £1 per section returnable), and tenders to the Town Clerk by April 22nd.

WHITEHAVEN.—The Corporation is recommended to apply to the Local Government Board for sanction to borrow £1,700 for a surface condensing plant, battery, switchboard, and booster, extensions of mains, and auxiliary plant at the electricity works.

WIGAN.—An application is to be made to the Local Government Board for sanction to borrow £22,696 to cover expenditure on capital account, in addition to committments during the coming year.

WILLESDEN.—The Electrical Engineer has been instructed to prepare the necessary specifications and advertise for tenders for the installation of additional plant at an estimated cost of £1,500 at the Salusbury Road sub-station, in order to cope with the increased demands of the district. An additional feeder cable is to be laid from the Salusbury Road sub-station at an estimated cost of £2,070, to relieve the present overload on the High Road, Kilburn, feeder, and mains are to be extended in Furness Road at an estimated cost of £62. The Council has approved the action of the chairman of the Electricity Committee authorising extension of mains in St. Gabriel's Road (estimated cost, £31) and Teignmouth Road (estimated cost, £17 10s.).

WOOD GREEN.—Messrs. May & Hawes have been retained to advise on the electrical work for the new infirmary. An offer has been received from the North Metropolitan Electric Power Supply Co.

YORK.—A Local Government Board inquiry was held on Tuesday into an application by the Corporation for sanction to borrow £25,285 for the purpose of the electricity undertaking.

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TENDERS RECEIVED AND ACCEPTED

BECKENHAM.—It was stated at the last meeting of the Beckenham Urban District Council that the superintendent of the Fire Brigade had reported that the present system of fire alarms gave rise to many unnecessary calls, and that tenders had been submitted for an improved system known as the "Stuart and Moore Pendulum" system. The Council decided in favour of acceptance of the National Telephone Co.'s tender to fix this system in Beckenham at an annual charge of £180. It was pointed out that the annual rent paid for the existing system, including daily testing, was £172. The only other tender was that of the G.P.O., for what was known as the "Buzzer" system, with street posts and overhead wires, at £152 per annum, to which the superintendent estimated that £26 should be added as the cost of testing, and £10 for the rent of an exchange, making a total of £188.

BRIERFIELD.—The Brierfield District Council has accepted the tender of Messrs. Carter & Co., of Nelson, for the maintenance of fire-alarms in the district during the year ending March 31st, 1909.

ELECTRIC POWER IN STEEL WORKS.—Messrs. Marples, Leach & Co. advise us that they have been successful in securing the order for the supply, delivery, and erection of a high-tension two-phase alternating-current induction motor for driving two 10 in. and 8 in. mills at the works of Messrs. Samuel Osborn & Co., Ltd., Sheffield. This motor is being wound for the high-pressure distributing mains of the Sheffield Corporation Electric Supply Department at 2,000 volts, two phase, 50 cycles. The motor is normally rated at 350 b.h.p., but is capable of sustaining very considerable overloads for short periods without injury; it is being provided with wound rotor, brush lifting, and short-circuiting device, by means of which the wear and tear on the brushes and slip rings is reduced to a minimum. In order to enable the fly-wheels to take their proper share of the work, the rotor is being provided with a bank of resistances which rotate with the machine, thus allowing a considerable percentage of slip when the load exceeds the normal. This motor is the largest motor which has yet been placed upon these mains, and it is anticipated that very great economy will result in the working of the mill.

ERITH.—The Council has accepted the tender of George Wright, Ltd., at £7 13s. 6d., for the supply and fixing (exclusive of builders' work) of a collapsible steel gate (8 ft. by 8 ft.) for the Northumberland Heath tramway shelter.

The Council has also accepted the following tenders for annual supplies of stores to the electricity department:—Oils, W. H. Wilcox; gauge glasses, W. H. Wilcox; carbons, Veritys, Ltd.; meters, General Electric Co., Ltd.; incandescent lamps, Veritys, Ltd.; joint boxes, Callender's Cable & Construction Co., Ltd.; cut-outs, British Insulated & Helsby Cables, Ltd. With regard to tenders for cables, &c., the Electrical Engineer is to obtain samples from several of the lowest tenderers and report thereon to the Electric Lighting and Tramways Committee.

GREAT EASTERN RAILWAY.—An order for 10 "Cascade" induction motors for driving printing presses has been placed with the Sandycroft Foundry Co., Ltd.

HEYWOOD.—The following tenders have been accepted:—Section A: Boiler, &c., Messrs. Thomas Hill & Sons, £1,605; Section B: Engine, dynamo, condensors, &c., Messrs. Browett, Lindley & Co., Ltd.; Section C: Lighting switchboard, Messrs. Whipp & Bourne, £827; tram feeder cable, British Insulated & Helsby Cable Co., Ltd. The Heywood Electricity Committee have also instructed the Borough Engineer to prepare specifications and quantities for the extensions (buildings and foundations) at the electricity works.

ILFORD.—The following contracts have been entered into for the ensuing year:—Cables, W. T. Henley's, Ltd.; coal, Dinham, Fawcus & Co., Ltd., E. Foster & Co., Ltd., Lindsay Blee & Co., Ltd.; house service and fuse boxes, General Electric Co., Ltd.; incandescent lamps, Cryselco Electric Lamp Co., Ltd.; joint boxes, W. Lucy and Co., Ltd.; meters, Ferranti, Ltd., and Siemens Bros. Dynamo Works, Ltd.

LONDON: *London County Council.*—The following tenders have been received for shafting, pulleys, &c., for the first portion of the central car depôt in Woolwich Road:—Forced Lubrication Co., Ltd., £400 3s. 2d.; Smith & Grace Screw Boss Pulley Co., Ltd., £453 17s. 8d.; David Bridge & Co., Ltd., £485 13s. 7d. and £466 15s. 2d.; The Unbreakable Pulley & Millgearing Co., Ltd., £553 2s. 3d. and £556 12s. 6d.; Buck and Hickman, Ltd., £572 1s. 3d. and £546 7s. 8d. The Highways Committee recommend the acceptance of the tender of the Forced Lubrication Co. at £400 3s. 2d. The Highways Committee also recommend the acceptance of the tender of Messrs. H. W. Ward & Co., at £103 14s. 9d., for accessories for a 7½ inch capstan lathe at the same depôt.

The Highways Committee further recommend the acceptance of an offer by Messrs. Hadfield's Steel Foundry Co. to undertake, for a sum of £4,524 10s., the manufacture and delivery of the special trackwork required for the renewal of the permanent way of portions of the tramway track in Westminster Bridge Road, Kennington, Clapham, Old Kent Road, and Camberwell Green. The tramways in question were among the first to be constructed by the Council for electric traction, and electric car services have been in operation since May, 1903, and January, 1904.

The following tenders have been accepted in connection with the construction of 20 new car bodies by the Tramways Department, of car furniture, brake and sanding gear, window operating gear, and ventilator operating gear:—Hurst, Nelson & Co., car furniture, £369 0s. 9d.; United Electric Car Co., 50 sets of brake gear at £4 19s. per set; Hurst, Nelson & Co., 50 sets of sanding gear, movable steps, and life-guards, at £8 2s. 6d., £3 12s. 6d., and £4 5s. a set respectively, and 50 sets of window operating gear at £12 10s. a set; Hoskins & Sewell, Ltd., 50 sets of ventilator operating gear at £3 a set. The tender of Messrs. Hurst, Nelson & Co., for the supply of 400 sunblinds for the 50 car bodies referred to, and a further 18 for maintenance purposes at £292 10s., has also been accepted.

As the result of a careful examination it has been found that certain of the plates of the battery at the Victoria Embankment generating station have deteriorated, and the Highways Committee recommend that an offer by the Electrical Power Storage Co., who supplied the battery, to carry out the necessary repairs for £130, should be accepted.

Fulham.—The Borough Council has accepted the following tenders for annual supplies for the electricity department:—General Electric Co., Ltd., fuse wire, &c.; G. A. Pestalozzi & Co., carbons; Lucy & Co., house cut-outs; Duckham & Co., Ltd., cylinder oil; W. H. Wilcox & Co., Ltd., crank chamber oil; H. Edmonds & Co., packings, &c.

Hammersmith.—The Electricity and Lighting Committee has accepted the tender of the Main Colliery Co. for the supply of Graigola and Victoria coal, at 15s. 10d., for a period of three months, with the option of continuing the contract for a further nine months.

Marylebone.—The following tenders have been accepted for stores for the electricity undertaking: Edison & Swan, Ltd., cut-outs and switch blocks; W. McGooch & Co., Ltd., pear switches; Wm. Patterson, dynamo brushes, brass wire brushes, copper gauze brushes, copper tinsel brushes; Reason Manufacturing Co., Ltd., house service meters; Chamberlain and Hookham, Ltd., prepayment meters.

TYNESIDE.—An order has been placed with the British Thomson-Houston Co., by the Tyneside Electrical Developments Co., for an exhaust steam turbine, having an output of 1,500 k.v.a. at 2,875 volts, 40 cycles, at a speed of 2,400 revs. per min. This machine will work in connection with the Tees Bridge Iron Co. We give further particulars in a note on page 588.

WORCESTER.—The tender of Messrs. J. Wood & Sons, Ltd., for extensions to the pump-house at the Hylton Road station has been accepted at £149 10s.

COMPANIES' MEETINGS AND REPORTS

ANGLO-ARGENTINE TRAMWAYS.—At the annual general meeting on Thursday the report and accounts given in our issue for April 2nd were adopted. Mr. J. Concanon, the chairman, who presided, dealing with the prospects of the undertaking, said that he thought the profits for the year 1908 would show a considerable increase. Up to April 1st the gross receipts showed an increase of £30,742. With regard to the financial stability of the company, he mentioned that the balance standing to the credit of the paving depreciation fund, and the general depreciation renewals fund, was £215,979. With a view to ascertaining more closely the figure which should in future be charged annually to revenue under this head, an exhaustive examination of the question would be made towards the end of the year. The directors propose to make an issue of £500,000 new debentures very shortly, £200,000 of which would be applied to meeting additional capital expenditure for increased rolling stock, &c., and the remaining £300,000 to the purchase of £300,000 of La Capital Traction & Electric Co., of Buenos

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Aires 5 per cent. debentures. This might be regarded, the Chairman said, as a step towards the acquisition of other tramway undertakings.

BALAGHAT GOLD MINING.—Lord Ribblesdale, presiding at the annual meeting last week, called attention to the fact that the cost of electrical power supplied from the Cauvery Falls power scheme had been reduced from £24 to £10 per horse-power per annum, a reduction which would, he said, result in a saving to the company of £7,770 per annum.

BATH ELECTRIC TRAMWAYS.—The report and accounts to December 31st, 1907, states that owing to the condition of the money market during the greater part of the past year the extension to Saltford was not proceeded with. It is proposed to construct this section at the first favourable opportunity. The additions to capital expenditure account during 1907 amounted to £1,284. The falling off in the number of passengers carried has adversely affected the revenue account. The decrease in earnings may be wholly attributed to the unsatisfactory weather conditions prevailing during 1907. Various economies have been effected during the past year, and further savings in expenses are proposed which should benefit the year now current. After charging the expenses of operation and administration, there remains a balance of £13,368, to which is added balance brought forward from previous year, making a total of £13,749. Deducting interest on 4½ per cent. first mortgage debenture stock, interest on loans, and dividend on preference shares for the year to December 31st, 1907, there is a balance of £2,489, which the directors recommend should be carried forward. At the meeting on Tuesday the report and accounts were adopted.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT.—The accounts for 1907 show an available balance of £54,180, including £2,267 brought forward. After payment of debenture stock interest and preference dividend there remains a sum of £17,130, out of which a dividend at the rate of 4 per cent. per annum is recommended, carrying forward £2,130. The report makes mention of the fact that the appropriation of the available balance of the Brisbane Tramways Co., of which this company holds all the shares, includes an allocation to renewals of £15,000, carrying forward £296.

BRITISH ELECTRIC TRANSFORMER.—The annual meeting was held last week, Mr. J. Albright presiding. One of the directors, Mr. A. M. Billington, dissented from certain paragraphs in the report, and an amendment to the resolution to the effect that the report be received, but not accepted, was carried. A poll is to be taken.

BROMLEY ELECTRIC LIGHT & POWER.—The report for 1907 states that satisfactory progress has been made by the company, the number of connections having increased from 71,222 to 77,802, and the revenue from £13,997 to £15,237. Considerable extensions have been made to the generating plant during the year, and an additional sub-station has been erected at Elmstead. The year's trading, including the amount brought forward, shows a profit of £12,386, and after payment of debenture interest and depreciation of stock there is a balance of £8,953. A further dividend for the last half-year, making 5½ per cent. for the year, is recommended, and the sum of £4,500 placed to reserve account, leaving £308 to be carried forward. At the annual meeting last week, when Mr. F. E. Gripper, the chairman, presided, the report and accounts were adopted. The Chairman said that if the business of the company increased during the current year at the same rate as it had during the past year or two, the directors would have no hesitation in paying a dividend of 6 per cent. The amount placed to the reserve fund was nearly 3 per cent. of the whole of their capital, and this, he thought, was a very satisfactory condition of things. No new capital had been issued during the year, but the sum of about £6,000 had been spent on machinery.

CALCUTTA TRAMWAYS.—The report for the year ending December 31st, 1907, shows gross traffic receipts £167,378, working expenses £104,235, and a revenue balance of £63,333. Against this have been debited the following amounts: Debenture interest, £15,750; interim dividend, £24,081; preference dividend, £8,253, leaving a balance of £15,248. To this is added the amount brought forward, £822, and interest earned, £2,908, making a total of £18,979, from which the directors recommend that a final dividend at the rate of 2s. 6d. per share, and that the balance of £1,778 be carried forward. In view of the heavy amount charged for maintenance during the year, the directors do not propose to make any addition to the depreciation fund, which, after adding £2,185, interest on the depreciation fund investments, and the £5,000 transferred from the balance of profit and loss account for 1906, and deducting £5,817, written off during the year for renewals, now stands at £48,080. The gross receipts are in excess of those of the previous year, which then constituted a record, by £8,521. The expenses, on the other hand, have increased by £17,317, made up of power expenses £2,024, due wholly to the fact that the plant had to be overhauled in consequence of the excessive pressure put upon it by the increased traffic, traffic expenses, £1,710, due to increased efficiency of service, maintenance and repairs, £7,164, principally due to the difficulties experienced in maintaining the cars owing to the pressure of the traffic and inadequate space for repair shops, and general expenses, £6,418, mainly due to the necessarily increased amount payable for income tax and the settlement of claims of the municipality for track rent in excess of the amount agreed for the original system. These claims had for a long time been in dispute, and a compromise was only arrived at last year. A very important factor in the reduced amount available for the service of the ordinary shares has been that so much more has been needed for the fixed charges on the new capital raised for the construction of the extensions. During the year the new ordinary shares, which had up to December 31st, 1906, been bearing interest at 5 per cent. per annum, ranked for 1907 *pari passu* with the old shares, and, in addition to this, it was found necessary to raise further capital in the shape of preference shares for the purposes of the extensions, which also became a charge upon the earnings, in priority to the ordinary capital. These additions to capital only became revenue-producing to a small extent, by reason of the unexpected delays in the construction and opening of the extensions. After their repeated disappointments, the directors hesitate to name a time for the opening of those extensions which are practically completed, but they may say that it is confidently expected by those in charge that the Howrah system, and the Behala line, will be ready for traffic by May 1st.

At the meeting on Tuesday the report and accounts were adopted.

CORK ELECTRIC TRAMWAYS & LIGHTING.—The report for the year 1907 shows receipts amounting to £51,513, and expenses, £31,797. The total balance available, after adding amount brought forward, is £20,419, from which has to be deducted interest on debentures, £4,600, leaving £15,819. The half-yearly dividends on the 5 per cent. cumulative preference shares absorbed £6,145, reserve for depreciation, £2,500, whilst the sum of £2,990 has been written off. Of the balance a 3 per cent. dividend on the ordinary shares is declared, and £733 15s. 9d. carried forward. The lighting and power business again shows very satisfactory progress, the receipts from these sources showing an increase of £2,870, or over 12 per cent. as compared with the previous year, and they now exceed the traction receipts. The large increase in the price of coal has, however, adversely affected the costs, but the directors have not raised the price of electricity as it is hoped that the high price of coal will not be permanent. Owing to bad weather experienced throughout the year and to trade depression the traffic revenue has been very disappointing, there being a decrease of £792 as compared with the previous year's receipts. During the years 1906 and 1907 it became necessary to replace certain cables laid under the bed of the river at a cost of £1,742. At December 31st, 1906, £412 was written off this amount, and the directors have now written off the balance of £1,330. During the past year a considerable length of overhead line has been renewed out of revenue, and larger percentages have been written off certain items than in former years. Capital expenditure during the year has been mainly expended on house services and additional plant for the power station. No shares or debentures have been issued during the year. The meeting is on the 28th inst.

CUBA SUBMARINE TELEGRAPH.—The report for the half-year to December 31st, 1907, shows total receipts of £17,478, and expenses £6,177. To the balance of £11,300 has to be added the sum of £6,500 brought forward from last account. £3,000 have been added to reserve fund, which now stands at £106,000, and after providing for preference dividends and 6 per cent. dividend upon the ordinary shares, a balance of £7,000 is carried forward. At the meeting on Wednesday the report and accounts were adopted.

HARROW ELECTRIC LIGHT & POWER.—Mr. G. W. Spencer Hawes presided at the annual general meeting last week, when the report and accounts were adopted. The number of units sold during the year have increased by 53,000, the largest since the company came into existence, and arrangements are in hand for the installation of additional generating plant. The total receipts amounted to £8,862, compared with £7,938 for 1906, and the total expenditure, excluding depreciation, amounted to £3,867, compared with £3,285. Fuel costs show a slight increase owing to a rise in the price of coal of 2s. 8d. per ton, whilst repairs and maintenance, in consequence of the over hauling of house meters, &c., also show an increase. After deducting debenture interest and interim dividend on preference shares there is a balance of £2,521, and the report recommends payment of a final dividend on the preference shares and 5 per cent. on the ordinary shares, leaving £479 to be carried forward. The capital expenditure during the year amounted to £1,615. The average price obtained was 5·12d. against 5·28d. during 1906, and the working expenses have increased from 2·42d. per unit to 2·45d. per unit. The sum of £1,900 has been placed to depreciation account, which now stands at £15,369. In his speech the chairman stated that, in consequence of the assessment upon the company's property having been increased from £560 to £1,200, they appealed, with the result that it had been reduced to £855.

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NORTH OF SCOTLAND ELECTRIC LIGHT & POWER.—The accounts for the year 1907 show a gross profit of £1,795, including £101 brought forward from the previous year. After deducting interest on debentures and loans, and writing off £115 balance of exhibition suspense account, £467 depreciation on free wiring and meters, and putting £677 to reserve, there is a loss of £98.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY.—The report for the year 1907 refers first to the fact that the directors have had under consideration the question of making provision for renewals other than that ordinarily charged against the year's revenue, and the sum of £1,716 has been set aside for this purpose. The total revenue amounts to £33,296, and expenditure, including debenture interest and the amount for renewals referred to above, £26,547. Adding to the balance the sum of £494 brought forward, the sum available for distribution is £7,243. Of this, £500 is to be set aside for a cumulative sinking fund for the redemption of outstanding debentures, and an amount is placed to depreciation and reserve account, which brings this to £13,000. In addition, a 7 per cent. dividend is declared upon the ordinary shares, making 6 per cent. for the year, and £243 is carried forward. Capital expenditure during the year amounted to £898, and the total capital expenditure to date is £155,303. The company has joined the British Electric Federation.

RIVER PLATE ELECTRICITY.—The accounts for 1907, after providing for debenture interest and depreciation, show a net revenue of £17,290. The figure for last year was £12,018. Dividends of 6 per cent. on the preference and ordinary shares are recommended, and the sum of £4,000 is carried to reserve. The amount carried forward is £5,410. The dividend on the ordinary shares for 1906 was 2½ per cent.

"The Future of the Telephone Service."—Mr. Herbert Laws, in reply to Mr. A. R. Bennett's last letter on this subject, repeats the statement that he has no position in the National Telephone Co.'s organisation, and, therefore, no title. This correspondence is now closed.

North-west London Tube Railway.—In connection with the deputation from residents on the route of the Victoria-Marble Arch-Cricklewood tube railway, mentioned in our last issue, Mr. J. Devonshire, Managing Director of the Metropolitan Electric Tramways, Ltd., has written to the Chairman of the Organising Committee stating that his directors were quite disposed to think that the proposed tube railway would adequately meet all the requirements of the district. If, therefore, the tube railway is proceeded with, they will take no further steps in the direction of the re-promotion of a tramway along Edgware Road.

Middlesex County Council Tramways.—The Chancellor of the Diocese of London, Dr. Tristram, K.C., on Wednesday last week, granted an application by the Vicar and Churchwardens of St. Peter's, Cricklewood, to sell to the Middlesex County Council a strip of the churchyard for the purpose of a street widening in connection with the construction of a tramway under Section 4 of the Middlesex Light Railway Order of 1903. The agreement in question will be between the lessees of the County Council, the Metropolitan Electric Tramways, Ltd., and the purchase price, which is to be allocated to the repair of the roof of the north aisle of the church, and the decoration of the east end of the church, is £50.

Electricity in Horticulture.—The *Electrical World* describes a new application of electricity to accelerating the growth of plant which has been made by a Mr. Hartman, of Turbine, Ontario, who has employed electrical heating for garden frames for vegetables and flowers. In the comparatively cold climate of Northern Ontario a current of from 15 to 20 amperes at a potential of 110 volts has been found to be sufficient. The heater has been successfully used for two seasons, and consists of about 260 ft. of No. 12 B. & S. gage iron-wire wound in coils 2 in. in diameter. A piece of 1½-in. pipe was used in winding the coil, which was afterwards cut into seven parts and mounted on porcelain knobs on a piece of asbestos board, the coils being connected in series. The heater was placed under a rough board frame about 6 ft. by 8 ft., the floor of which above the heater was covered with about 5 in. of earth, the two sashes afterwards being used to cover the top of the frame. Electrical energy was taken from a 110-volt circuit, and, owing to the line losses, the actual current received at the frame last year was 15 amperes at 80 volts. The previous year a current of 18 amperes at 100 volts was obtained, and good results were obtained in both cases. The heat was found to be sufficient to keep the earth always noticeably warm, and in the cold early spring weather tender flowers and vegetables grew rapidly. In some cases the growth was so rapid that the plants were large enough to be set out to advantage were it not for the danger of frost.

NEW COMPANIES

MARPLES, LEACH & CO.—This company was registered on April 6th, with a capital of £20,000 in £1 shares (14,000 six per cent. cumulative preference), to adopt agreements (1) with W. M. Rolph, R. A. Marples, and S. G. Leach, and (2) with R. A. Marples and S. G. Leach, and to carry on the business of electricians, electrical, consulting, mechanical and general engineers, makers of and dealers in electric tramcars, motor-cars, flying machines, aeroplanes, carriages, cycles, and other vehicles, manufacturers of and dealers in dynamos, motors, telephones, bells, electroliers, and arc and other lamps, distributors and suppliers of electricity, &c. The subscribers are W. M. Rolph, R. A. Marples, S. G. Leach, F. K. Bull, F. Huy, F. J. Duncan, and G. A. Macdonald. No initial public issue. The number of directors is not to be less than three nor more than five; the first are W. M. Rolph, R. A. Marples, and S. G. Leach (managing directors). W. M. Rolph may, upon certain conditions, appoint other directors. Qualification (except directors appointed by W. M. Rolph), £1,000. Remuneration as fixed by the company. Registered office, 26-30 Artillery Lane, Bishopsgate Street Without, E.C.

NORTH BRITISH ELECTRIC POWER SYNDICATE.—This company was registered on March 31st, with a capital of £4,325 10s., in 4,300 "A" shares of £1 each, and 510 "B" shares of 1s. each, to promote a company or companies for constructing, establishing, and working an undertaking or undertakings for the generation, distribution, supply, and employment of electricity in the United Kingdom or elsewhere, to adopt agreements (1) with the Hon. Ferdinand C. Stanley and F. M. Voules, (2) with B. Bernheim and W. B. Cownie, and (3) with the National Electric Construction Co., Ltd. The subscribers are:—P. R. Reeves, W. J. Park, W. J. McNelly, W. Eacott, R. Bott, S. Jordan, H. O. Hill. No initial public issue. The number of directors is not to be less than three nor more than five; the first are J. T. Jervis, B. Bernheim, W. B. Cownie, and Sir Home Gordon, Bart. Qualification 100 "A" shares. Remuneration £50 each per annum (chairman £25 extra). Each share confers one vote, provided that the "A" shareholders may not vote on any resolution to reduce the capital by cancelling all the "A" shares and returning the amounts paid up thereon with such sum as shall, with the aggregate amount of dividends paid thereon, be equal to interest at 10 per cent. per annum from the date of issue. Registered office: Queen Anne's Chambers, Westminster, S.W.

PRIVATE TELEPHONE CO.—This company was registered on April 4th, with a capital of £1,000 in £1 shares, to adopt an agreement between M. Atkinson and M. C. Greenhill of the one part, and L. M. Porter of the other part, and to carry on the business indicated by the title and that of electricians, manufacturers of and dealers in electrical apparatus, mechanical and electrical engineers, &c. The subscribers are M. Atkinson, M. C. Greenhill, Florence E. Pittard, A. Green, G. S. Jacob, F. J. Radcliffe, and H. C. Bennett. No initial public issue. The number of directors is not to be less than two nor more than three; the first are M. Atkinson and M. C. Greenhill. Qualification £100.

RIPPINGILLE MANUFACTURING CO.—This company was registered on March 30th, with a capital of £2,000 in £1 shares, to take over the business of a manufacturer of electric fittings, iron, steel, and brass castings, surgical and other instruments and appliances, carried on by F. S. Rippingille in Plume Street, Aston-juxta-Birmingham, as the Rippingille Manufacturing Co., and to adopt an agreement with the said vendor. The subscribers are:—F. S. Rippingille, H. Martin, R. A. Baker, H. H. Cooper, Mrs. M. E. Jagger, W. T. Packwood, W. J. Baker. No initial public issue. The number of directors is not to be less than two nor more than five; the first are F. S. Rippingille (permanent managing director), and two others, to be appointed by him. Remuneration of managing director, £350 and 10 per cent of the net profits; of other directors, £25 per annum. Registered office: Plume Street Works, Aston-juxta-Birmingham.

"X" SYNDICATE.—This company was registered on March 31st, with a capital of £2,000 in 1,900 ordinary shares of £1 each and 2,000 deferred shares of 1s. each, to acquire and turn to account any invention relating to the production, treatment, storage, application, distribution, and use of electricity, and to carry on the business of electricians, engineers, makers, and suppliers of and directors in electricity, electric power, and light, manufacturers of electrical apparatus, &c. The subscribers are:—C. J. Feeny, V. F. Feeny, R. Fraser, F. Morse, C. H. Clarke, S. L. Morse, E. F. Cassor. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first. Remuneration, £50 each per annum (chairman £100). Registered by L. B. Feeny, 19 South Molton Street, W.

Indian Telegraph Service.—According to the *Manchester Guardian*, the strike of telegraph operators is at an end, and normal working has been resumed. This must mean that the Viceroy has foregone the decision to give the new rules a month's trial.

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MISCELLANEOUS CITY NOTES

CITY OF SANTOS IMPROVEMENTS CO.—Subscriptions have been invited during the week for £150,000 5 per cent (tramways) debentures at 95 per cent. These will be secured by a trust deed upon the tramways and electric lighting concessions of the company. The debentures are redeemable at par by the operation of an accumulative sinking fund of 1½ per cent. per annum, commencing in 1909. The company reserve the power to redeem all or any of the debentures at any time upon six months' notice at 105.

BABCOCK & WILCOX.—A dividend of 2s. 4 4/5d. (including bonus) has been declared, making 20 per cent. for the year 1907.

INDO-EUROPEAN TELEGRAPH CO.—A dividend for the six months ended December 31st, 1907, of 17s. 6d. per share, making 6 per cent. for the year, and a bonus of 20s. per share is recommended. The Board also recommend a special distribution of 15s. per share free of income tax, out of interest upon investments.

KALGOORLIE ELECTRIC LIGHT & POWER CO.—A dividend on the ordinary shares of 5 per cent. per annum for the six months ending June 30th, 1908, is recommended.

MARCONI'S WIRELESS TELEGRAPH CO.—It is announced that the report and balance sheet will be issued immediately after Easter. The annual meeting will be held on April 30th.

MEXICO TRAMWAYS CO.—A dividend of 4 per cent. per annum for the March quarter is recommended.

MONTE VIDEO TELEPHONE CO.—A dividend of 6 per cent. per annum less income tax is recommended on the ordinary shares for the half-year to March 31st.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.—A circular has been issued to the profit-sharing secured noteholders setting forth a scheme which has been recommended by Messrs. Speyer Bros., and the London and Amsterdam Committees, for dealing with the company's 5 per cent. profit-sharing secured notes, which fall due on June 1st. The main features of the scheme are as follows :—The company will deposit and pledge an additional £3,500,000 (nominal) Tube shares, and the equity of the power house, with the London and Westminster Bank, the trustee for the noteholders, and issue £1.000,000 Prior Lien 5 per cent. bonds, due November 1st, 1920, for cash requirements, £3.000,000 4½ per cent. bonds, due January 1st,. 1933, and £5,200,000 6 per cent. income bonds, due January 1st, 1948. The noteholders are asked to exchange their notes as to 40 per cent. nominal value into 4½ per cent. bonds, and as to 70 per cent. nominal value into income bonds at par, the exchange taking place as on December 1st, 1907. In order to bind any dissentient minority of the noteholders, it is necessary to proceed with the scheme under the Joint Stock Companies Act of 1870, and for this purpose the company will be put into temporary voluntary liquidation. A receiver and manager is being applied for concurrently with the issue of the circular, so as to protect the assets during the interval caused, which must of necessity elapse before the scheme can be made binding. It is proposed that Sir George Gibb be appointed.

In the Chancery Division yesterday, Mr. H. Terrell, K.C., applied by consent for the appointment of a receiver and manager. The matter was one of great urgency, he said, because, if proceedings were taken by the holders of the profit-sharing notes against the company, the Chelsea power house might have to be shut down, and consequently the whole of the railways supplied from it would be stopped. The assets of the company, it was pointed out, consisted of very large holdings in the capital and debenture issues of the Metropolitan District Railway Co. and the three tube railways connected with it, and also large holdings in the London United Tramways, Ltd. Counsel, on behalf of Messrs. Speyer Bros. and the London and Westminster Bank assented to the application, and Mr. Justice Warrington appointed Sir George Gibb, the vice-chairman and managing director of the company.

WESTERN UNION TELEGRAPH.—A dividend of 1¼ per cent. for the March quarter has been declared. The net revenue for the quarter was $666,937.

Tramway Strike in America.—The *Standard* New York correspondent states that in Chester, Pennsylvania, the tram-drivers and conductors, with the hearty support of the townspeople, have struck to secure recognition of their trades union. The police have been fired on, and trams have been smashed.

Faraday House.—As a result of the recent scholarship examination, the Governors of Faraday House have awarded an exhibition of twenty guineas per annum, tenable for three years, to Cyril Launcelot Underwood, of the Grammar School, Bedford.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night was £59 to £59 10s. per ton (last week, £60 5s. to £60 15s.).

A NEW LAMPHOLDER.—We are asked to state that the sole selling agents for the Bruston patent lampholder and lamp cap described on page 576 of our last issue are Messrs. A. Vandam & Co., of 39 Victoria Street, S.W.

BROCKIE-PELL ARC LAMPS.—The Brockie-Pell Arc Lamp Co. have notified us that they have removed to works and offices at Wimbledon, S.W., where all their well-known makes of open type, enclosed, and flame arc lamps will in the future be manufactured under the same supervision as before. All accessories for lamps previously supplied can be obtained without any delay, and all inquiries should be addressed to the Brockie-Pell Arc Lamp Co., Wimbledon, S.W. Telephone No. : 200 National.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—The Monobloc Accumulator Syndicate is being wound up voluntarily. Mr. H. Newson-Smith, 37 Walbrook, London, is liquidator.

DISSOLUTIONS OF PARTNERSHIP.—James Smith and Albert Barron, carrying on business as electric fittings merchants, &c., at 46A Holborn Viaduct, and 48–9 Farringdon Street, London, as J. J. Smith & Co., have dissolved partnership.

Mr. C. W. Stansell and Mr. R. A. Stansell, carrying on business as electrical engineers, &c., as Stansell & Son, Taunton, have dissolved partnership. Debts by C. W. Stansell, who continues.

APPOINTMENTS AND PERSONAL NOTES

Mr. Charles Lill, of East Ham, has been appointed sales engineer to the Hackney Electricity Department, at a commencing salary of £120 per annum, rising by annual increments of £10 to a maximum of £150.

Mr. Thompson, Mains Superintendent in the Erith Council's Electricity Department, has tendered his resignation.

Mr. J. Arthur Sykes, deputy engineer and manager of the Heston and Isleworth electricity undertaking, has been appointed head of the electrical department of a large rolling mill, shipbuilding and steel works in Scotland.

Councillor Barrow has been appointed Chairman of the Birmingham Tramways Committee, in place of Alderman Leale, who has been appointed Chairman of the Water Committee.

Mr. A. Harris, of the Liverpool Post Office, has been presented with a tantalus and a set of gold sleeve links and studs by the staff on the occasion of his departure from Liverpool to take up the post of general superintendent of telegraphs in Bristol.

Mr. R. Ley Alkin, A.M.I.E.E., of the electrical engineering and contracting firm of L. J. Healing & Co., of Yokohama, Kobe, and Tokyo, will shortly arrive in England on a business and pleasure trip. His address will be c/o Tozer, Kemsley & Fisher, Ltd., 84 Fenchurch Street, E.C.

NEW PUBLICATION

"Proceedings" of the American Institute of Electrical Engineers. April. (New York : The Institute.) 50 cents.

Electric Signalling for Railways.—The electro-pneumatic system of Messrs. M'Kenzie & Holland, Worcester, for operating the points and signals which has been in operation for some time at the Newcastle station of the North-Eastern Railway, is being installed at the Glasgow Central Station of the Caledonian Railway.

High-Speed Electrical Machinery.—Mr. Miles Walker has kindly pointed out a slight error in his remarks as reported on page 549 of our last issue in the discussion on Messrs. Stoney & Law's Paper. The dimensions of the 2,000 kw. rotor of which he spoke should have been given as 20 inches diameter by 40 inches long.

Telegraph Traffic.—The via Fao route has again been interrupted and restored, and there is a momentary interruption of cable communication between Mole St. Nicholas and Cape Haitien. The Japanese lines were also down until the 15th inst., resulting in the loss of telegraphic connection with Tokio and Yokohama beyond Shidzuoka. The Eastern Extension, Australasia, & China Telegraph Company have laid the cable between Cocos and Java, and the line is now open to international traffic. The rates are the same as on the "Via Madras" line. The Alaska cable has suffered an interruption beyond Sitka.

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Binding Covers for Vols. I. and II. of *Electrical Engineering*, Jan.-June and July-Dec., 1907, can be obtained, price 2s. each, post free 2s. 4d., from the above address. Readers can have their volumes bound by their own bookseller; or they may send their numbers with index to us, carriage paid, with the reader's name and address, and a remittance of 4s 6d. per volume under separate cover. The volumes will then be bound and returned carriage paid to any address in the United Kingdom.

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SUMMARY

An electric omnibus has made the run from London to Brighton on one charge. (Page 612.)

The following books are reviewed in this issue:—"Stationary Steam Engines," edited by William H. Fowler; "Experimental Electrical Engineering and Manual for Electrical Testing," by V. Karapetoff; "An Introduction to the Study of Electrical Engineering," by Henry H. Norris; "The Post Office Electrical Engineers' Journal"; "The Hughes and Baudot Telegraphs," by Arthur Crotch. (Page 613.)

Full statistical information regarding the working of the Liverpool Corporation Tramways is given in the annual report, which has been issued by the Traffic Manager. An analysis of the accounts shows that the total expenses per car-mile, including all capital charges, were 10·104d. A sum of £55,587 was carried to reserve, renewal, and depreciation account, and £27,793 was contributed in aid of the general rates. (Page 615.)

Some notes are given of the electrical engineering exhibits at the Birmingham Exhibition of Arts and Industries. (Page 616.)

The type of electric lift in service at Chicago in the Board of Trade Building, and known as the "Mabbs" elevator, is of interest on account of the novel construction of the mechanism. The driving motor itself is the counterweight for the car, and climbs up and down a rack in a separate shaft. The control of the motor is effected entirely through the field circuits, and special automatic braking arrangements are provided. (Page 616.)

In a Paper read before the Cleveland Institute of Engineers, Mr. H. Crowe described a form of the Ilgner system for driving reversing rolling mills, and gave an interesting series of records of current consumption in actual cases. He also dealt generally with the advantages of electric over steam driving. (Page 617.)

An interesting discussion followed the reading of Mr. Eustace Thomas's Paper on works management last week at the Manchester Local Section of the Institution of Electrical Engineers. Various opinions were expressed as to the amount of "red tape" necessary to hold the organisation together; and Dr. Garrard gave a detailed description of the cost-keeping methods in use at the works of Messrs. Ferranti, Ltd. (Page 619.)

Three wireless telegraph installations are included in the equipment of the United States Naval Academy. The main station is used for picking up and retransmitting messages from ships. Transmitting apparatus of the Slaby-Arco type is used, with a de Forest electrolytic receiver. A smaller installation on the Stone

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system is used for demonstration purposes, as well as a simple form of home-made apparatus. (Page 620.)

A GOOD deal of attention is being paid in America to the electric driving of paper mills. A description of the equipment of a large mill where water power is available is given in an illustrated article. (Page 621.)

IN the course of a Paper read before the American Institute of Electrical Engineers by Mr. C. W. HINE, a number of methods of voltage regulation in rotary converters were summarised, particular attention being paid to the use of small booster machines mounted on the same shaft and connected in series with the alternating side. (Page 624.)

A LECTURE by Mr. POULSEN on wireless telephony and telegraphy is summarised, and is supplemented by notes on recent developments in the Poulsen apparatus. (Page 625.)

A PAPER, entitled "Notes on Electric Haulage of Canal Boats," by Messrs. L. B. STILLWELL and H. PUTNAM, was read last month before the American Institute of Electrical Engineers. In this Paper the authors describe some tests made on a certain canal in Pennsylvania, and a careful comparison of the energy consumption in the locomotive and mono-rail tractor systems respectively is made, the result of which is favourable to the former system. Speed limitations and locking times are among the points considered. (Page 627.)

IN a Paper before the Glasgow Local Section of the Institution of Electrical Engineers, Mr. G. STEVENSON advocated the use of squirrel-cage induction motors for electric driving in preference to slip-ring motors, even for motors up to 100 B.H.P. The author described the application of friction clutches to electric driving with squirrel-cage motors, and finally criticised the regulations of Local Authorities and supply companies with regard to the installation of squirrel-cage motors. (Page 629.)

A PAPER on the transmission of power over long distances by underground cables was read by Dr. RICHARD APT before the Elektrotechnischer Verein at Berlin recently. The author advocated the use of single-core cables in preference to three-core cables for three-phase supply at pressures above 30,000 volts, and worked through an example of transmission at 40,000 volts over a distance of 87 miles by underground cables to show that such a scheme was a reasonable proposition. A short description of the high-tension cable line of the County of Durham Power Distribution Co. was also included in the Paper. (Page 631.)

A VERY complete electric-car testing plant has been installed in an American educational laboratory. The car under test is supported on wheels representing the track mounted on shafts, which also carry flywheels for producing the equivalent of inertia of a train, and generators which can act as electric brakes to produce the effect of gradients. (Page 634.)

So far metallurgical difficulties have prevented the working up of silicate ores of nickel. But by means of a chlorination and electrolytic process it is now suggested to work the ores of New Caledonia and North Carolina. The subject of diaphragms for electrochemical processes is one of perennial interest to electrochemists, and there is still room for improvements in the various diaphragms at present employed. Under ELECTROCHEMISTRY AND ELECTROMETALLURGY some of the diaphragms at present employed are referred to. Other subjects dealt with are the production of hydrogen peroxide, the manufacture of artificial rubies, and the report of the British Aluminium Co. (Page 634.)

UNDER "Electrical Science" in the British and American Section is an abstract of a recent Paper on the effect of annealing on the magnetic properties of various magnetic substances. A Paper by BRAGG and MADSEN on the nature of Gamma-Rays and an article by HERING on the fundamental law of electromagnetic induction are also abstracted. In the Papers abstracted in the Continental Section, RIES studies the photoelectric properties of selenium, ZEEMAN observes the Zeeman effect with the interferometer, and FISCHER describes a method for exhibiting electric lines of force. Some experiments by BECQUEREL pointing to the existence of positive electrons inside atoms are also mentioned. (Page 635.)

A PATENT specification by Sir OLIVER LODGE, published last Thursday, describes an improved method of exciting a Ruhmkorff coil. Another by H. S. HATFIELD and F. M. LEWIS relates to the construction of enclosed arc lamps in which flame carbons may be used, means for circulation of the gases being provided. A specification by A. H. HUMAN describes an arrangement for electric driving with an intermittent load, with which the use of an auxiliary flywheel machine is dispensed with, and D. MARZI has one relating to an improved loud-speaking telephone apparatus, in which a lever operates the diaphragm and is controlled positively in both directions. (Page 637.)

A CORRESPONDENT sends a note with regard to the laying of underground cables. (Page 639.)

A SCHEME for a working agreement between the Belfast Corporation and the Cavehill and Whitewell Tramways Co. is now under consideration by the Corporation.—An agreement has been arrived at between the Liverpool Corporation and the National Telephone Co. by which the present charges for unlimited service shall be maintained to existing subscribers, but the message rate or the measured system of charging is to be applied to all new subscribers.—The Paddington Borough Council has rejected a recommendation by its Works Committee that a portion of the Harrow Road should be electrically lighted in preference to gas.—At meetings of the Beckenham and the Londonderry Corporations, objection was taken to sending delegates to the annual conference of the Incorporated Municipal Electrical Association, but eventually it was decided that delegates should attend.—In proposing a somewhat increased tariff for electricity supply in Brighton, Mr. J. CHRISTIE gives as his reason the high price of coal, which, he says, approximates to two-thirds of the total cost of generation. (Pages 639–641.)

THE Perth (W.A.) Postmaster-General's Department invites tenders for large supplies of telephone material.—Extensions to the Ayr Electricity Works, at a cost of £15,000, are recommended.—Two electric lifts are required by the Antwerp municipality.—Tenders are invited by the Eccles Corporation for a Lancashire boiler and 210 kw. generating set; for overhead tramway lines, with tangential suspension, telephone system, &c., by the Haslingden Corporation; for electric supplies by the Govan Corporation; for 175 double-deck roof-covered electric car bodies, with equipment for the overhead trolley, surface contact, and conduit systems by the London County Council; and for steel tramway poles, overhead line equipment, &c., by the Rawtenstall Corporation.—The Calcutta Corporation has received three tenders for public lighting, two of which are by the Calcutta Electric Supply Corporation, and the Oriental Gas Company respectively. The former has submitted alternative tenders, the annual cost of which are £43,637 and £38,818, against £34,117 by the Gas Company. The Electric Lighting Committee recommends the acceptance of the latter, but a poll of the ratepayers is to be taken. A concession has been granted by the Dutch Government to the Amsterdam & North Holland Electric Tramways Co. for the construction of a system of electric tramways in Holland. (Pages 641 and 642.)

THE report of Messrs. Babcock & Wilcox for 1907 shows a balance available for distribution of £335,664. Dividends of 3 per cent. on the preference shares, and

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8 per cent. on the ordinary shares, in addition to a bonus of 4 per cent., are to be paid. The balance carried forward is £38,664, after placing £100,000 to reserve fund, and £25,000 to the dividend equalisation fund. The City of Birmingham Tramways Company's accounts for 1907 show a balance of £33,367; a 5 per cent. dividend and a bonus of 5 per cent. is recommended. The report of the Dudley & Stourbridge Electric Traction Co. shows a balance available for distribution of £11,898, and a 5 per cent. dividend is recommended. A balance of £88,523 is shown in the accounts of the British Aluminium Co. for the year 1907. A final dividend of 7 per cent. is recommended on the ordinary shares, carrying forward £36,502. (Pages 642 to 644.)

After delaying the question of improving the lighting of a portion of Harrow Road for some time, the Paddington Borough Council has refused to act upon a recommendation of its Works Committee to adopt electricity, and the present unsatisfactory condition of affairs is apparently to be allowed to continue. The cost of the present gas system is £3 per lamp per annum, or £198 for the 66 lamps in the part of the road under consideration. The Metropolitan Electric Supply Co. and the Gas, Light & Coke Co. early this year offered to improve the lighting, the former proposing to instal 24 flame arc lamps at an average annual cost of £13 each, or a total of £312 per annum, *plus* an initial cost of about £170 for new posts where tramway poles were not available. The Gas, Light & Coke Co., on the other hand, offered to instal 66 lamps, each containing two Kern burners, for £305 5s. per annum, with no initial outlay, as the new burners could be placed on the old lamp-posts. The Committee reported that they had come to the conclusion that electric lighting was undoubtedly better than gas for improving the lighting and appearance of the thoroughfare, and that the Council would be justified in adopting it, notwithstanding the slight additional cost. It may also be pointed out that a memorial in favour of electric lighting from 200 ratepayers in Harrow Road was followed by a further memorial containing 75 signatures. When the Works Committee's report was first presented to the Council early in March, it was decided—to meet the objection of the Finance Committee that the proposal would open the question of electric lighting for the whole borough, involving the Council in additional expense—to postpone the consideration of the matter until the next meeting. A special meeting was held last week, however, to consider the position, with the result above indicated. We think that the Paddington Borough Council cannot be well advised if it is so fearful of incurring unduly heavy expenses if the question of electric lighting over the whole borough is considered. Main streets can undoubtedly be better and more economically lighted by flame arc lamps than by any system of gas lighting, and although the incandescent gas lamp has hitherto been able to hold its own against the carbon filament and Nernst lamp in side streets, the advent of the metallic filament lamp has now put an entirely different complexion on the matter. In the case of a small and not over rich municipality, the burden of incurring the necessary capital expenditure for changing its street lighting from gas to electric, and the obligation of writing off that part of the capital expenditure on the former which has not yet been redeemed, may be a deterrent, but a borough so rich and important as Paddington should not evade its duty of providing its citizens with the most suitable street illumination. We quite agree with the Finance Committee that the substitution of flame arcs for gas jets in Harrow Road would probably result in an agitation by the ratepayers for better lighting in many other parts of the borough, but that is the greater reason for a beginning to be made in this direction.

The extended applications of electric driving, and the greater variety of conditions under which motors have to work, have led electrical engineers in the last few years to devote more attention to the design of motors for specific purposes. Especially in the case of large powers, a careful inspection of the nature of the work to be done, and the conditions of running, is often made before the type, or sometimes even the design, of the machine is settled upon. The user is, of course, to some extent limited in the choice of motor by the nature of the available electric power supply, and in the case of a three-phase circuit the relative claims of an induction motor with a short-circuited rotor, and one with a wound rotor and slip-rings have to be weighed. Mr. G. Stevenson, in his Paper before the Glasgow Local Section of the Institution of Electrical Engineers, considers this question at some length, and strongly favours the view that, in consequence of the simplicity of its electrical and mechanical construction, and the absence of brush-gear, the squirrel-cage motor is to be preferred to the slip-ring machine for practically all purposes where constant speed is required. He even goes so far as to say that, instead of providing some electrical method of starting up on load, the machine should be run up to speed light, and should then, by means of some suitable friction clutch, be connected to the load. There is no doubt that a well-made clutch, carefully adjusted and carefully handled, will give excellent results, especially if the motor is provided with a fairly heavy flywheel; but there is always a possibility, in the case of starting up against a heavy torque, of the clutch engaging quicker than is intended, and reducing the speed of the motor to such an extent as to blow the fuses. On the other hand, if undue slip is allowed, the wear in the clutch becomes excessive, and very frequent adjustment is required. On the whole, we are inclined to think that, in most cases, the advantage as regards behaviour in unskilled hands and cost of maintenance will lie with the purely electric method of starting. Although the slip-ring method is an extremely simple one, there are isolated cases in which trouble has been experienced, especially with motors placed in positions subjecting them to great vibration; but there are alternative methods, as, for instance, the use of the motors described by Mr. L. J. Hunt in a Paper before the Manchester Local Section of the Institution of Electrical Engineers last year (Electrical Engineering, Vol. I., pages 545 and 606). Mr. Stevenson appears to be surprised that the rules of the various supply authorities vary so much with regard to the permissible size of squirrel-cage motors which may be connected to their supply mains. It must be remembered, however, that it is only recently that improved design and construction have permitted the use of much smaller air-gaps than formerly, and have reduced magnetic leakage in the larger sizes of squirrel-cage motors, which have now a far better power factor and lower starting current.

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The "solid" system of laying cables, that is to say, laying the cables in wooden, stoneware, or iron troughs, and filling up the troughs with a bituminous compound, has been for some time past the favourite method employed on distributing networks in this country. During recent years, however, there has been a revulsion in many instances in favour of laying cables, suitably armoured, "direct" in the ground. It is not only the lower cost of this method that has been the cause of its gaining favour once more, but also the fact that trouble has not infrequently been occasioned by the bituminous compound in ducts on the solid system when a heavy short-circuit occurs. Cases have been known in which melted and even burning bitumen has run down along the service cables into houses, but a more frequent cause of trouble has been the giving off of an explosive gas when some of the filling compounds are heated up to a high temperature by a short circuit. Another point is that service joints take longer to make on the solid system, and the job is more "messy" than in the case of the plain "direct in ground" system. In the course of a short note on the subject, a correspondent mentions a case, however, in which the lead covering, not protected by being laid solid, has been attacked by electrolysis, owing to insufficient bonding. He mentions, however, that the cable was laid in a clayey soil, and that clay was also used at the service boxes to keep the compound from running out. It is not sufficiently well known that certain clays have a direct chemical action on lead, and that it does not necessarily require the presence of stray tramway return currents for the lead to be attacked. Possibly in this particular case, the bonding, which should certainly not have been neglected in the first instance, may nevertheless not prove a permanent cure for the evil. While we are of opinion that the solid system is employed in a large number of instances where armoured cables laid directly in the ground would be more suitable, those who are about to adopt this latter method should first take the precaution of having samples of the soil analysed.

ARRANGEMENTS FOR THE WEEK

TO-DAY (THURSDAY), APRIL 23rd.

Institution of Electrical Engineers.

8 p.m. Extra Meeting at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W., when the discussion on Messrs. Handcock & Dykes' Paper, "Electric Supply Prospects and Charges as Affected by Metallic Filament Lamps and Electric Heating," will be concluded.

TUESDAY, APRIL 28th.

Royal Institution.

3 p.m. Afternoon Lecture I. on "The Development of the Modern Steam Turbine and its Application," by G. G. Stoney.

WEDNESDAY, APRIL 29th.

Institution of Electrical Engineers: Students' Section.

7.30 p.m. Meeting at Finsbury Technical College, Leonard Street, City Road, E.C. Paper to be read: "Radio Telegraphy," by Marvin and Smith.

FRIDAY, MAY 1st.

Royal Institution.

9 p.m. Evening Discourse on "The Scientific Work of Lord Kelvin," by Prof. J. J. Larmor, F.R.S.

ELECTROBUS RUN TO BRIGHTON

One of the fourteen electric omnibuses which have been constructed by the Electric Vehicle Co. for the Brighton and Hove Omnibus Co.'s service was run on Monday from London to Brighton as a demonstration of the possibility of a run of this length (56 miles) on a single battery charge with a vehicle of the proportions of an omnibus. The omnibus ran from the Hotel Cecil to the Palace Pier, Brighton, and afterwards climbed the steep ascent from the Parade to the Western Road and proceeded to its garage in Hove without any recharging, and we are informed that another 20 miles could have been covered if necessary. The only trouble experienced was a hot bearing in one of the road wheels. No difficulty was experienced in climbing the hills encountered with the seven tons weight of the car and its load, although the speed in some cases drooped to about two or three miles per hour; but it must be understood that the omnibus was provided with the standard gear designed for an average speed on fairly level roads of 12 to 14 miles per hour. Had the gear been lower, better results could have been attained on the hills. The average current consumption on the level when travelling at 12 miles an hour was 80 to 85 amperes, and when hill climbing at five or six miles an hour, between 100 and 125 amperes, the battery voltage being 95. On several occasions the ammeter showed momentarily a consumption of 250 amperes, but by placing the motors in series the car speed was reduced and the consumption lessened to about 100 amperes. Upon completion of the run the battery showed, when discharging at 85 amperes, a voltage of 85, and on open circuit 92 volts. The lower figure shows 1·79 volts per cell, and the higher one 1·96 volts. The vehicle is of the ordinary double-decked type, to seat 34 passengers, conductor and driver, 18 outside, and 16 inside, and weighs with full complement of passengers and accumulators 7 tons. The battery consists of 47 cells with pasted plates, made by the Tudor Accumulator Co., and has a capacity of 560 ampere hours on a 5-hour discharge rate. The weight complete with electrolyte was 30 cwt. The omnibus is driven by two six-pole series-wound enclosed motors rated at 5 h.p., and running normally at 800 revs. per minute. The drive to the rear road wheels is through double reduction spur gearing and silent chains. The wheels are driven independently, so that no differential is needed. The controller is of the series-parallel drum type, operated by a handle in centre of driving seat. It provides for 5 speeds forward and 3 reverse speeds. Three mechanical brakes are fitted. The first acts on the countershaft, the second on both gear rings on the road driving wheels, while the third is an emergency electric brake sufficiently powerful to hold the car on any gradient.

Telegraph Traffic.—Nothing of importance has to be reported this week except that the dispute between the Indian Government and the telegraph operators is at an end. A five-weeks' trial of Mr. Medland's scheme has been agreed to, and absentees from duty will be permitted to return, but will lose pay for the strike period. On the 20th inst. the cable between Paramaribo (Dutch Guiana) and Cayenne (French Guiana) was restored after having been interrupted since March 14th.

Code Telegrams.—The Postmaster-General has addressed a letter to the Glasgow Chamber of Commerce in reference to the proposal at the International Telegraph Conference at Lisbon to modify the use of code telegrams. The letter refers to the tendency to compile artificial groups of words which in many cases can hardly be regarded as pronounceable, with the result that such words are difficult to transmit, and are likely to lead to error. The Postmaster-General is of the opinion that in many cases unreasonable use of the concession to use code words has been made, and he gave as an instance the following words, which appeared in a code recently submitted: buiksroty, bywrgrochx, and liqraqkper. The object the Postmaster-General has in mind, the letter continues, is that the present conditions as to the pronounceability should be somewhat more clearly defined, in order to put some limit for the future to a growing tendency which, if unchecked, cannot fail to produce results highly injurious to the telegraph service generally, and, therefore, to the public and to commerce. There is, however, no intention of adopting other than a wide and even generous interpretation which would cover the great bulk of the codes at present in use.

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REVIEWS OF BOOKS

Stationary Steam Engines. Edited by William H. Fowler. 295 pp. 9¾ in. by 7 in. 326 illustrations. (Manchester: Scientific Publishing Co.) 12s. 6d.

This book is written by a well-known and experienced author, and is provided with numerous excellent illustrations. It deals with many types of reciprocating engines, and enters very thoroughly into the designs of cylinders, valves, pistons, and packings. The practical considerations of engine frameworks and moving parts are dealt with, as well as types of governors, valve gears, flywheels, and lubricating arrangements. Various representative types of slow and high-speed engines are very fully illustrated and explained. The types of slow-speed engines include those constructed by Musgrave, Van den Kerchove, Hicks-Hargreaves, the Wallsend Slipway Co., Galloways, J. & E. Wood, Escher-Wyss & Co., Allis-Chalmers, Robey, Borsig, Sulzer, Carels, Bollinckx, and Fairbairn, Combe & Barbour. These, it will be seen, include the principal makers in Europe and America, and the full descriptions, admirable blocks, and detailed drawings will be found most useful. The various valve gears adopted by the above-named makers are dealt with very fully.

The author then illustrates some well-known types of high-speed reciprocating engines. These are explained in a practical manner. Bearing pressures, cylinder clearances, &c., which require more detailed attention on the part of the designer of high-speed engines are carefully set out. Some more information might have been given on the working difficulties with piston rings, which may be said to be the only detail in high-speed engines which is not wholly satisfactory. Sectional drawings and descriptions of Willans & Robinson's central valve, Belliss & Morcom, Browett-Lindley, W. H. Allen, Brotherhood, Scott, Reavell, McLaren, Peache, Sissons, Clarke-Chapman, Westinghouse, and Alley & McLellan's engines are given, so that almost every well-known type of British high-speed engine is described.

In the chapter on governors, reference is made to a Paper by Captain Sankey on the subject of the relative advantages of throttle and cut-off governing. Strange to say, no reference is made to the late Mr. Willans' paper, read in 1893, as we might have expected. The principal types of governors in use are fully dealt with. The kinematics and construction of engine flywheels form a very excellent chapter; we do not, however, see any reference to the trouble due to slackening of keys, which has proved a serious difficulty in some large flywheels. The concluding chapter on condensers contains a lengthy reference to Professor Weightman's Paper, read before the Institute of Naval Architects. Jet, surface, barometric jet, ejector, and evaporative condensers are shortly described.

We think the author dismisses the subject of cooling towers too shortly, as only steel towers are described, and no reference is made to the more commonly used wooden towers. We would suggest that the author might with advantage also include in a future edition the recommendations of the Engineering Standards Committee as a reference, and as well as a chapter on pipework. We strongly recommend the book to all engineering students, draughtsmen, and engine designers.

Experimental Electrical Engineering and Manual for Electrical Testing. By V. Karapetoff. 790 pp. 9 in. by 5¼ in. 538 illustrations. (London: Chapman and Hall.) 25s.

This book, says the preface, is written as a laboratory manual suitable for the general electrical engineering work of most American colleges of engineering. It will, however, not only be read with interest by those engaged in teaching in this country, but will also be found useful to many engaged in actual work.

It is arranged on what the author calls the "concentric" system, for fuller details of which he refers us to his paper at the 1907 Convention of the A.I.E.E. While each subject is dealt with by itself, it is intended that the book shall be gone through three times; first taking the elementary part of each chapter, then a second time going further into each subject, and the third time taking the more advanced parts. The method appeals to us. By having the whole in one text-book, the second and third course men are made sure of their back-work, while the first course man, if he is worth anything, will skim over the more advanced parts, and will see what his work is leading to—an encouragement the first course man frequently lacks.

One of the most valuable parts of the method is the "report" which the student is constantly being called on to make, on all kinds of apparatus and plant, from ammeters and bridges to lifts, wiring, and tram-car controllers. Reasonable lines for these are pointed out, but so as to encourage individuality, not uniformity. Most English teachers will envy the wide range of plant on which his American colleague appears to be able to turn his pupils loose.

In the earlier part of the book—Instruments, the Magnetic Circuit, Lighting, &c.—there are a few points which might be corrected. Photometry is well treated, and there is an excellent chapter on illumination; but we cannot understand the Marshal luminometer being accepted without comment. It was brought out and abandoned by Mr. (now Sir William) Preece in very early days, and the method of varying the power of the standard lamp by voltage is very little better now than then. Among meters, again, the way in which "originality" is allowed to the Sangamo Meter makes one think the author has never heard that the Ferranti has been in wide commercial use for years. There is a little mistake of a decimal also in the Carey-Foster Bridge. Its limit of accurate work is given at 0·01 per cent., whereas it is nearer to one in a million in everyday work.

A very wide range is dealt with in lines, generators, motors, efficiency tests, transformers, armature winding, switchboards, railways, controllers, &c. To deal thoroughly with any one of these subjects would take up the whole book; to deal superficially with all would be useless. The author steers the middle course with some skill, giving a sufficient number of well-chosen groundwork matters, clearly dealt with and worked out, and a few practical commercial examples. He doubtless feels that a student who has gone steadily through what he finds in this book will have learnt to work, and be able easily to read up any branch in which he wants to specialise, besides having a fairly wide knowledge on most work outside his own branch.

As to mathematics, the author's feeling seems to be that for engineers, graphics are better than analytics, and neither than either. We think that in this many engineers will agree with him.

There is one unpleasing little bit. Joint resistances are treated as a mid-Victorian Cambridge don would have done it, instead of by a few lines of common sense and reciprocals; and then left in the form $\frac{1}{R_{jt}} = \Sigma_1^n \frac{1}{R}$, from which the pupil may—or may not—disinter the only formula that he will ever want, viz., $R_{jt} = R_1 R_2 / R_1 + R_2$. But perhaps this is only put in to show how bad men would have written this book, just as the four appallingly bad illustrations serve as a foil to the remaining 534 which are exceptionally good.

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An Introduction to the Study of Electrical Engineering. By Henry H. Norris. 404 pp. 9 in. by 5¼ in. 179 illustrations. (London: Chapman and Hall.) 10s. 6d.

The idea of this book is good—to give a general view of electrical engineering based on the various applications familiar to all; a general view, not exactly to the man in the street, but rather to the technical man in other branches. The further the writer goes the further he gets away from this idea, which is a pity. When he remembers for whom he is writing he sometimes does put things so very nicely and clearly that we hope for a second edition, leaving out half or three-quarters of the present matter, and replacing it with as good as that which remains.

The first fifty pages may be summed up as "who first did what, and when," and they form a very convenient, short, historical summary. The chapter on electrical quantities and units is very clearly put, but is more suitable for clearing the brain—and it often wants it badly—of the working engineer, who knows them already in practice, rather than for the beginner. One excellent point, here and in other parts, is that immediately after a statement, one or more numerical examples are often given: merely question and answer, which can be worked out from what has just been said. This clinches the matter on the spot, and makes sure it is really understood. We generally find such examples, if given at all, are collected at the end of the chapter, where they are but little use, as most readers cut them. Another excellent feature is giving at the beginning of the book a list of "Symbols used in Electrical Literature." It saves a good deal of trouble. Doubtless the omission of some such words as "by me and my friends" is a printer's error.

As to the rest of the book, if rewritten with Figs. 75–6, 82, and 133–4 as patterns of what is wanted, and with some slight sense of order, proportion, and sequence, the whole would make a very good and useful work, for there is much good matter in it.

This present edition, indeed, may be of service to a man who has been at work for some years, and lacks a clear conception on certain points.

The Post Office Electrical Engineers' Journal. Vol. I. Part I. 80 pp., 9¾ in. by 6 in. Published for the Institution of Post Office Electrical Engineers, by H. Alabaster, Gatehouse & Co. Price 1s. nett quarterly.

The new quarterly journal of the Institution of Post Office Electrical Engineers differs from the majority of the official journals of scientific and engineering institutions. It does not contain, as might be expected, duly revised and corrected versions of Papers read before the Institution, with reports of the discussions, but is made up of a number of articles which have apparently been contributed specially to the Journal. Only three pages are devoted to minutes and reports from the nine local centres of the Institution. The journal starts with some "words of welcome" by Sir John Gavey, and it also contains a short statistical article on telephone progress in London by Mr. G. F. Preston (General Manager of the Post Office London Telephone Service). There are several excellently written technical articles, some of which, however, suffer considerably by the very poor reproduction of the diagrams with which they are illustrated.

Messrs. C. C. Vyle and E. V. Smart describe the polarised sounder designed by Mr. Vyle, in which the cores of a sounder, resembling in general appearance the ordinary pony pattern, are inductively magnetised by a permanent magnet placed with its poles at a distance of five mils below the bottom of the cores. This keeps the magnetisation on the steep part of the curve, without, however, there being any danger of reversal. It is stated that a 500+500-ohm polarised sounder of this pattern can be actuated by half a milliampere, that three milliamperes can produce Morse characters at 20 words per minute, and 10 milliamperes give strong loud-working signals. The inductance of the instrument is 62 henries. At present the sounder is in use on a 400-mile line from London to Glasgow, and on other long-distance lines. Mr. Chas. E. Hay has contributed an article on the "Common Battery Duplex," a system in which a line is worked duplex from a battery placed at one end only; he has devised a means of overcoming previous difficulties in working this system. A serial article on "The Telephoning of London," is commenced by Mr. W. Noble, Superintending Engineer of the Metropolitan Central District. The first instalment deals with the initial survey of the underground duct construction. Among the interesting figures given in Mr. Preston's statistical article already alluded to are the average number of calls per line per day in various London exchanges. At the Central Exchange the average is the highest, but yet only 6·81, while at Hampstead it falls to 3·1. These low figures, however, are obviously due to the large proportion of message-rate circuits; there are 30,245 subscribers on the message rate as against 3,855 on the unlimited service rate Other articles are "The Typewriter and Piece Work in Telegraphy," by Donald Murray (on the large use of the typewriter and of abbreviations on the United States telegraph system), "Common Battery Telephone Transmission Systems, and Some Methods of their Application by the Post Office," by M. Ramsay; "Glasgow Trunk Exchange—New Equipment," by J. S. B.; "The Zones and the Trunk Lines," by John Lee (Assistant Traffic Manager), "The Skerries Wireless Telephone," by J. S. Elston (an earth-plate conduction system put down in 1899 or 1900, and apparently not giving very good results).

The journal is edited by Messrs. H. R. Kempe, H. Hartnell, A. W. Martin, J. E. Taylor, T. F. Purves, A. O. Gibbon, and D. H. Kennedy (Managing Editor). We are surprised to see that a journal edited by engineers of the Post Office Telegraph Service, and circulating practically only among this class of readers, should be permitted to publish advertisements of electrical manufacturing firms.

The Hughes and Baudot Telegraphs. By Arthur Crotch. 83 pp. 4¾ in. by 7 in. 41 illustrations. (London: S. Rentell & Co.) 1s. 6d.

This little book is almost entirely descriptive of the instruments named in the title, and takes it for granted that the reader is acquainted with the general principles of telegraphy. The Hughes type-printer has never been extensively used in this country, and thirty years ago had nearly disappeared from the Post Office stations. For international lines the advantage of delivering the actual instrument slip in plain letters, and so avoiding errors due to linguistic differences, has served to keep it in general Continental use, in spite of the somewhat highly skilled labour needed for the operation and maintenance of a complex instrument. So when the Post Office took over the cables of the Submarine Telegraph Company, the Hughes was again numbered among Post Office apparatus. To those familiar with the original instrument, the description in the book under review will be of interest, as showing how it has been improved in certain details, of which the substitution of an electric motor for the heavy driving weight must be an immense relief to the operator. The governor described is another considerable improvement.

In the diagram of the Hughes Duplex Repeater, Fig. 16, it is impossible to follow the action of the two six-way switches and the "Simplex-Duplex" switch, and the text gives no assistance. Neither is the function of the Wheatstone receiver in the "leak" circuit mentioned, nor the speaking sounders shown. This may lead to no difficulties to those in the "Service" who recognise the repeater set as available for either Morse or Hughes working, but is perplexing to the less well informed. The diagram is extremely difficult to follow at all, owing to the confusing effect of crowded parallel lines, and the absence of identifying numbers or letters at the terminals.

The description of the Baudot system is not easy to read, but with a little care, and reference backwards and forwards, a clear understanding of the system, and the somewhat intricate apparatus employed, is attainable, and understanding will result in admiration for the ingenuity displayed throughout. The reference backwards and forwards is partly due to several cases of wide divorce between the figures and the text describing them; an irritating characteristic of many descriptive works, which the author and printer would do well to alleviate in future editions in this case. The author's plan of starting by a detailed description of the mechanism, and finishing with a statement of what it does, might also be modified or reversed with advantage. It gives one the feeling of marching with a guide who points out a series of landmarks with no indication of what they lead up to. Nevertheless, the careful reader will reach the destination of comprehension, and perhaps that is in itself sufficient praise for such a highly technical descriptive work. The diagrams are for the most part clear and intelligible. Fig. 37 requires lettering to distinguish the "correcting" and "corrected" stations. The half-tone blocks of the Hughes instrument and repeater should be replaced by better specimens.

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LIVERPOOL CORPORATION TRAMWAYS ACCOUNTS

THE seventh annual report of the Traffic Manager of the Liverpool Corporation Tramways for the year ended December 31st, 1907, has just been issued. An analysis of last year's report was given in ELECTRICAL ENGINEERING, Vol. I., p. 585. There has been no extension of track during the year, the length of track operated remaining at 104 miles. A few new routes have been arranged, and two extensions are proposed. Full particulars of the routes, services, and fares, together with a map of the system, are given. During the year there were 37 fatal accidents caused by vehicles in the city, of which 10 were tramway accidents. The plough lifeguard with which the cars are fitted has pushed 27 people who had fallen in front of the cars, or had been knocked down, clear of the metals without any serious injuries. The ratio of fatalities to passengers carried amounted to 1 in 12,404,324, as against 1 in 30,523,632 in 1906. The total number of cars in stock at the end of 1907 was 515, of which 402 were double-deck cars with top canopies, and 86 were double-deck cars without top canopies, the remaining 27 being single-deck cars. On an ordinary day 398 cars are in service. The improved sanding apparatus, described in full in ELECTRICAL ENGINEERING, Vol. I., p. 585, and which was designed by Mr. C. W. Mallins, the Traffic Manager, has proved so satisfactory that it is to be fitted to all the cars. The following figures for the last three years show the increase in traffic on the system, which comprises 104 miles of track:—

	1905.	1906.	1907.
Passengers carried ...	119,123,644	122,094,528	124,043,239
Car mileage	12,067,033	12,115,934	12,231,799
Traffic receipts ...	£550,084	£563,777	£572,822

Thus the increase in the number of passengers carried for the year 1907 over 1906 was 1,948,711, or 1·59 per cent. The increase in receipts was 1·6 per cent., and the increase in mileage 0·95 per cent. The average earnings per car-mile for 1907 amounted to 11·24d., as against 11·17d. for 1906, or an increase of 0·07d. per car-mile. The density of the traffic is still increasing. In the busy season of 1906, 5,967 cars arrived at and left the Pierhead on the different routes per day. The figure in 1907 was 6,075 cars per day, and the number of cars passing the Town Hall was 3,712 per day.

The table in the opposite column is an analysis of the cost of working entirely under electric traction for the years 1906 and 1907, reduced to pence per car-mile.

The working expenses analysed in this table amounted to £398,734, and the receipts from all sources were £598,366, of which £572,822 was traffic receipts as given above, and £7,389 was by advertising. Of the balance of £199,632, interest and sinking fund absorbed £110,361, and £5,891 was paid as rental of leased lines, leaving a final excess of income over expenditure of £83,380. Of this £27,793 was contributed towards the rates, and £55,587 was carried to reserve, renewal, and depreciation account.

The average length of a penny stage was the same as for the previous year, namely, 2 miles 699 yards, and the average fare per passenger was also the same, or 1·108d.

The total capital expenditure up to December 31st, 1907, including the purchase price of the horse undertaking amounted to £1,913,189, of which £11,378 was spent during the year under review. Of this sum of £11,378, over £10,000 represents the cost of new cars and their electrical equipment. A table, showing how the capital expenditure up to December 31st, 1906, was made up, was given in the article to which reference has already been made.

ANALYSIS OF EXPENSES PER CAR MILE

	Year ended Dec. 31st, 1906.	Year ended Dec. 31st, 1907.
Traffic expenses—	d.	d.
Superintendence	·090	·098
Wages of motormen and conductors ...	1·938	1·973
Wages of other traffic employees ...	·322	·322
Cleaning and oiling cars	·261	·265
Cleaning, salting, and sanding track ...	·033	·035
Fuel, light, and water for car depots, cash offices, and waiting rooms, including cleaning	·041	·041
Ticket check, including wages of inspectors and clerks	·126	·135
Uniforms, badges, bags, and belts ...	·078	·058
Lighting routes	·003	·003
Miscellaneous	·053	·050
	2·945	2·980
General repairs and maintenance—		
Permanent way	·636	·624
Electrical equipment of line	·123	·152
Buildings and fixtures	·050	·031
Workshop tools and sundry plant ...	·013	·011
Cars	·807	·825
Other rolling stock	·002	—
Miscellaneous equipment	—	·001
	1·631	1·644
Power expenses—Cost of current... ...	1·980	2·109
General expenses—including rates and taxes, management charges, compensation and law charges, &c. ...	1·079	1·090
Total working expenses (not including capital charges) ...	**7·635**	**7·823**
Rent of leased lines	·116	·116
Interest and sinking fund	2·171	2·165
Total expenses (including capital charges)	**9·922**	**10·104**
CAR MILE EARNINGS	11·17	11·24

Wireless Telegraphy.—It is reported that the Canadian Government proposes to establish a wireless or cable telegraph service between Prince Rupert and Queen Charlotte Islands and between various larger islands.

Electricity in Brazil.—In a report upon the mining industry in the State of Minas Geraes, Brazil, by Mr. G. Campbell, H.M. Vice-Consul at Rio de Janeiro, the following paragraph appears under the heading "Electricity": "Fortunately, there are abundant supplies of water, which are being used for working the mines and for lighting towns. There is a great future for electricity in the country, and it is already developed to a considerable extent. Small towns of 4,000 inhabitants have electric light, and some have trams. It is true that at present it is impossible to read a book by the light, but that will be improved. Add to this that there are numbers of small factories whose existence must depend on economy, that butter and cheese are made in large quantities, and that Brazil is ambitious to become a manufacturing country, and there should be many opportunities for electrical engineers." The report later states that a firm of electricians might be able to obtain some small orders, and could use this opportunity to study the country and the abundant water supply with a view to eventually installing a plant for smelting purposes.

The Iron and Steel Institute.—The annual meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 14th and 15th, at the Institution of Civil Engineers, and its annual dinner will be held on the first of these days. Accompanying the programme of the meeting is a description of the new premises into which the Institute are moving, consisting of a suite of 10 rooms, formerly occupied by Sir Douglas Fox & Partners at No. 28 Victoria Street. Although in the same building as the Institute's former quarters, the accommodation afforded is much increased. Amongst the Papers which are expected to be discussed is one on an experimental electric furnace for the smelting of iron, by Prof. B. Igewsky (Kiev), and a Paper by Mr J. W. Lambert on the pyrometric installation of the Ordnance Factories, Woolwich. It is announced that the autumn meeting of the Institute will be held at Middlesbrough, and that an invitation to members to accompany an excursion of the Canadian Mining Institute in September has been received. It is proposed to visit the mineral areas of Eastern Canada, including the silver-cobalt ore region, the nickel and iron mines of Ontario, the asbestos and chromite regions of Quebec and other districts.

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BIRMINGHAM EXHIBITION OF ARTS AND INDUSTRIES

We announced in our issue of March 26th the opening of an Exhibition of Arts and Industries by the Lord Mayor of Birmingham in the Bingley Hall, the proceeds of which are to be devoted to the building of a convalescent home under the auspices of the Hospital Saturday fund. As is usual in exhibitions of this nature, there is a considerable section entirely devoted to engineering.

The first exhibit to attract our attention was a 60-B.H.P. suction gas plant made by T. H. & J. Daniels, Ltd., Stroud, Glos., which generates gas for driving an adjacent 63-B.H.P. vertical high-speed gas engine by Messrs. E. S. Hindley & Sons, Bourton, Dorset. The engine is coupled direct by a solid bolted coupling to a direct-current generator mounted on an extension bed-plate, the speed of the combined set being 500 revolutions per minute. Forced lubrication is used; the engine has three cylinders, and magneto ignition gear is employed, the timing of the spark being adjustable whilst the engine is running, either on the three cylinders simultaneously, or on each cylinder separately. The governing is effected by throttling the gas supply, and consequently each cylinder makes an explosion in every cycle. The Daniel gas plant above mentioned also supplies gas for a 12-B.H.P. "Dudbridge" gas engine, the plant being capable of running this small engine on light load alone, thus proving that suction plants can work at loads far below their normal rated capacity, a fact which the performances of many plants have gone to deny.

The 60-h.p. producer and engine are daily supplying current for the exhibition at a cost, we were informed, of 1/10d. per B.H.P., including water and anthracite coal at 33s. 6d. per ton. The National Gas Engine Co. are exhibiting three of their engines; one of these, of 6·5 B.H.P., is supplied with gas from a suction producer of their own design, and provides light for company's stand at a cost stated by the makers to be 1/5d. per B.O.T. unit. This engine is of the horizontal type, with massive flywheel, and the dynamo, which is direct-coupled to the engine crankshaft, is carried on an extension bed-plate.

Several motors, switchboards, and measuring instruments of various types are shown by the Walsall Electrical Co., Ltd., who are the official electrical engineers and contractors to the exhibition. Messrs. Mawdsleys, Ltd., of Dursley, Glos., are showing a number of their motors, dynamos, and electrically-driven machines; it is one of the dynamos made by this firm which is driven by the Hindley gas engine above mentioned. Several machines for the removal of iron from brass and other metal are exhibited by Messrs. The Rapid Magnetting Machine Co., Ltd., of the Crescent, Birmingham. One useful machine on view was for the removal of iron from destructor furnace slag and other heavy material. Their standard type of machine separates iron from brass and other metal turnings. The only representatives of the makers of electrical fittings are Messrs. Best & Lloyd, of Handsworth, Birmingham, who display a number of pendants and wall-brackets in a variety of styles and finishes, prominent among these being the well-known "Surprise" pendant.

The University of Birmingham have a stand at which are to be seen the Hoho welding process, bridge megger, arc and mercury vapour lamps, and samples of insulators and accumulator plates. A choking coil, recently built at the University for experimental investigations, was also a feature of this stand. The City of Birmingham Electric Supply Department occupy a very prominent position and attract a large amount of attention. The exhibit is intended to interest prospective consumers, and a feature of the stand is the inquiry office, at which, according to the placards, information and advice can be obtained in connection with any application of electricity. There is a display of metallic filament lamps (Osram and tantalum), the efficiency of which is demonstrated by measuring instruments, and a number of flame arc lamps are also to be seen. Various motors, some driving machines and tools, are shown in operation. Heating devices of both the convector and radiator types are largely in evidence, and there are also some electric ovens and other cooking apparatus.

Accounts of the North Metropolitan Electric Power Supply Co.—A slight error occurred in the arrangement of the figures of the analysis of the revenue account of this company on p. 586 of our last issue. The figures 0·066 pence per unit and the corresponding total £3,075 should stand for the total distributing costs, and the total works costs should be £29,678, or 0·637 pence per unit. The error does not affect the final total of £40,252, or 0·865 pence per unit.

American Protest Against the Revocation Clause in the New British Patents Act.—It appears that considerable exception has been taken in the United States against the clause in the new Patents Act under which any person may apply for revocation of a patent on the ground that the manufacturer of the patented article is carried on exclusively or mainly outside the United Kingdom. No similar clause exists in the United States, although in some European countries a similar protective condition is in force. It is reported, however, that negotiations are on foot for "a conventional arrangement" between the Governments of Great Britain and the United States, "by which the lapse of a patent for non-working may be reciprocally waived."

AN AMERICAN DESIGN OF ELECTRIC LIFT

In a recent issue of the *Western Electrician* (Chicago), a description is given of the electric elevators installed in the Board of Trade Building in that city. The requirements of the service in this building are very severe, in that the traffic is not only heavy throughout business hours, but exceptionally so while the Exchange is in session, for large numbers of brokers have to be carried with the utmost speed from the Exchange floor to their respective offices. When the building was constructed in 1883, four hydraulic elevators, operating at a speed of 500 ft. per minute, were installed. These machines were replaced in 1887 by electric elevators of the screw type, and an additional electric elevator of the drum type was installed to run from the main to the Exchange floor only. A fifth electric elevator of the Mabbs type was installed in 1902, and in 1906 the older screw-type elevators were also replaced by elevators of the Mabbs type.

The principle of the Mabbs elevator is that the operating motor constitutes the counter-balance of the car, and works up and down a rack. The cable and sheave rigging is arranged so that the motor is geared two to one; *i.e.*, when the driving motor runs up half the height of the building, the car is lowered from top to bottom, and *vice versa*. The cables attached to the car run over a sheave in the space over the elevator-shaft, then down again and around a sheave at the top of an A-frame fixed to the driving motor, and are fastened to a girder about midway of the height of the building. The driving motor has a vertical shaft, and drives two worm wheels on horizontal shafts on either side of the motor. On each end of each of these shafts is a pinion. These engage the four racks mounted on the faces of the vertical cast-iron columns at each corner of the motor-shafts. Thus, when power is supplied to the motor, it climbs up or down the motor shaft, moving the car respectively down or up the elevator-shaft. The two shafts need not be close together; in this particular installation the two shafts are separated by 35 ft. in one instance. The conductors supplying the current to the motor are arranged on porcelain blocks mounted on the inner face of one of the cast-iron columns. The contact-brushes, of which there are eight per motor, have each a contact surface of over one square inch, and are mounted on self-adjusting holders.

The motor is entirely controlled through the field circuits. The field system consists of four poles on which are three distinct windings, a light series field winding, used only in starting, the main shunt field winding, which is always connected while the motor is running, and an auxiliary shunt winding which is gradually cut out during accelerating. With the main shunt field winding alone excited, the maximum speed of the armature is obtained, which is somewhat over 1,000 revs. per min. The motor is enclosed, and the gearing below is entirely enclosed in a case, which is filled with oil to nearly the centre of the horizontal shafts. The oil does not have to be replaced more often than once in every two and a half years. The pinions and racks, which are lubricated with grease, make less noise in operation than the motor. All the gearing is machine cut, and is of steel, with the exception of the worm wheels, which have phosphor-bronze rims. The wear on the rims has been insignificant.

Below the sheave mounted over the motor is a slack-cable device which trips the main circuit-breaker immediately any cable is loosened. Below this device and on top of the vertical shaft of the motor is the automatic friction brake, which consists of a pulley and brake-shoes applied by the action of a spring. When the machine is running, these shoes are held out of contact with the brake pulley by solenoids; consequently, directly the current is cut off by the operator or by the action of the circuit-breaker, this friction brake is automatically applied.

At the top and bottom of the elevator-shaft are placed powerful pneumatic buffers. The control of the elevator motor is effected entirely by electromagnetic switches, which are interconnected to give a definite sequence of action with rapid and smooth acceleration and retardation of the car. Speed control is through adjustment of the auxiliary shunt field. In stopping the machine, current is cut off from the armature, and the latter is short-circuited through a bank of resistances, thus obtaining a considerable braking effect.

Automatic stops are placed at the upper and lower limits of travel of the machine, which slow down the motor and cut off the current in case of negligence of the operator. The worm gearing is a preventive against the car starting to move without the application of motive power. The cars are six square feet inside, and the height of travel is about 130 ft. The motors have an average energy consumption of 3·5 kw. hours per car-mile. The running speed is about 550 to 600 ft. per minute.

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ELECTRICALLY-DRIVEN REVERSING ROLLING MILLS

MR. HENRY CROWE read a Paper on April 6th before the Cleveland Institute of Engineers on the above subject. He said that in these days of keen competition possibilities of any reduction in the cost of the manufacture of iron and steel were of great importance. He did not propose to describe electrically-driven three high or other continuous-running mills, but remarked that when a works possess their own power station, or can purchase electricity cheaply enough, there could be no doubt of the many advantages of this system.

He then showed a diagram of the main electrical connections of a reversing mill equipment of the well-known Ilgner system. The current from the power station passes an isolating switch and a three-pole oil switch fitted with an overload release, and the amount of current and its potential is recorded by the usual ampere, volt, watt, and watt-hour meters. The current then passes through a transformer, which operates the slip resistance motor, and on to the induction motor, direct coupled to the continuous-current generator and the flywheel of the Ilgner set.

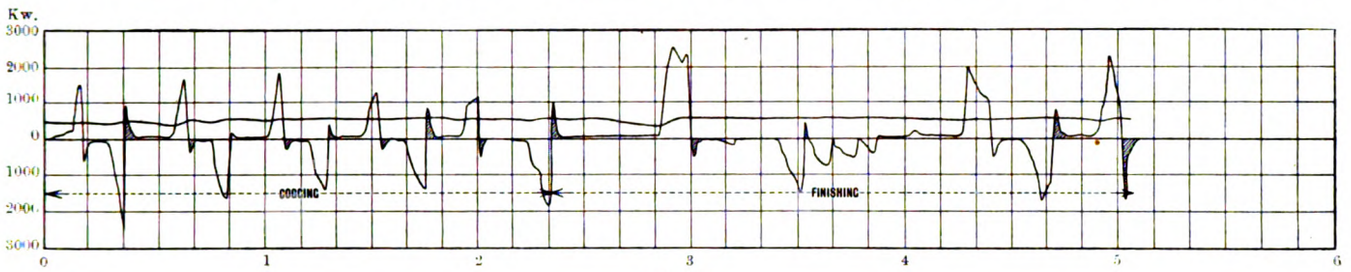
The brushes of the reversing mill motor are directly coupled to the brushes of the generator of the Ilgner converter set. The armatures of the generator and the mill motor are protected against excessive currents by the automatic circuit breaker, and these machines are further protected by a no-voltage release in connection with the fields of the mill motor.

The current required for exciting the field magnets of the mill generator and the reversing mill motor is obtained from a special motor-driven exciter set.

In starting up, the Ilgner converter set and the exciter set are run up to speed. The field magnets of the mill motor are generally fully excited, and the polarity of these magnets is never changed; but this is not so with respect to the magnets of the generator. When the controlling lever is in mid-position there is no current passing round the field magnets of the generator, consequently no current generated and therefore the mill motor is stationary. On moving the controlling lever in one direction the fields are excited and the mill turns at a speed and in the direction of rotation corresponding to the position of the controlling lever which regulates the amount of current passing round the fields and the direction of that current. It is convenient to be able to run the mill at a greater number of revolutions than that corresponding to the maximum torque, and this is effected by the operator pulling the controlling lever still further over, which puts a resistance in series with the mill motor fields, reducing the density of the fields and so increasing the speed of the mill with a corresponding decrease in torque.

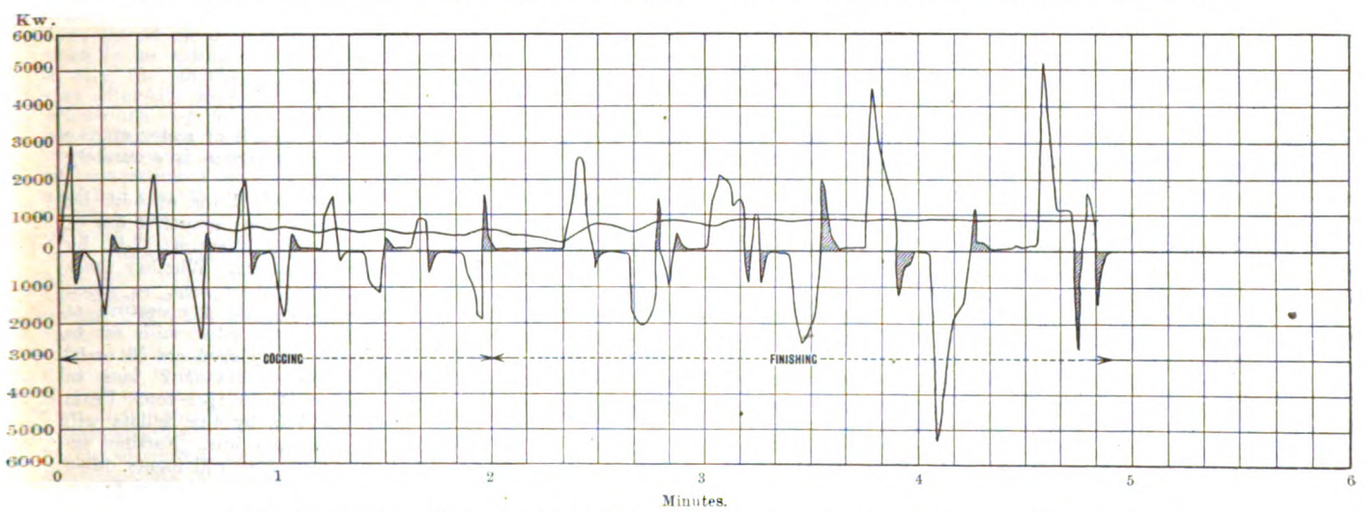
In large rolling mills the power required may vary from 0 to 10 or even 15,000 h.p. in either direction, but these great powers are not required for long periods, and to attempt to drive a mill of such powers without the aid of some system which would average up the power would be practically impossible, such great fluctuating loads would have disturbing effects on any power station, and the cost of the power station would be prohibitive had it to be made large enough to provide for the heaviest loads. By the use of heavy fly-wheels running at high speeds a great amount of energy can be stored up and readily given out again.

The method of slowing down the speed of the fly-wheel can be done in direct-current motors by suitably compounding the fields, and in an induction motor by inserting resistance in the rotor winding by what is known as the automatic.



Elongation 14·6 times. Average power put into rolls, 338 kw. for 310 seconds. Power put into converter 488 kw. or 48 units=29 units per ton rolled. Efficiency 69 per cent.

FIG. 1.—POWER CURVES FOR $15\frac{3}{4}'' \times 15\frac{3}{4}''$ INGOT. 1·45 TONS ROLLED IN 15 PASSES INTO 4″ × 4″ BILLETS.



Elongation 63 times. Total units put into mill, 44·96. Total units put into converter, 60·8. =45 units per ton.

FIG. 2.—POWER CURVES FOR $15\frac{3}{4}'' \times 15\frac{3}{4}''$ 1·35-TON INGOT ROLLED IN 17 PASSES INTO 2″ × 2″ BILLETS.

In one form of this, the resistance consists of metal plates suspended in earthenware tanks containing water; the position of these plates, which is controlled by the "slip motor," regulates the amount of the resistance. Should the current from the mains increase, the current to the slip motor, which is supplied from a series transformer, also increases, with the result that the resistance plates are lifted, thereby adding resistance to the rotor of the induction motor driving the converter set, and thus reducing the speed of the motor and allowing the fly-wheel to give up the requisite amount of energy to pull the piece through the rolls. On the load decreasing, the current to

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the slip regulating motor also decreases, its torque therefore diminishes and the resistance plates fall, reducing the resistance in the rotor of the induction motor, which therefore increases its speed, and the energy which was taken out of the fly-wheel is now restored. This slip-regulating resistance is also used as a starter for starting up the Ilgner converter set. After the stator switch has been thrown in, the resistance of the rotor is gradually cut out by the lowering of the resistance plates by means of a hand-wheel. The liquid forming the resistance is kept cool by means of a series of cooling pipes placed in the tank, through which a continuous stream of cold water is circulated.

Special precautions have to be taken to make the generator and the mill motor run sparklessly with the brushes in one fixed position. In addition to the ordinary exciter, the installation at Teschen is provided with a second exciter generator, whose field current is that of the main current driving the mill motor; its voltage therefore corresponds to the load on the mill. The current generated by this special exciter supplies special windings on the mill motor and generator. The mill motor fields are further strengthened, this device has the effect of preventing excessive rushes of current, and prevents the circuit breaker from flying out should there be any careless handling of the controller.

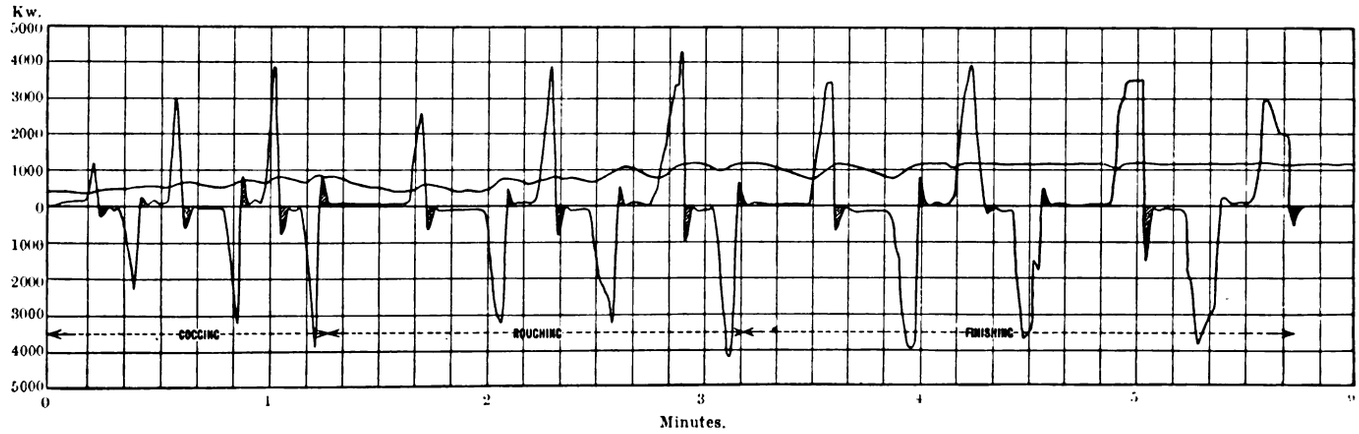
It might be supposed that the power required to make the mill motor and rolls reverse rapidly and frequently is a very considerable loss, but in this system of control the power given out by the coming to rest of the mill motor and rolls can be given back to the fly-wheel. The control lever is moved in such a position that the back electro-motive force in the mill motor is greater than that of the generator of the converter set. The mill motor thus becomes a generator and the converter generator a motor, so that the mill receives a heavy braking current and at the same time the power used in stopping the mill is not wasted, but is partly restored to the fly-wheel set.

The author then referred at some length to the advantages of steam engines possessed by the electric motor for rolling mill work in the way of uniformity of torque.

An important advantage of the even torque of the electric drive is that there is less likelihood of breakage of boxes, spindles, and wobblers of rolls. Yet another advantage is the fact that when the piece bites the rolls the mill does not appreciably slow down, as instantly the mill motor tends to slow down extra current flows through the armature owing to the reduced back electromotive force, so that the mill motor exerts automatically the requisite torque to pull the piece through the rolls. Therefore the mill will not stall, but will pull anything through up to the maximum power for which the circuit breakers are adjusted. For the same reason the mill will not appreciably race when the piece is through the rolls, although the driver will naturally use the inertia of the mill to perform the rolling of the tail end of the bar, and for this reason electrically-driven mills run exceedingly smoothly and quietly. With regard to the question of acceleration, there is no doubt that the steam engine with the small inertia of its moving parts can reverse and accelerate much more rapidly than any large reversing mill motor that has yet been put to work. But this is a question of putting plenty of power into the motor and of keeping the diameter and weight of the armature down. At the same time it is not always wise to reverse a mill too quickly; for example, when there are three or four stands of rolls coupled together, to reverse such a mill too quickly is not wise, as it only tends to break boxes and spindles, and there is no object gained in reversing a mill in less time than it takes to get the piece back to the rolls. Whether the electric motor will reverse quickly enough to suit very rapid reversing, such as is required for the soft rolls of a plate mill where the slab is very short and the reversals very rapid, has not yet, I think, been tried, but it must be remembered that when the slab is very short the speed of the rolls is low, and this being so rapid reversing is not so difficult as would appear at first sight.

Figs. 1, 2, and 3 are reproduced from records showing the current or power put into the rolling mill motor, also the power required from the power station to roll a 1·45-ton ingot into 4 in. by 4 in. blooms, a 1·35-ton ingot into 2 in. by 2 in. billets, and a 1·8-ton ingot 11 in. by 6 in. girders respectively.

From these diagrams it will be seen how very perfectly the fly-wheel converter averages up the great varying loads on the mill. In rolling 4-in. by 4-in. blooms it will be seen that the greatest load on the mill is some 2,500 kw., while the current taken from the power station is steady at about 600 kw. In rolling down to 2-in. by 2-in. billets it is interesting to see how very much more power is required to reduce the section down to 2 in. by 2 in. as compared with 4 in. by 4 in., the 2-in. by 2-in. billets taking some 60 per cent. more power than the 4 in. by 4 in. The third diagram represents the rolling of 11-in. by 6-in. girders, the power in the mill motor rising as high as 4,000 kw., while the current taken from the power house is represented by about 700 kw. rising to 1,200 kw. while in the finishing rolls. Now that the recording of the actual power required to pull the bar through each pass is so easily and perfectly recorded, any uneven drafting of the rolls will be more easily corrected. The total power used by the rolling mill is accurately recorded by a watt-hour meter on the switch board, and the cost of providing power is accurately known for every section rolled per ton.



Units in mill motor, 69. Units from power house, 94. Efficiency, 73·5 per cent. Units per ton rolled, 52.

FIG. 3.—POWER CURVES FOR 17″ × 18″ INGOT ROLLED IN 19 PASSES INTO 11″ × 6″ JOISTS.

It would appear, then, that to roll, first, 1 ton of 4-in. by 4-in. billets requires 25·4 kw. or 430 lb. steam; second, 1 ton of 2-in. by 2-in. billets requires 38 kw. or 650 lb. steam; 11-in. by 6-in. girders requires 50 kw. or 860 lb. steam. Whether these figures will be improved upon remains to be seen, so much depends on the hardness of the steel and the temperature at which the rolling is carried on. One of the latest mills set to work is the mill at Rombach, which already produces 50 to 60 tons of 3¼-in. square billets direct from ingots of 2 tons in weight, with a current consumption of 22 kw. per ton. From these figures it is to be expected that 4-in. by 4-in. billets will be produced for 20 kw. per ton, or even less. Further interesting data relating to the kws. required to roll ingots down direct into rails, joists, billets, is published in *Stahl and Eisen*, from which it will be seen that to roll

53lb. rails	from	1·4	ingots	70 kw.	are required.
72lb. ,,	,,	1·5	,,	60 ,,	,,
41lb. joists	,,	1·8	,,	56 ,,	,,
86lb. ,,	,,	1·85	,,	53 ,,	,,
4″ & 4″ billets		1·45	,,	29 ,,	,,
2″ & 2″ ,,		1·35	,,	52 ,,	,,

The average production when these figures were taken varies between 12 and 18 tons per hour. It will be seen that the output is very small, the rolling being carried on too slowly to give good results in current consumption. 29 kw. is given for 1 ton of 4-in. by 4-in. billets at the rate of 17 tons per hour, when only 14 tons per hour were rolled in the same mill the current consumption rose to 33 kw. per ton. Whereas at Rom-

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bach, with 50 to 60 tons per hour of 3¼-in. billets, the current consumption is much more favourable at 22 kw. Whether the electric mill is rolling much or little, the Ilgner converter set is running all the time, and this absorbs about 120 kw.

The disadvantages of the electrical reversing mill are the high capital expenditure, and the electrical losses between the motor driving the fly-wheel converter and the mill motor. There appears to be no inducement to any firm who have to produce their electricity by burning coal directly under boilers to instal a special power station to drive a mill, or even two mills, say a cogging mill and finishing mill, supposing there was a saving in the coal bill, the capital outlay required for the electrical plant would probably counterbalance any possible saving in the coal bill. The great advantage of electrical rolling, in fact the greatest advantage of all, is that the generation of all the power required, for the whole works, is in one large central station.

That electrically-driven mills have made more rapid progress in Germany than in England is partly accounted for by the fact that coal is dearer in Germany than in England. And also that the rolling mills work in conjunction with blast furnaces which produce large quantities of electricity very cheaply with the aid of the gas engine, and without cheap electricity electrically-driven mills will make no headway. It cannot, of course, be said that which pays well in Germany would necessarily also pay well in England, neither can it be said that electrically-driven mills are right for every works, each works must consider their own conditions.

The new mill at Rombach, equipped by the A.E.G. of Berlin, consists of two stands of rolls 32 in. diameter. The two mill motors are capable of exerting 15,000 h.p. at 120 to 160 revolutions. The voltage of each motor is about 600, and the torque is 90 metre tons. The Ilgner converter is drawn by a motor of 2,800 h.p. Four fly-wheels of 25 tons each, making 300 revolutions per minute, are used to equalise the loads. The mill is designed for an output of 60 to 70 tons per hour.

THE MANAGEMENT OF ENGINEERING WORKSHOPS

Manchester Discussion

THE Paper by Mr. Eustace Thomas, which was read before the Manchester Local Section of the Institution of Electrical Engineers last week, and was given in abstract in our last issue (page 580), was followed by an interesting discussion. The Paper itself dealt with some of the general principles by which economy may be obtained in manufacturing works, especially as regards shop routine, lists of materials, drawings, records, &c., and the day work as compared with the piece work or premium system.

In declaring the discussion open, the chairman, Mr. M. B. Field, said a few words emphasising the importance of the subject, which he thought had not been treated of by the Institution before.

Mr. Gunther said, in reference to the comparison of general and specialised shops, he thought that a general shop, that is, not taking every class of work, could be run quite as efficiently in its way as shops which are highly specialised, such as those dealing with small electrical appliances, and so well known that the efficiency comes out really very fine indeed. As to each workman having a drawing or sketch, that goes without saying. In all well organised places he agreed that the drawings should be of as complete a character as possible, fully dimensioned, and wherever possible, if it is a job likely to be repeated, the drawings should carry all leading particulars. He did not quite see that in an ordinary works a routine book was necessary. As a rule, the job that a man had given to him was not the same day after day except in a place making one class of work; but where one man had to do each day the same class of work, or extending same over several days, no doubt a routine book would be very advisable. His firm had considered the question of numeration of tools, drawings, and stock pieces very carefully, and had come to the conclusion that the best thing was to sweep all that away, and to commence with the drawing. Inspection of work at each stage, in the case of stock orders, was often a very difficult matter to arrange. He was afraid that premium and piece work were going out in engineering works. When non-union and unskilled labour was being dealt with it was easier, but when dealing with unions it was rather too big a task.

Mr. H. Bevis (General Electric Co.) thought that the value of a good foreman could not be over-estimated. A good deal of the efficiency of a shop depends upon the foremen, and he thought that they should be employed more exclusively on clerical and administrative work. It was quite a mistake to give them the technical work to do; this should be rather for the tool-shop or drawing-office, and it should be the foreman's chief aim to finish and produce the work under the conditions mentioned in the Paper. He believed that statistics were most valuable, and paid for themselves over and over again if they were utilised properly. Coming to the question of auxiliary stores, he thought that it was an essential thing to have what they called sub or auxiliary stores. The main stores should keep raw material and everything that was common to several departments. The sub-stores should contain only material that was common to the department in which it is used. To obviate the possibility of material not being in the main or sub-stores when required, he believed in having assembly rooms. The whole of the parts were assembled, and the job was never put out to the bench until they had got the whole of the parts. He did not agree with the remark in the Paper: "If the assemblers are on piece or premium work they draw attention themselves to any inaccurate manufacture of parts coming to them." This was, no doubt, some check, but where they were making quantities of stuff, he thought it was then rather too late. The time that they should be checked up was when it was being manufactured in the early stages. If they were only going to send it back when it was found not to fit, it was too late to save the loss.

Mr. Eckstein (Messrs. Eckstein, Heap & Co.) did not believe in making a works rely absolutely upon red tape. As regards the auxiliary stores, he did not quite see what would happen when a job was stopped, and the material had to be returned to the main stores. His idea of an auxiliary store was a place provided in absolute vicinity of the bench, where the workman had a certain amount of material to see definite orders through, but any such auxiliary stores must not be allowed to develop into a number of general stores.

Mr. H. W. Wilson doubted that a certain amount of red tape was desired or necessary; his experience was that red tape accumulated until it became not only unnecessary but undesirable, and several cases had come under his own personal notice where this red-tapeism had caused considerable loss, both of time and money. Systems, whilst very admirable things, could be carried to extremes, and the tendency of all systems, unless continually being checked, was to get too complicated to make a job profitable. It was better, in his opinion, to have a certain small amount of waste going on in small parts than to have the things checked and cross-checked until the cost of the clerical labour was more than the actual manual labour in making them. With regard to the check on times set, the primary object of a manufacturing business was to make a profit, and the two principal items were, broadly speaking, material and labour. Material no one could vary very greatly, but the item where an ingenious works manager had a chance of making a saving was on the labour if he could persuade in some way his men to manufacture a bit more than men in other works. It was thus most desirable to have an expert check on times set.

Dr. C. C. Garrard (Messrs. Ferranti, Ltd.) said that the most important thing about the management of any engineering works was the cost-keeping. The functions of the shop superintendent and foremen must be organised in correlation with the cost department. A proper system of cost-keeping should not only form a basis for estimating, but should serve as a method of management, and transform a merely qualitative works control to a definitely quantitative one. Every job or process should be actually priced in money terms before it is started, and the work controlled during process, so that at any instant the management can know what any process has cost up to that particular moment. Regarding the relative merits of the piecework and the premium bonus systems, he preferred the former. The great objection to the latter was that the workmen got the idea that they did not receive the whole benefit of their extra exertions.

Dr. Garrard then proceeded to outline the system of cost-keeping which he had introduced at the works of Messrs. Ferranti, Ltd. The previous system in use in the works in question had been the "Lewis" system, the foundation of which was the job card which each man received. On one side of the card was the space for the man's time, on the other for the material used. Thus the workman had to go to the stores to draw out material and get it entered on his card. This was, however, very unsatisfactory. Not only did the material for a certain order get divided up in a lot of job order numbers in an entirely fortuitous manner, but a lot of time was wasted by each individual man bothering about finding material. The proper principle was for each man to be supplied with material as fast as he required it, and without him shifting from his machine or bench to find it. It was one of the principle functions of the up-to-date foreman to see that this was done, so that the time lost in going from one job to another was reduced to a minimum. The system he had referred to was a modification of the Lewis system with additions. For every job which was not an absolutely standard article with a constant selling price, an estimate card was made out in the drawing office before the job was put in hand. It was the duty of the works management to

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see that the article manufactured came within the estimate. Each shop had its own stores, and the material required for every works order number was issued by the stores as requisitioned by the foreman. For standard articles, standard printed requisition sheets were used to avoid waste of time in writing. The material costs for each works order number were kept by the cost clerk who worked in the stores. All issues were entered on cards. Four different-coloured cards were used. These were for stock materials from the stores concerned, castings from the foundry, materials from other departments, and materials from the general stores. Every item went through the shop stores however, and the only object of dividing the cards in this manner was to facilitate departmental book-keeping. The total of the four cards gave the total material costs on any works order number. When the works order number was complete a summary card was made out and filed in the drawing office. This, together with the estimate card and the labour analysis card, were filed together in special drawers like a card index. As regards the labour, each works order number was divided up into a number of job order numbers corresponding to the different processes. Time-work cards or piecework cards were issued to the workmen for each job order number. When each job was finished the sheet was returned to the job clerk, who entered up the total time and cost in his time book. The labour costs were entered up on the job number card and summarised on the labour analysis card, a copy of which analysis was kept in the drawing office record as explained above. As regards stock order numbers, these were treated in exactly the same manner as the works order numbers, and the stock parts when completed went into the stores at the price they had actually cost, and were also debited out on the various works order numbers at the same price. As many similar articles as possible were put through on each works order number. As regards pricing stock parts, these were priced at the actual cost in labour, material, and testing, *plus* shop establishment charges. The shop establishment charges did not include general establishment charges, which remained, more or less, unaltered whatever the output. The shop establishment charges included all shop charges which varied with the output, such as general labouring, supervision, &c., and which were directly under the control of the shop management. These varied with the output, but not so fast as the output. They varied between 40 per cent. and 60 per cent. of the labour cost. All goods made were costed in this manner, and, as an inducement to the reduction of cost, a bonus was paid, based upon the difference between this shop cost and the selling price. In order to be able to control costs of standard articles he had found it a good plan to plot the costs in the form of curves.

Mr. Eustace Thomas replied briefly. With regard to the catalogue numbers, he still thought that the matter of catalogue numbers was rather an important one. They had found in doing a great deal of general work, and having to design special pieces for special apparatus, these were apt to get associated with a particular job, which was forgotten in a very short time. A new draughtsman coming in, and having no recollection of this job, would start and re-design this over and over again, and parts would get multiplied out of all reason. It was quite true, and it was very regrettable, that workmen as a whole had deteriorated very considerably in consequence of the system of manufacture adopted. It was often found that if one relied upon a workman to think out a matter, one was apt to get "left."

WIRELESS TELEGRAPH PLANT AT THE UNITED STATES NAVAL ACADEMY

An article in the *Electrical World*, by Lieut.-Com. W. H. G. Bullard, describes the wireless station at the United States Naval Academy, Annapolis, Maryland, which forms one of a chain of stations on the Atlantic Coast.

The station was established not as a transmitting station for long distance, but rather as a relay station to forward messages from other stations or from vessels. For this reason the power installed was small, the station set having only a rated capacity of 2·4 kilowatts. This power is obtained from a storage battery of 40 cells, giving a normal voltage of 80 volts. When occasion demands, this battery is charged from power obtained from the main power station supplying the Naval Academy with light and heat. The transmitting circuit contains the induction coil, condensers, inductance and spark gap of the Slaby-Arco type. Direct current from the storage battery is led to the primary of the induction coil, and the make-and-break is effected by means of a mercury turbine interrupter, making 1,600 revolutions per minute. With a line voltage of 80 volts, a maximum of about 25 amperes may be used in the primary windings. The condenser consists of seven leyden jars, connected in multiple with a total capacity of 0·014 microfarad. The inductance is a spiral conductor of No. 8 copper wire, consisting of 9·9 turns of a mean diameter of 17 in. The spark gap is a single break between zinc electrodes with a normal length of $\frac{3}{4}$ centimetre and a maximum length of $2\frac{1}{8}$ centimetres.

The receiving device now used is of the De Forest type of electrolytic cell used in connection with the head telephones of the Schmidt-Wilckes make. This cell uses a Wollaston wire, glass jacketed, and of 0·006 in. diameter, as the anode, and a platinum wire as the cathode, in a solution of pure nitric acid. In connection with this cell is used a primary battery, with potentiometer. Associated with the detector in the receiving circuit is a capacity 0·005 microfarad with a variable inductance of two coils of copper wire wound with 500 turns on each coil. The aerial is a loop of a total length of 1,054 ft., consisting of four wires of phosphor bronze. It has a horizontal length of 100 ft. and a vertical length of 166 ft. The aerial is coupled direct to the transmitter inductance and has a natural wave length of 335 metres. The wave length ordinarily used is 318 metres for the lower hump and 420 for the upper. With the coupled circuit for 425 metres, the lower hump is 348 metres and the upper hump is 500 metres.

In the Department of Electrical Engineering at the Naval Academy, and entirely distinct from the working station described above, is installed a 5-kw. Stone wireless telegraph plant. This is used for the sole purpose of demonstration and for the instruction of midshipmen in their electrical course. The power is obtained from the Academy power plant, direct current of 110 volts being converted by means of a motor generator into an alternating current of the same voltage.

The distinguishing features of the Stone set are the multiple arrangement of the transmitting inductance, the series key for making signals, the spark gap and the "weeding-out" circuit of the receiver. The set is inductively coupled to the aerial, and consists of four coils in parallel for the primary, connected inductively as an air transformer to four coils in parallel in the secondary. One terminal of each secondary coil is connected to the aerial through a loading coil, and the other to ground. With the high frequency of the alternating current - 120 cycles per second—and the large inductance, this is necessary to produce the short wave-length desired. In this system, the circuit is made and broken to produce the proper signals on the high-potential side of the induction coil. This obviates breaking the heavy current of the primary and the consequent arcing and burning of the key contacts. The high-potential side is made and broken in both leads of the mains by a line of contacts in series. These contacts are actuated by small electromagnets, wired in series with the low-potential current of 110 volts. Inserted in this circuit is a resistance to reduce the current through the electromagnets to about one ampere. The key that operates the series keys is on the operator's table, and is a simple telegraph key whose terminals are connected to a small condenser. Making and breaking this auxiliary current has the effect of making and breaking the line on the high-potential side of the induction coil. The spark gap consists of a series of parallel brass rods through which the spark occurs, and it can be regulated by a rod on one terminal which slides over them, cutting out more or less of the rods. To remove the metallic vapour formed at the spark, a strong blast of air is blown over it from an auxiliary blower. The receiving circuit contains the usual inductance and capacities, and normally consists of three circuits, all inductively connected. The third circuit contains the electrolytic detector and head telephones. The middle circuit is termed the "weeding-out" circuit, and is used when sharp tuning is necessary to cut out interference. All the capacities are of the variable sliding type, and the primary inductance of the sliding bare wire type. Arrangements are made for varying the mutual induction of all the circuits by moving one inductance in relation to the other in each circuit. The condenser is of the glass-plate tinfoil type, made up in four sections, one being connected to each of the four primary circuits of the oscillating transformer. Its dielectric is castor oil, which is used to reduce the violet discharge at the edges of the tinfoil on the glass plates.

In connection with the instruction of midshipmen, there is installed in the Department of Electrical Engineering another small wireless telegraphy plant of no particular make or system, but containing all the elements required for the proper sending and receiving of signals. The power is transformed from the Academy plant voltage to a lower voltage of continuous current by a small rotary transformer. This direct current is used with an ordinary induction coil with a hammer make-and-break; a battery of leyden jars forms the condenser, and a helix of copper wire the inductance. For receiving, a small incandescent lamp is used as a detector, the filament being removed and the interior filled with nitric acid introduced to cover the platinum points of the leading-in wires. This is used in connection with an ordinary telephone receiver.

A new wireless plant of 20-kw. capacity has been contracted for by the Bureau of Equipment, Navy Department, to be installed at the Naval Academy, which will make one more plant that can be utilised for instruction and demonstration purposes, and an installation of wireless telephones will shortly be made to aid in the general course of instruction.

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THE ELECTRICAL EQUIPMENT OF AN AMERICAN PAPER MILL

THE accompanying illustrations show the arrangement of American electric motors of direct-current and alternating-current types installed in the Watab Paper and Pulp Mill at Sartoll, on the Mississippi River.

Power is supplied by a hydro-electric station located near the centre of the river, adjoining the grinding-room. This latter contains a number of grinders operated directly by water power from special turbines, but all of the other power is electrically transmitted to the various electrically-driven machines in the different departments. The main mill building, which is of reinforced concrete, includes a machine-room and basement 72 × 250 ft., and a beater room and basement 40 × 122 ft., also a wood-room and basement 36 × 70 ft. There is also a boiler-house 58 × 72 ft., and a pulp mill 32 × 152 ft., as well as a pump-room 20 × 70 ft. The boiler-room contains two Stirling water-tube boilers which furnish steam for heating the building and for drying the paper. The power-house is 72 ft. long and 32 ft. wide, and the water is supplied by a dam 600 ft. long, thrown straight across the river, and affords a head of approximately 17 ft. The power-house and grinding-room form a part of the dam, and the remainder consists of gates and spillway of the ordinary rock filled crib construction.

The electric power generating installation includes three 600-kilowatt three-phase 60-cycle 480-volt alternating-current revolving field generators, each direct connected to a sextuplex water-wheel operating at a speed of 200 revolutions per minute. The exciting current for these generators is supplied from a 75-kilowatt 120-volt direct-current generator, coupled to a single water-wheel, or from a motor-driven exciter of the same capacity. There are two motor generator sets in use, each consisting of a 250-kilowatt 240-volt direct-current generator coupled to a 480-volt synchronous motor to supply current to the variable speed motors in the machine-room.

It is stated that the alternating system was adopted as being best suited to withstand the rigorous requirements of paper-mill work, and least liable to give trouble with motors when located in moist places. The current is distributed through a 13-panel switchboard, arranged with wattmeters and ammeters, so that an accurate log may be kept of the power required by each separate department. Thirteen feeder circuits carry current to 51 constant speed alternating-current induction motors, and to eight variable speed direct-current motors of the Allis-Chalmers' design and construction.

The variable speed shaft of each of the two 154-in. Beloit machines is driven by a 250-h.p. variable speed direct-current motor, coupled directly in the centre of the shaft. This motor operates at a speed of from 370 to 540 revolutions per minute, corresponding to a paper speed of from 300 to 600 ft. per minute. The entire speed variation is accomplished by means of resistance in the shunt field of the motor. The field rheostat has 138 steps, and a change of approximately 2 ft. per minute in paper speed is obtained for each step. This is a much finer variation than can be obtained easily through the medium of any mechanical speed-changing device; it must be borne in mind, too, that the changing of speed is accomplished without any loss of time, as the controller is located on the machine-room floor, adjacent to the drying rolls, and the movement of the controller handle by the attendant occupies little more than a second.

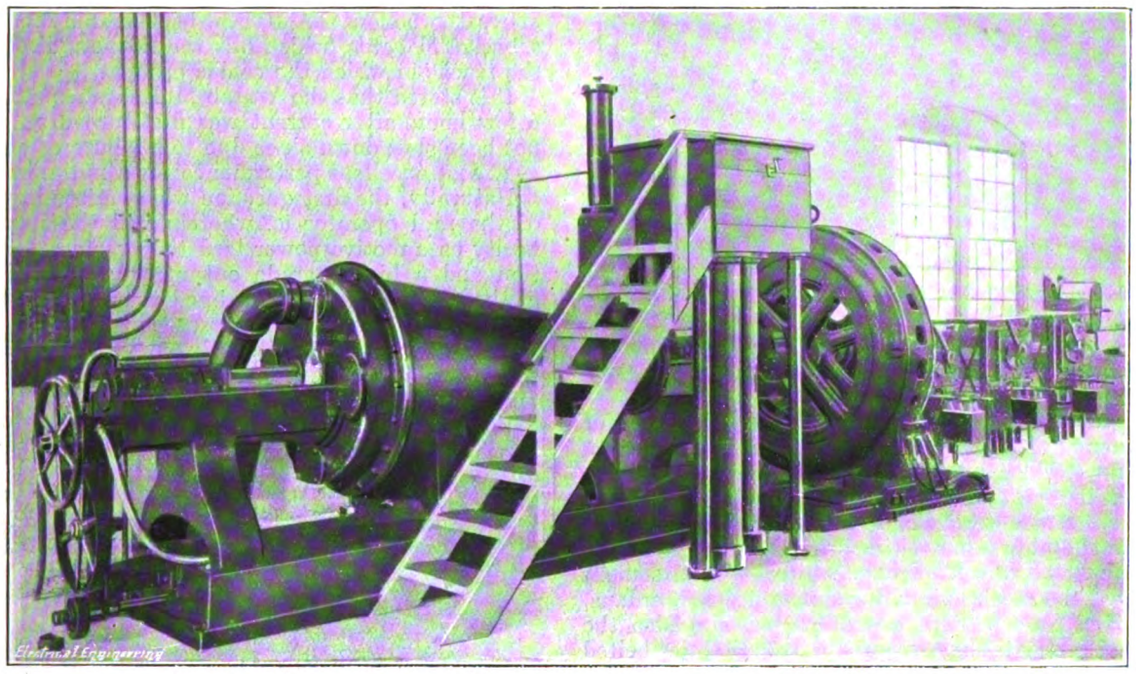


Fig. 1.—"Majestic Jordan" Machine, driven by 150 h.p. Induction Motor.

At the head of each machine the re-winder is driven by a variable speed 30-h.p. direct-current motor, having a speed range of 2 to 1. Two 7½-h.p. motors of the same type, with 25 per cent. speed variation, operate the shakes of the two machines. The only other direct-current motors in the mill are two of 5-h.p. capacity, with a speed range of 2 to 1, which drive special cutters located in the machine-room basement. At the wet end of each machine, in addition to the shake, the group consists of a save-all, driven by 5-h.p. back-geared induction motor, suction pump driven by 30-h.p. geared induction motor, fan pump with 40-h.p. direct-coupled motor, machine pump with 7½-h.p. geared motor, and machine chest agitator and flat screens driven by a 30-h.p. belted motor. To this group belong

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also the broke beater, driven by a 40-h.p. belted motor, and the broke beater pump, driven by a 40-h.p. direct-coupled motor. The beater-room is equipped with six beaters and two Majestic Jordan machines. The beaters are driven in pairs, one right and one left, by three 100-h.p. motors located in the basement. These motors have their shafts extended both ways with pulleys on either end; outboard bearings are also provided to ensure rigidity and freedom from belt slippage. Belts connect the motors directly with the beater pulleys.

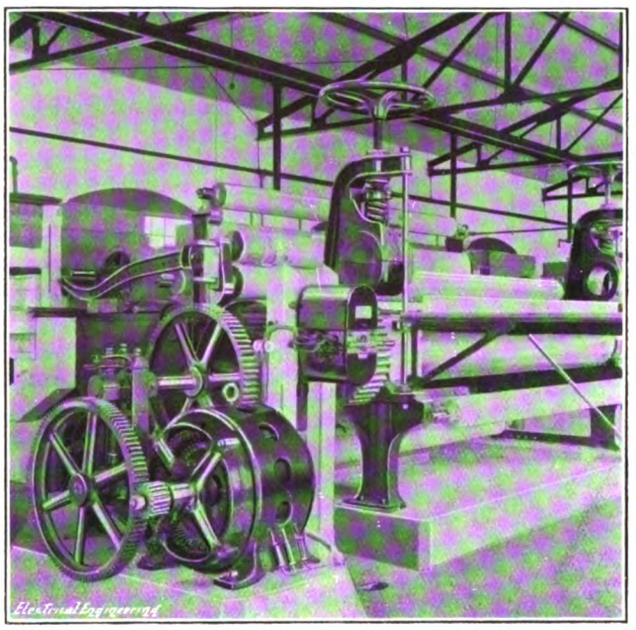


Fig. 2.—10 h.p. Motor backgeared to Wet Paper Machine.

A unique feature of the mill is the electric drive for the Jordans, each of which is directly coupled to a 150-h.p. motor, running at 312 revolutions per minute. As shown in Fig. 1, the base of the Jordan is extended to receive the motor, which is arranged to slide on rollers as the plug is moved in or out by means of the regulation hand wheel. In the beater-room basement are located the stock pumps for supplying the Jordans, each driven by a 7½-h.p. geared motor, and also the Jordan chest agitators driven by two 15 h.p. belted motors. The controllers for starting and stopping all motors governing the supply of pulp to the beaters and the Jordans are located on the beater-room floor, so as to facilitate rapid handling of stock.

The pumps controlling the water supply and those for handling the ground wood pulp are located in the pump-room, the entire water of the mill, outside of the boiler feed, is obtained through three 6-in. centrifugal pumps, each direct connected to a 40-h.p. motor. Two centrifugal pumps for pumping pulp from the grinders to the flat screens in the wet machine-rooms are located in a pit beneath the pump-room. Each of these is direct connected to a 50-h.p. motor. In this room are also the centrifugal Decker chest pump, direct coupled to a 40-h.p. motor, the triplex pressure pump for grinders driven by a 40-h.p. geared motor, the triplex back-off pressure pump driven by a 7½-h.p. geared motor, and the silver screen driven by a 5-h.p. back-geared motor.

The wet drives are located in the wet machine-room, also two Deckers and twelve flat screens. The wet machines are each driven by a 10-h.p. back-geared motor, as shown in Fig. 2. The flat screens, which are located immediately behind the wet machines, are shown in Fig. 3. They are driven through friction clutches connected to a line shaft by means of the mitre gear, this line shaft being direct coupled to a 100-h.p. motor. The Deckers are driven by belts from the wet machine shaft. A machine shop, adjacent to the wet machine-room, is driven by a 10-h.p. belted motor.

There are six barkers and a 60-in. log saw, with the necessary conveyor in the wood-room equipment. Some of these machines are shown in Fig. 4. The logs used for making pulp are taken from the river to the saw by a log haul, which is driven by a 5 h.p. back-geared motor. The saw and live rolls are direct coupled to a 30-h.p. motor, the coupling being of sufficient weight to act as a flywheel, and thus reduce the actual power required for sawing. The sawed wood is carried to the barkers by a conveyor driven by a 10-h.p. back-geared motor; this same motor also drives a splitter. Each of the barkers are driven by a 7½-h.p. direct-coupled motor, the iron base of the barker being cast with a pedestal to receive the motor. The prepared wood is carried to the grinding-room by a conveyor driven by another 10-h.p. back-geared motor. A shaving fan, driven by a 40-h.p. belted motor, blows the chips from the barkers directly on to the boiler grates. What additional coal fuel is required is carried in hoppers above the boilers. A 10-h.p. back-geared motor drives a basket elevator, which fills the hoppers directly from the trucks in which the coal is brought.

It is stated that the Watab Mill began making paper a few hours after current was first turned on, and has not been shut down since due to a failure of equipment—a most excellent performance for a mill of this kind.

Naturally, the first question which arises in the mind of the mill operator is, wherein will the use of electricity as a motive power lead to lower cost of production and a higher grade output. As a result of use of the motor drive, it is claimed that there is not only reduction of transmission losses, but greater reliability and greater elasticity, also reduced cost of maintenance, as well as a steady speed throughout the mill, besides tending to far greater cleanliness.

With regard to the reduction in the transmission losses, actual tests show that these losses, in the case of mechanical drive, vary from 40 to 60 per cent. of the power delivered at the engine or water-wheel shaft; 50 per cent. being a very fair average. This figure, of course, does not apply to the grinders or the beater shaft when driven direct, as is usually the case. It is claimed that, in comparison with this, with the electric system power can be transmitted from the shaft of the prime mover to the shaft of the driven machine, with an average loss of from 20 to 25 per cent., from 3 to

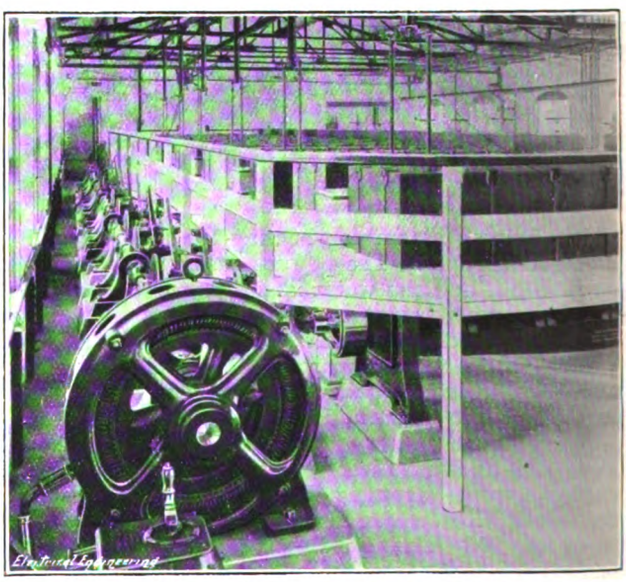


Fig. 3.—100 h.p. Motor driving Flat Screens.

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5 per cent. of this being in the wiring, and the balance in the generators and motors. Also the loss is reduced to this low point regardless of the complexity of the system.

From the above it is clear that in the power transmission alone a saving of from 15 to 40 per cent., depending on the conditions to be met with in each individual case, can be effected by the use of the electric system. A modern two-machine mill, with prevailing tendency towards large size machines, will require, outside of the grinders, from 1,500 to 2,000 h.p. Assuming the minimum saving of 15 per cent. on this, we shall have a net gain of from 225 to 300 h.p., which will represent a considerable annual saving in expenses. It is maintained that in a steam-driven mill this saving would be represented by the decreased consumption of fuel; in a mill where water is the prevailing power the saving will appear in the additional volume of water available for grinding pulp, or for extensions; and in these days pulp is a very valuable asset, which can always be marketed to mills that are unfortunate enough not to possess sufficient water power to grind their own pulp.

That there is greater reliability with electric drive than with the complicated combinations of shafting and gearing often seen in paper mills is obvious when we

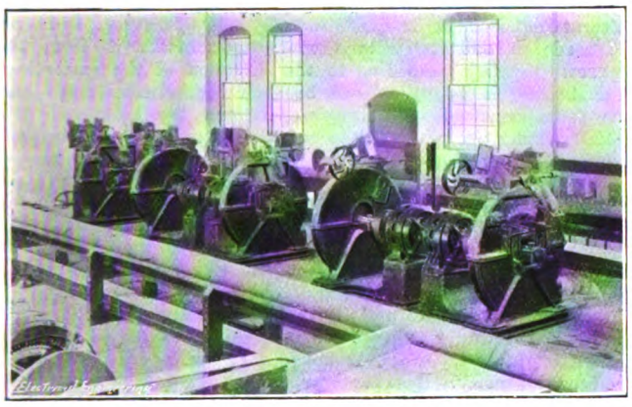


Fig. 4.—Electrically-driven "Barkers."

consider the reduction of the number of intermediaries between the machine and the prime mover.

Such motor troubles as are heard of from time to time are in nearly every case directly traceable to poor engineering in laying out the installation, or the negligence on the part of those employed to look after the electrical apparatus.

With electric drive it is also claimed that there is greater elasticity, and in this expression is included the greater ease of providing power equipment for extensions. Another point of elasticity in electric driving for such work as paper mills is that one may distinguish between the different types of power service required throughout the mill, and to treat each individual case on its merits and in the manner calculated to secure the highest efficiency of operation, utilising constant or variable speed motors, as may be most suitable. In the old days it was always a case of belting, but with the electric system we can either direct connect, gear, or belt the motor to the driven machine, as may seem best. In general, for paper mills, it is better to direct couple wherever this can be done without too great an investment in the motor by reason of the necessity for very slow speeds. It may be said that the practice usually followed in up-to-date mills is to direct connect the centrifugal pumps, Jordans, barkers, log saw, and variable shaft of the paper machines; gear all duplex or triplex pumps, rotaries, calenders, and wet machines; gear or belt the conveyors, rag dusters, and cutters; and belt the beaters, elevators, and all group drives. The grinders are usually direct coupled to the water-wheel shafts in water-driven mills, although there are some engineers who favour driving these also by direct-connected motors.

With regard to reduced cost of maintenance, in an electrically equipped mill, where shafting is practically eliminated, it is only necessary to see that the bearings of the motors and generators are properly lubricated, and, in case the equipment is of the direct-current type, to keep the commutators in order. Burn-outs in the windings of the motors are now practically unheard of, but even if they should appear, the motor can be repaired without much expense. The services of at least one man and possibly two or three are saved outright, and there is less expense for supplies.

The steady speed which is obtainable throughout the mill with electric drive is another of the many advantages. It is claimed that electric driving produces ideal conditions for the paper machine, which is the very heart of the mill, and the successful operation of the auxiliary apparatus is of no avail if there is trouble at this point. Nothing contributes so much to satisfactory operation as a steady speed, which can at the same time be readily varied, and uniform temperature in the steam which is used for drying. As will be seen, both of these requisites are possessed by the electric system.

By means of the variable speed motor the speed can be varied at the will of the operator over a very wide range, without a serious alteration in the motor efficiency. One of the most important features of the speed change lies in the fact that the successive increments of the change are very small; each step on the controller means a change of only 1½ to 2 revolutions on the motor, or on the variable speed shaft to which the motor is direct coupled. The speed can be varied over the entire range without a shutdown, which means that the machine tender can change from one grade of paper to another, no matter how great a difference, without stopping the machine. The difficulties of maintaining a constant speed, when the machine is driven from one engine operated under a varying steam pressure and varying load, are too well known to require more than mention. The clumsy and inefficient mechanical speed changers, step pulleys, and cones are always a source of trouble, and, compared with electric transmission, are the makeshift of a past age. It is held that the single objection raised by some manufacturers to the electric system is with regard to the economy of the drive on the paper machine itself. They contend that as long as it is necessary to use steam for drying it would be better to drive the machines by engines and use their exhaust rather than drive by motors and dry by live steam. In a consideration of this point some engineers divide the mills into two classes: those whose initial power is water, and those whose initial power is steam. Even the most ardent advocates of the use of steam engines and exhaust steam will admit the superiority of electric drive in the case of mills of the first class, where ample water power is available for all purposes, for there can be no question that the generation of electric power from water is cheaper and more efficient than the generation of steam power from coal. The only argument, therefore, is with respect to mills of the second class, which must produce all or a part of their power from steam. Many such mills, partially steam driven, could be placed in the water power list by the adoption of the electric system, the power thus saved being equivalent to that produced by steam. Admitting, for the sake of argument, that in mills of the second class it is more economical to use engines on the machines—which contention is open to dispute—the many advantages of the electric drive, as described herein, are more than sufficient to outweigh the

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possible saving in fuel. It is claimed that there is no reason why the exhaust from the main engines driving the electric generators could not be used for drying, if desired; and if this is done the question of economy is wiped out entirely.

Another contention which has been advanced by paper manufacturers who are using electric driving on their machines and live steam for drying, is that the use of live steam permits of maintaining a constant temperature on the dryers, resulting in a uniform sheet of paper of high finish, a condition which cannot be as easily secured by exhaust steam on account of the varying pressure in the line. If the mill be driven by water power, no engines whatever will be required; if by steam, the engines will be used solely to drive the electric generators in the power-house. It is maintained that in either case the drying will be done by live steam taken directly from the boilers, and brought down to the proper pressure through a reducing valve. A constant pressure is assured by this method, which means a uniform temperature in the dryers of the machine. There is no reason in a steam-driven mill why the exhaust from the engines driving the generators cannot be used for this purpose, if desired, but if the drying is done with exhaust steam, it is almost out of the question to maintain a uniform temperature.

There is also with electric drive a great saving in space as doing away with so much shafting, &c. As the motors are mostly direct-geared or coupled, very little space is required by them, thus permitting the placing of the various machines close together, and at the same time affording ready access to all. As the result, a large floor space is available for the storage of stock, in such a manner as to afford ready access, not only to the stock itself, but also to adjacent machinery.

Another feature of importance with electric drive is the decreased chance of injury to employees. The greater cleanliness for electric drive is also of particular importance in a paper mill.

VOLTAGE REGULATION IN ROTARY CONVERTERS

IN the course of a Paper by Mr. C. W. Stone, read recently before the American Institute of Electrical Engineers on recent development in synchronous converters, or, as they are more generally termed rotary converters, the author dealt with the subject of voltage regulation. With a synchronous converter, as is well known, it is not possible to regulate the direct voltage of the machine by means of the field rheostat, as is done with a direct-current generator, without changing the power-factor; for the ratio between the impressed alternating voltage and the direct voltage is fixed by the design of the machine. Hence where voltage regulation is necessary, as for lighting work, charging storage-batteries, &c., some means of changing the impressed alternating voltage is necessary. Some of the different methods used to accomplish this result were briefly described as follows:—

On the step-down transformers used with the converter, taps can be placed either on the primary or the secondary side, and switches used to transfer from one tap to another. This scheme has many objections and is seldom used now. If the taps are on the primary, oil-switches would have to be used if the voltage were at all high. Such switches would be practically out of the question. If the taps are on the secondary, a dial-switch can be used, but only with the smaller size machines, as it is difficult to build a dial-switch to handle large currents satisfactorily except at prohibitive expense. This method is also objectionable as it means fluctuation in the lights whenever the switch is moved to a different tap.

The common way of obtaining control of the voltage in railway work is to insert in the leads from the secondary of the transformer a reactance, thus causing an artificial drop in the impressed alternating voltage. This method, while simple and effective with the limited ranges in voltage required for such work, would not be applicable for large ranges in voltage. Too much reactance may cause pulsation troubles, and it also has a bad effect on the entire system.

The arrangement in most general use to-day is to connect between the secondary leads of the transformer and the synchronous converter an induction regulator, by which it is possible to obtain almost any range of voltage within the capacity of the machine. This scheme of operation is in such general use that it will not be necessary to describe it in detail. The principal objection to this arrangement is that another piece of operating machinery is used with each synchronous converter outfit, increasing the cost, requiring valuable floor space, and making it necessary to open the secondary leads from the transformer, a complication with large low-voltage machines.

The next development in this line took place abroad, where an entirely different scheme was used. A few machines of this type have also been built by one of the large manufacturing companies in this country. This method makes use of an alternating-current booster or "bucker," mounted on the same base with the synchronous converter. The field has the same number of poles as the converter, and the armature is mounted on the same shaft as the synchronous converter armature. Alternating current is generated in this armature, and can be made to add its voltage to or to subtract it from the impressed voltage according to the direction of the excitation. This booster is usually placed between the collector rings and the main armature of the converter, and the taps from the collector rings are connected to equidistant points of the booster armature; similar points on the booster armature are connected to the synchronous converter armature, thus placing the two in series, separate and distinct windings for each phase being used. The principal objections to such an arrangement are that here again we have an additional operating machine, as in the case of an induction regulator. Extra weight is added to the shaft between its points of support. The ventilation of the converter armature and its accessibility are impaired. Any serious trouble with this smaller machine results in the dismantling of the main synchronous converter in order to repair the small booster. Another way to construct such a machine is to make it a revolving field machine, mounting the field on an extension of the shaft beyond the bearing of the collector-ring end of the synchronous converter. As the armature is stationary, the leads from the secondary of the transformer are led directly to this winding, and from this winding to the collector rings of the synchronous converter.

This arrangement has the twofold advantage of being accessible, and not interfering with the ventilation or accessibility of the synchronous converter. This booster can be applied to any standard converter, and, being overhung, it is possible to carry a spare machine which can be placed in position quickly and without interfering with the body of the main synchronous converter.

The next development is very radical and is unlike any of the other schemes used. It was first proposed by J. L. Woodbridge some time ago. It has been known for some time that the ratio of conversion between the alternating current and direct current sides of a synchronous converter could be changed by varying the width of the pole-face. Each field pole is divided into three sections on each side of which are two windings. One of the windings on each section is the main shunt winding, and the other is the regulating winding. All the main windings are connected in series and excited in the ordinary manner. The regulating windings, however, are connected differently. The windings on the two outer sections of all poles are connected in series with one another, and the windings of all the central sections are connected in series with one another. The voltage of the direct-current side of the converter is increased by exciting all the outer sections in a direction to assist the main shunt field, and the middle section an equal amount in opposition to the main field. If both these windings are excited in the opposite direction the direct voltage will be lowered. All that is needed in this arrangement is a field rheostat in the regulating field circuits in addition to the main field rheostat ordinarily used. With machines arranged this way the power-factor can be held constant at all loads, yet all the range in voltage desired can be obtained.

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Since this method was proposed, another and still simpler method has been brought out. This scheme was proposed by Mr. J. L. Burnham. Instead of making each pole with three sections and with two windings on each, only two sections are used. On each section only one winding is used. The large section corresponds to the main shunt winding on an ordinary synchronous converter, while the regulation is obtained entirely by changing the excitation of the smaller section, exciting it in one direction to boost the voltage, and in the other to lower the voltage.

MR. POULSEN ON WIRELESS TELEPHONY AND TELEGRAPHY

At the London Institution on Wednesday, the 15th inst., a large audience listened to Mr. Valdemar Poulsen's account of recent progress in the application of the so-called "undamped" electrical waves to wireless telegraphy and telephony.

The lecture was read by Mr. Nevil Maskelyne, and began with a sketch of the differences between the sustained waves used by Mr. Poulsen and the intermittent waves used by Mr. Marconi and others. The relative advantages of sustained over

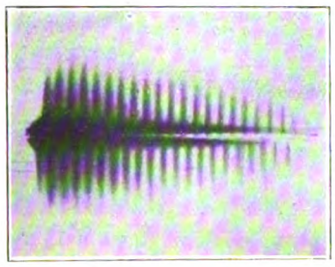


Fig. 1.—Oscillograph of Damped Oscillations Without Antenna.

intermittent waves for the purposes of wireless telegraphy were set forth by Mr. Poulsen at length. In his view, though the spark waves rendered excellent service in the introductory stages of the development of wireless telegraphy, yet, as a means for widely-extended intercommunication they are entirely unsuitable. The only thing to be said, in any case, in favour of spark telegraphy is that there is no necessity for the costly network of wires required for line telegraphy. A spark telegraph station resembles a signal gun; and just as a gunshot communicates vibration to everything around it capable of motion, so the electric waves produced by a spark communicate more or less of their energy to everything they meet that is capable of conducting electricity. Now each spark must possess initially sufficient energy to bridge the whole distance to be traversed, and this amount of energy must be liberated in the very short time of the life of the spark. Hence the process must be explosive in character; and this being so, it follows that it cannot fail to produce an enormous effect at short distances, and, consequently, there are great difficulties in avoiding interference.

It was not until the much-coveted continuous oscillations were produced that wireless telegraphy became really efficient from a practical point of view. Here the lecturer summarised the discoveries of Duddell and himself, which led up to methods of producing powerful oscillations, and some very good oscillograph photographs were thrown on the screen in illustration of

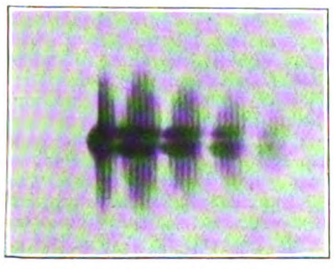


Fig. 2.—Oscillograph of Damped Oscillations With Antenna.

the physical difference between damped and undamped oscillations. Figs. 1, 2 and 3 show several oscillograph records. Figs. 1 and 2 are pictures of spark-produced oscillations of 1,680 metres wave-length. In Fig. 1, the condenser circuit has no antenna coupled to it; in Fig. 2 an antenna is in use, with a coupling of closeness about 14·5 per cent. Fig. 3 shows a record made by sustained oscillations produced by the hydrogen arc, the wave-length being 3,000 metres. This photograph shows very clearly that the discharge in one direction is more intense than that in another, a fact arising out of the necessary asymmetry of the arc method of generating oscillations. These photographs are produced by means of the "tube-oscillograph," which is a "vacuum-tube" containing air at a pressure of the order of a millimetre of mercury, and having two equal axial electrodes, of straight aluminium wire, nearly touching. The negative glow on the cathode is photographed, and when the tube is in an oscillatory circuit the negative glow shifts, of course, to and fro from one electrode to the other. It may be mentioned that the rotating mirror used for observing these high-frequency oscillations is run at about nine or ten thousand revolutions per minute.

The lecturer proceeded to explain a special feature of wireless telegraphy by means of continuous waves is the possibility of numerous stations operating simultaneously within the same area. Another characteristic and important advantage of the new waves, and one which is, from a physical point of view, intimately connected with the absence of interference, is that the continuous waves are less weakened by their passage through space than are the spark waves. This may be understood by remembering that the spark waves influence, to some extent, all electrical conductors that they meet. Continuous waves, however, only give up energy when they meet with conductors that have the same rate of oscillation as themselves. The continuous-wave system of wireless telegraphy is thus, *par excellence*, a long-distance system. A third advantage of the continuous waves lies in the fact that they can be made of small intensity, and yet, because of their persistence, convey to a distance in say, a tenth of a second, the same amount of energy as is conveyed by

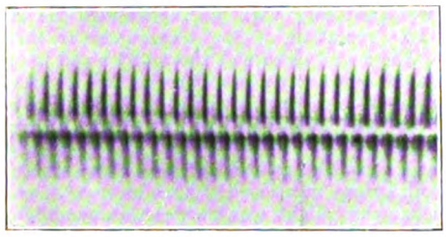


Fig. 3.—Oscillograph of Undamped Oscillations.

a few very intense sparks. Thus, while the spark telegraph for long distances must operate with a tension of from 50,000 to 100,000 volts, the new system requires only 2,000 to 3,000 volts for the same distance. This brings great advantages in respect of reducing insulation difficulties.

Turning to wireless telephony, the lecturer summarised previous attempts at wireless telephony, and then gave a very brief account of his own successes. Readers will best understand the method most recently used by referring to Figs. 4 and 5. The microphone is in a circuit inductively coupled to the antenna and the generating circuit; and the variations of the resistance of the microphone, by modifying the induced alternating current through it, react on the antenna and similarly modify the stream of radiation from the antenna. This causes similar variations in the oscillations produced in the detector circuit, in the rate of heat development in the detector *D*, and in the thermo-electric current through the telephone *T*. The microphone is usually a compound affair, consisting of several ordinary microphones in series, as in Fig. 6. In this way phonograph music played in Berlin has been heard at Lyngby, near Copenhagen, a distance of 460 kilometres (290 miles), and speech has been transmitted distinctly from Lyngby to Esbjerg, a distance of 270 kilometres (170 miles). Mr. Poulsen remarked that he did not at present intend to telephone across the Atlantic. Telephony without wires becomes mainly of importance when comparatively short distances are concerned, where the safe reproduction of speech does not demand any sacrifice of simplicity in the apparatus. As regards interference, the lecturer

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said that there is no doubt that a multitude of voices can find their way through space in all directions without mutual disturbance, every voice speaking by means of its "ether-tone," with the particular person addressed. Wireless telephony, he continued, has probably good prospects in another direction. It is well known that telephony through submarine cables presents great difficulty, and although considerable progress in this domain has been made during recent years, speech can as yet be transmitted only through short cables. In this respect wireless telephony will probably fill a vacant place, principally on account of freedom from that distortion which limits transmission of speech through cables.

The lecture closed with the old Latin tag, *Suaviter in modo et fortiter in re*, and then the lecturer gave a demonstration of wireless telephony between the lecture table and a distant point of the room.

Apart from the telephonic apparatus, a quantity of new telegraphic apparatus was on exhibition. Two items of great interest were a machine for automatic transmitting and one for quick receiving. The automatic transmitter produces dots and dashes in the waves radiated from the aerial by merely closing a circuit inductively coupled with the aerial. Such a closed circuit has, when the coupling is close, very considerable oscillatory currents induced in it, so that in this transmitter the coil is made to rotate through positions of maximum and zero coupling, and is closed or opened only when passing through the zero coupling position. The operation of the transmitter is thus perfectly sparkless. The actual closure of the rotating coil is controlled by the perforated paper tape run through the transmitter, dots being translated into short periods of closure and dashes into long periods. The tape exercises its control through an ingenious mechanism, of which the principal feature is a horizontal balance lever, rapidly rocked by the motor that drives the rotating coil before mentioned. This lever catches on another lever, which makes slight movements corresponding to the perforations of the tape, only when a perforation is passing the

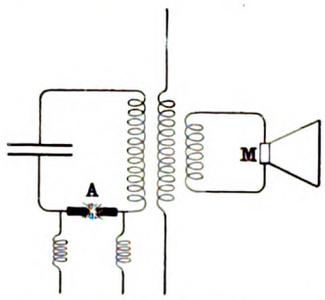


Fig. 4.—Sending Circuit.

A = Arc.
M = Microphone.

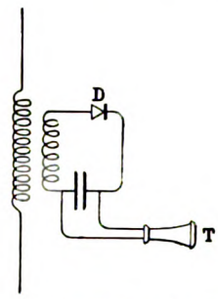


Fig. 5.—Receiving Circuit.

D = Thermo-electric Detector.
T = Telephone Receiver.

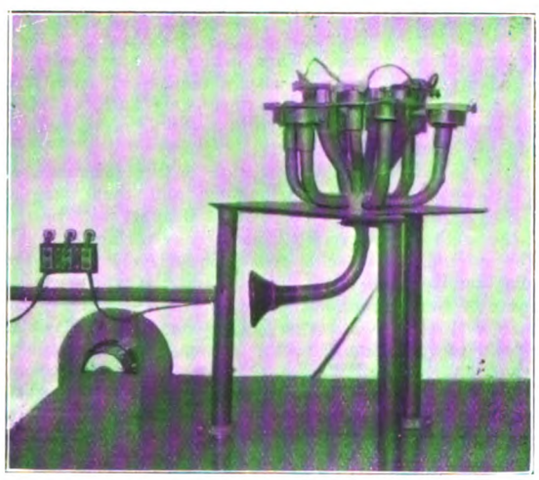


Fig. 6.—Microphone Arrangement for 250 Miles.

mechanism, and thus a very broad spring contact is powerfully operated. This trouble is all necessary because currents of 30 to 50 amperes of high frequency may circulate through the closing contacts. The transmitter can send 200 words per minute. Unfortunately, the best of the printing receivers can record at only 120 words per minute. This particular receiver formed the second item of great interest among the apparatus shown. It consists of a thread galvanometer, in which the current from a thermoelectric detector passes along a fine wire strung in a strong transversal magnetic field. The deflections that occur allow a narrow beam of light to pass the instrument and fall on a moving sensitive strip. The exposed tape passes immediately through developing and fixing baths, and may be exposed

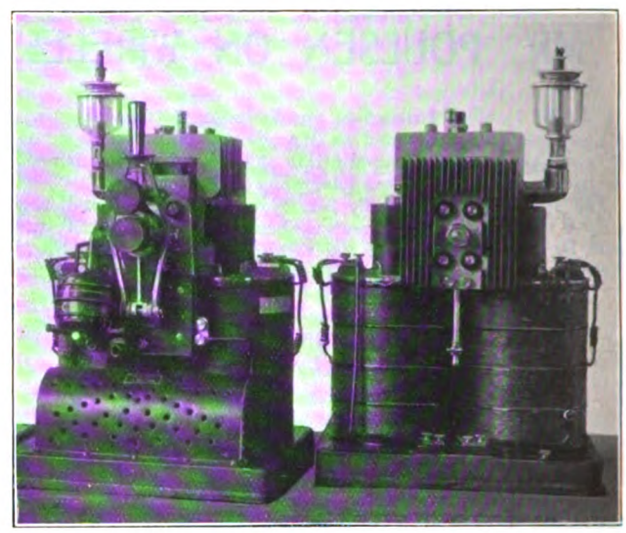


Fig. 7.—Front and Back Views of 1½ kw. Generator.

to daylight five seconds after the receipt of the signals. There were also on view a few modern powerful oscillation generators. Fig. 7 gives front and back views of the largest standard apparatus, which produces 1 to 1½ kilowatts of oscillatory energy, and is suitable for transmission to distances of a thousand miles.

The Chicago Drainage Canal Power Plant.—According to the *Western Electrician* (Chicago), a commencement was made on March 23rd of the supply from the power station on the Chicago Drainage Canal at Lockport, which was described in Electrical Engineering, April 2nd, page 217. The 44,000-volt supply from the power house is transmitted to a sub-station at Western Avenue, Chicago, and from thence cables are taken to the various existing stations, and is principally used for street arc lighting. In one of these, which already contains alternating-current plant, step-down transformers have been put in, and the old steam plant retained as a standby. In the three existing continuous-current stations, the old arc-lighting machines are now driven from a countershaft by large synchronous motors connected directly to the 12,000-volt feeders. A series of new transformer sub-stations is also being established. Each will be equipped with three 250-k.v.a. 11,500-4,250-volt single-phase transformers. The primaries will be mesh-connected, and the secondaries in star, with eight 50-light circuits in parallel on each branch.

A New Dictionary of Engineering Biography.—In "British Engineers and Allied Professions in the Twentieth Century: Contemporary Biographies," Messrs. W. T. Pike & Co., of Brighton, have published a handsome volume of moderate size. To attempt to compile the biographies of "British Engineers" would, in itself, involve a somewhat voluminous publication if it were to be at all complete, so that when we find "allied professions" included in the scope of this work, it is not surprising that many eminent members of the profession are missing. In fact, it would be an interesting calculation to make, on the basis of the present volume, as to the number of similar volumes which would be necessary to give adequately contemporary biographies of British engineers and the allied professions. In the present edition there are some 700 biographies, all, with the exception of a few, accompanied by photographs. At the beginning there are also a number of engineering articles of a general character, including one by Mr. W. M. Mordey on "Electrical Engineering," and another by Sir John Wolfe Barry, K.C.B., on "Standardisation in British Engineering Practice," in addition to short histories of the Institutions of Electrical, Civil, and Mechanical Engineers, and other engineering societies. The biographies include a good number of electrical men and in all cases the careers and present occupations and distinctions are given with commendable brevity, and, so far as we have checked them, with accuracy. The work is a subscription publication, and a second edition is to be prepared.

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ELECTRIC HAULAGE OF CANAL BOATS

A PAPER read by Messrs. L. B. Stillwell and H. Putnam before the American Institution of Electric Engineers last month described the results of tests conducted by the authors during the autumn months of 1907 on a section of the Lehigh Canal, Pennsylvania. The object of the tests was to determine:—(*a*) Pull required to propel canal boats at various speeds and with varying numbers of boats in tow; (*b*) the relative merits, for the purpose contemplated, of locomotives supplied by trolley and operating upon a track of 42-in. gauge,

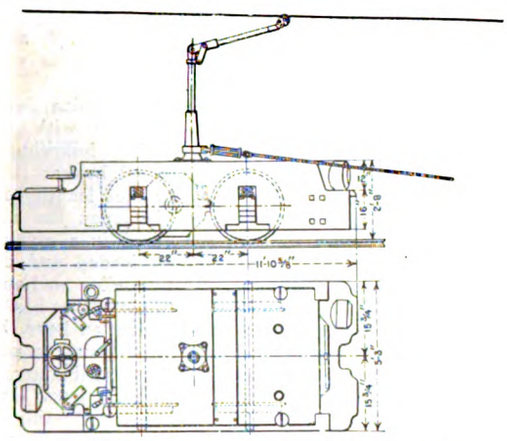


Fig. 1.—Mining Locomotive No. 15.
Equipped with two 28 H.P. Motors.

and a mono-rail system; (*c*) the best speed and length of tow as fixed by physical conditions. The upper section of the canal, on which the authors' tests were made, is equipped with the "Locomotive System." On this section an ordinary mining locomotive is used. Two locomotives were tested, each weighing under test conditions 16,000 lb. without testing instrument and crew. Each locomotive is equipped with two direct-current motors of 28 h.p., operating on 500-volt trolley circuits. The locomotive wheels are 28 in. in diameter, and gear ratio is 4·6 to 1. The wheel base is 44 in. The outline drawing of this locomotive is shown in Fig. 1. The locomotives were operated on a track of 42-in. gauge, and ballasted on the river section with broken stone, elsewhere with gravel. Forty-pound rails were used. The track was uneven and comparatively rough. On this section, two levels of the canal, aggregating 5,600 ft. in length, were in the open river exposed to the river currents. The voltage of the trolley circuits was varied to obtain various towage speeds.

Another section of the canal was equipped with the "Mono-rail System." On this section three traction machines or "Tractors" were used. Two of these tractors (Nos. 1 and 2)

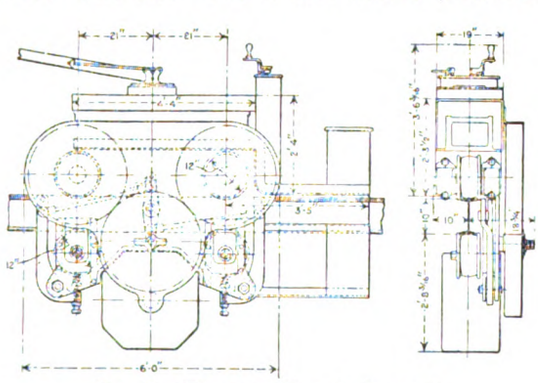


Fig. 2.—Tractors Nos. 1, 2, and 3.
No. 1 and 2 each equipped with one 40 H.P. Motor.
No. 3 equipped with one 25 H.P. Motor.

were manufactured in America. The electric equipment of each comprised one direct-current 40-h.p. motor. The gear ratio was 5·78 to 1; diameter of wheels 12 in., and length of wheel base 42 in. The construction is illustrated in Fig. 2. The ratio of leverage on lever wheels was 4·7 to 1; that is to say, the lower wheels are pressed upward against the lower face of the rail with a force 4·7 times the drag on the tow line. The adhesion of the machine, therefore, is a function not only of its weight but also of the pull which it exerts. Each tractor weighs 6,450 lb., and, under test conditions with instruments and crew, 7,350 lb. Tractor No. 3 was manufactured in Paris, and equipped with one 25-h.p. mining motor. Its wheels are 11·25 in. in diameter, gear ratio is 3·4 to 1, and wheel base 42 in. The general design is the same as that of Tractor No. 1, and is shown in Fig. 2. Owing to the fact that the frame of this tractor had not been designed to receive a motor of the exact dimensions of that with which it was equipped, it was impossible to locate the motor in its proper position; it was necessary, therefore, to use 500 lb. counterweight to secure equilibrium of the machine. The weight of the tractor complete was 5,093 lb.; including counterweight, test apparatus, and crew, 6,493 lb. The mechanical construction and workmanship of Tractor 3 made it superior to Tractors Nos. 1 and 2, as was evidenced not only by inspection but also very conclusively by the results of tests. In the comparative calculations of power required respectively by the locomotive and mono-rail systems, therefore, the results obtained in using Tractor No. 3 have been used. The tractors were operated upon a mono-rail supported at a height of 4 ft. above the ground by steel posts placed at intervals of 18 ft. The rail, as used in the installation on the canal, is an ordinary 10-in. I-beam weighing 75 lb. to the yard. The mono-rail with supports and braces complete weighs 120 lb. per yard, and is erected along the canal outside the towpath. A fourth tractor, No. 4, built in Paris, was also subjected to certain tests. This machine, without

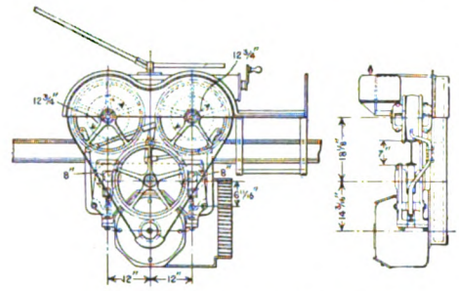


Fig. 3.—Tractor No. 4.
Equipped with one 15 H.P. Motor.

testing crew and instruments, weighed 3,465 lb. It was equipped with one direct-current 500-volt motor of 15 h.p. The diameter of wheels was 12·75 in., and the wheel base 24 in. This machine is illustrated in Fig. 3. For this smaller machine a section of mono-rail tract 1,200 ft. long was erected on wooden posts. The rail was in this case a 7-in. I-beam, weighing 45 lb. per yard, and was erected at a height of 4 ft. from the ground. In the tests the tow-line was approximately 200 ft. long. Four canal boats were loaded and used in all comparative tests made. These were 87·5 ft. long, 10·5 ft. wide, and drew 5 ft. of water. The weight of each was 24 tons empty, 138 tons loaded. The velocity of the current of water flowing in each section of the canal was determined at the time the tests were made, but to obtain an average value for towing resistance, including the effect of this current and also of track grade, all tests were made in both directions over each section of the canal. The average results are used in the calculations.

Effective tow-rope pulls required.—The effective tow-rope pulls as determined by dynamometer tests and corrected for the rope-angle for four, two, and one-boat tests, both light and loaded, are given in Table I.

Table I.

Boats.	Weight tons (2000 lb.) T.	Average speed in miles per hour. V.	Effective pull (pounds.) P.	Constant. $C = P/V^2T$.
Four boats loaded ...	548	2·98	2200	0·452
Two ,, ,, ...	274	3·62	1500	0·418
One boat ,, ...	137	4·00	1000	0·456
Four boats empty ...	95	4·00	1010	0·664
Two ,, ,, ...	47·5	4·20	560	0·668
One boat ,, ..	23·8	5·00	400	0·673

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From Table I. it appears that for boats, such as are used on the Lehigh and Delaware canals, the effective tow-rope pull in pounds, required by any number of loaded boats, is expressed approximately by the formula $P = 0{\cdot}45\ V^2\ T$, and for empty boats by $P = 0{\cdot}67\ V^2\ T$, where V is the speed in miles per hour and T the total tons (2,000 lb).

It was impracticable with the facilities at hand to secure reliable data as to the effect of the ratio of boat-section to canal-section. The immersed cross-section of a loaded boat is 54 sq. ft., while the average cross-section of a canal, on those sections upon which most of the tests were made, is 440 sq. ft.; the ratio of section being practically 1 to 8. The current in the open-river section is so varied that reliable results expressing difference in pull required in the comparatively narrow sections and in these wider sections could not be obtained.

Acceleration and Maximum Rope Pulls.—Compared with electric railway operation, the rate of acceleration practicable of attainment in towing canal boats is low. Acceleration, however, is relatively unimportant, as the time of run is long compared with the time consumed in acceleration. The greatest pull is exerted when the last control point is reached, but this does not greatly exceed the pull required at full running speeds.

The following are some of the results obtained with both loaded and empty boats: Acceleration in miles per hour per second for four boats loaded (average) 0·024, (maximum) 0·045; for one boat loaded (average) 0·057, (maximum) 0·103; and for one boat empty (average) 0·109, (maximum) 0·173. Average pull in lbs. during running for four boats loaded 1,990; for one boat loaded 650; and for one boat empty, 625 (all not corrected for rope angle).

Towing Machines Tested.—In most of the tests Mining Locomotive 15 and Tractors 1 and 3 were used. Comparison was made at speeds and effective pulls as nearly identical as was found practicable. As to meet these conditions the various machines tested required different amounts of operating energy, and as change in the energy affected the motor efficiency, the electric losses in the motors in all cases have been deducted from the kilowatt input in determining the mechanical efficiency of the machines. The mechanical loss of the motors and gears in each case is charged against the respective machines. The tow-line pull in all cases has been corrected to the effective pull in pounds in the direction of motion. The mechanical efficiencies of the three towing machines tested in this way were as follows:—Mechanical efficiency for an effective pull of 1,000 lb. (*a*) Mining Locomotive, 80 per cent.; (*b*) Tractor 1, 68 per cent.; (*c*) Tractor 3, 73 per cent. For an effective pull of 3,000 lb.: (*a*) Mining Locomotive, 84 per cent.; (*b*) Tractor 1, 74·8 per cent.; (*c*) Tractor 3, 77·5 per cent. Thus the Mining Locomotive has a considerably higher efficiency than either of the Tractors at all loads.

When running without load the machines preserved approximately the same relationship as they did when operating under load conditions, though the relative magnitude of the values were changed. When developing large draw-bar pulls, the mechanical losses in Tractor 3 were 50 per cent. in excess of those of the Mining Locomotive. Mechanical losses in Tractor 1 exceeded those of the Mining Locomotive by from 70 to 80 per cent. Under light running conditions these excess losses were reduced to about 7 per cent. in the case of Tractor 3, though the excess remained approximately 70 per cent. for Tractor 1. The running light losses are, in themselves, relatively unimportant, as the amount of power required is small, and the amount of idle running relatively very small; but, as showing errors in design and workmanship, which are corroborated by the results of the heavy load tests, they are important. It is apparent that the mechanical design of these Tractor machines can be improved materially. When running light, it would be reasonable to expect that these machines, if properly designed, should effect a saving in power consumed almost proportional to their less weight as compared with the Mining Locomotive. Under load conditions, especially as the draw-bar pull approaches the maximum of which the locomotive is capable, the latter machine, theoretically, should show the higher mechanical efficiency. This is due to the fact that when the Mining Locomotive utilises its entire weight for traction; to obtain a similar draw-bar pull with the Tractor, the two driving wheels on top must have a pressure upon them equal to the weight of the Mining Locomotive. In order to assist in determining the cause of the apparently excessive friction of these Tractors, at low rope-pulls and when running light, tests were made on a wet rail to determine the relative amount of reduction in friction, and other tests were made pulling the Tractors with the gears and motor disconnected. The results of these tests show that at a speed of six miles an hour the wet rail effects a saving of about 16 per cent. in total friction, running light, and at the same speed the gear and motor friction amounted to 28 per cent. of the total.

It would seem that the mechanical efficiency of tractors of this type might be improved by giving attention to the following facts:—(1) An increase in the size of wheels would tend to decrease losses; (2) the wheel base should be long and the "flange clearance" small; (3) the mechanical construction must be such that alignment of all bearings is preserved under all conditions of operation; (4) the point of rope attachment should be carefully selected in order to reduce flange friction to a minimum; (5) the rail surface should be as good as on ordinary railway tracks, and the construction should be such as to minimise vibration; (6) the use of guides for the pressure wheels should be avoided if practicable. If used, the vertical motion in the guides for the pressure wheels should be free; (7) the pressure wheels should have no flange; (8) arrangements for oiling the bearings of tractors as well as of locomotives should follow railroad practice.

Speed Limitations.—Tests were made to determine the practicable limits of speed when towing is done with towing machines. These limits depend upon the following:—(*a*) Ability to steer the boats; (*b*) wash of canal banks; (*c*) time required for locking; (*d*) tonnage capacity and length of tow. The selection of a best speed depends also upon the number of boats which must pass through the canal in a given time to handle its business. Single boats, both loaded and empty, were tested at speeds slightly exceeding five miles an hour and no difficulty was experienced in steering them. Two-boat tows loaded were operated at speeds up to 4·5 miles an hour, but at this speed care had to be exercised by the helmsman to keep his course true. Two-boat tows (light) were operated successfully at a speed of 5·3 miles an hour. Four-boat tows (loaded) were operated at a speed of 3·5 miles an hour. At this speed, however, it was necessary for the helmsman to exercise great care to prevent the boats yawing. Four-boat tows, empty, were operated at speeds up to five miles an hour, but great difficulty was experienced in steering; the drag of the rear boat's pulling the head boats against the bank in spite of anything the helmsman could do.

The authors' conclusions in regard to limits of speed, as fixed by conditions of practicable steering, are as follows:—(*a*) Single boats, loaded or empty, can be operated satisfactorily on tangents at speeds exceeding 5 miles an hour, but on the canal for satisfactory working 5 miles an hour is probably about the limit of average speed for such tows; (*b*) Two-boat tows are handled satisfactorily at speeds of from 3·5 to 4 miles an hour; (*c*) Four-boat tows loaded can be operated with a fair degree of success at speeds up to 3 miles an hour except on very sharp convex curves; (*d*) Four-boat tows, light, were found impracticable as tested. It is possible that improved steering gear might remedy the difficulties encountered, except that no conceivable steering gear would make it possible to handle four-boat tows, light, in a heavy wind.

At the higher speeds covered by the tests a tendency to cause wash of the canal banks was noted. The tests were not of sufficient duration to justify an attempt at estimating the relation of wash and speed. At a given speed the wash is greatest in narrow sections of the canal. To a certain extent in these narrow sections the speed is automatically regulated: the resistance to the passage of the boat being increased and this resistance immediately reacting upon the series motor. The speed of towing should be under the control of the operator, and to obtain best results the motor used should be capable of operating at any desired speed within the predetermined maximum limits. With equipment of this character, the speed can be regulated on those sections where the wash might otherwise be injurious.

Time Required for Locking.—Tests were made to determine the time required in locking one, two, and four boats, and to see if the time could be reduced in any way. The authors give the following average times based on the test results:—For locking with tows of various lengths and with locks of different sizes. Times for locking with four boats: (*a*) through a one-boat lock, 45 min.; (*b*) two-boat lock, 35 min.; (*c*) four-boat lock, 20 min. With two boats: (*a*) 21 min.; (*b*) 15 min.; (*c*) 12 min. With one boat: (*a*) 8 min.; (*b*) 10 min.; (*c*) 11 min.

Energy Consumption.—The average efficiency of the mining locomotive is about 1·5 per cent. higher than that of the tractor both with alternating-current and direct-current equipment, and the average efficiency at the trolley is about 2·8 per cent. higher with direct current than with alternating current. In this case, as in the case of direct-current equipment, it is evident that the difference in efficiency of the mining locomotive and the tractor, and of alternating-current and direct-current equipment, are relatively unimportant as compared with other factors upon

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which the choice of one or the other as a system of electrical haulage must depend. In Table II. are given the average results of a large number of tests made to determine the energy consumption at the trolley and the average input in kilowatts.

Table II.—*Speed, Kilowatt Input, and Watt-Hours per Ton-Mile. Average Run 1·52 Miles—Two-Boat Locks. Time Locking: 4 Boats 35 min.; 1 Boat 10 min.*

Conditions.	Speed.	Mining locomotive.		Tractor.	
	Average speed including locking. Miles per hr.	Average input at trolley. Kilowatts.	Watt-hours per ton-mile.	Average input at trolley. Kilowatts.	Watt-hours per ton-mile.
Direct current—					
Four boats loaded	1·40	8·7	11·3	8·8	12·0
,, empty	1·60	4·3	29·2	4·6	30·3
One boat loaded...	2·81	7·7	20·0	8·0	21·0
,, empty...	3·42	4·9	61·0	5·2	64·5
Alternating current—					
Four boats loaded	1·37	8·1	11·0	8·2	11·1
,, empty	1·59	5·0	33·5	5·3	34·8
One boat loaded...	2·90	9·0	22·6	9·4	23·3
,, empty...	3·67	6·7	77·0	6·9	80·8

For the conditions existing on the Lehigh and Delaware Canals, it is estimated that the efficiency of a system of electric power transmission and conversion supplying direct current to motors will approximate 70 per cent. from bus-bars at power house to motor terminals. If alternating-current motors be used the calculated corresponding efficiency is 75 per cent. Based upon these efficiencies and the traffic conditions as existing on the Lehigh and Delaware Canals, the watt-hours required at the power house per total ton-mile and per ton-mile of freight handled are given in Table III. It should be noted that the calculated power in the above table applies only to the special conditions imposed by the physical limitations of these particular canals and by the speeds for loaded and for light boats most suitable for their operation. In all these tables the "short" ton of 2,000lb. is used.

Table III.—*Watt Hours per Ton Mile at Power House. (Average Freight Haul 55·6 Miles.)*

Conditions.	Direct current.		Alternating current.	
	Mining locomotive	Tractor.	Mining locomotive	Tractor.
Watt-hours per total ton-mile—				
Four-boat tows ...	24·6	24·8	22·6	23·0
One-boat tows ...	42·8	45·3	48·3	50·2
Watt-hours per freight ton-mile—				
Four-boat tows ...	33·9	37·2	32·5	33·1
One-boat tows ...	61·5	69·0	69·5	72·2

POLYPHASE INDUCTION MOTORS FOR INDUSTRIAL PURPOSES

A PAPER dealing with this subject was read on April 14th by Mr. G. Stevenson, before the Glasgow Local Section of the Institution of Electrical Engineers. After referring to the fundamental rules which should be observed in the industrial application of electrical energy, the author emphasises the importance of the attainment of greater simplicity in the electrical part of the equipment. When installing polyphase motors there are two classes to choose from, namely: (*a*) Squirrel-cage motors, and (*b*) slip-ring motors. Naturally, the first thing to consider is the comparative cost of the two classes of motor, since, other things being equal, the choice will invariably fall on the cheaper machine. The advantage in this respect is on the side of the squirrel-cage type. If the prices of the starters are allowed for, then the squirrel-cage motor comes out still cheaper in sizes up to and including 50 h.p. Above 50 h.p. the prices of both types are practically the same. It should be mentioned that the motors here referred to are a standard line of 50-cycle 500-volt machines, which were chosen with speeds to suit their individual outputs. Thus the 5-h.p. machine is designed for a synchronous speed of 1,000; the 50-h.p. for 500, and the 100-h.p. for 500 revs. per minute, these being about the usual speeds which would be adopted in practice. With respect to the relative weights of the two types there is not much difference, the squirrel-cage machine being only about 3 per cent. lighter. The efficiencies, power factors, and overload capacities, however, are slightly higher for the squirrel-cage type. The absence of moving contacts in class (*a*) machine makes it absolutely sparkless, and therefore specially suited for operation in mines, or mills, where dangers from explosive mixtures or gases exist. Moreover, the robust construction of the rotor, due to the entire absence of coils and their attendant insulation, is a characteristic of this class of motor which appeals strongly to the mechanical engineer. It would therefore appear that class (*a*) motor should be installed in every case, but, unfortunately, it has the serious disadvantage that unless suitable precautions are taken on starting up, a somewhat excessive current is drawn from the line, and if the starting current is reduced, then the starting torque is diminished in proportion. There are several excellent methods of reducing the starting current, but nevertheless it is still the practice of some supply authorities to prohibit entirely the connection to their system of squirrel-cage machines, except in the very smallest sizes. As will be shown later, the views of the various power companies differ considerably in this respect. In order to determine the current taken from the line at starting in terms of the full-load current, and the resulting torque, the author tested some machines built for operation on a 500-volt, 50-cycle three-phase circuit. These tests showed that squirrel-cage motors, if switched straight on to the line, take from 4·55 to 6 times their full-load currents. The adoption of this method of starting is, therefore, out of the question, except in the very smallest sizes, say up to 10 b.h.p., on account of the violent disturbances which would result to the supply pressure. Moreover, the power factor under these conditions is of the order of 0·4, and this causes excessive idle or "wattless" currents in the line, thus affecting objectionably the pressure regulation of the system. The starting torque for a motor rated at 35 h.p. will be about 1·13 times the full-load torque, and this with a starting current equal to 4·55 times full-load current. These figures may be taken as being fairly representative of good modern machines, although by a special design of rotor it is possible to improve very considerably the results given above. In order to overcome the defects of squirrel-cage motors, methods must be employed which will permit of:—(1) A reasonable starting current being drawn from the line; (2) such arrangements in the disposition of the motor in relation to its work as will enable it to start under comparatively light load conditions, say, not exceeding half full-load torque; or (3) the adoption of a special form of "high torque" rotor.

Stator Starters.—One method of starting induction motors, when the operating conditions of the driven machinery permit, is to keep all the motors coupled up to the line and start them simultaneously with the engine and generator. This method, however, cannot be used except where the installation includes the generating plant. The current taken at starting is very small with this arrangement, but it would appear to be necessary to have separately driven exciters, in order that the main generator may be started from rest with full voltage on the field. Facilities for starting any individual motor would also have to be provided, since it would obviously not be feasible to shut down the whole plant and start afresh in the event of one motor being put out of action. The only example which the author has heard of is that of a cotton mill in Georgia, United States.

Viewed from the standpoint of simplicity, perhaps the next best method of starting class (*a*) machines is that patented by H. S. Meyer. The method adopted in the case of two-phase motors is to connect the stator windings in series at starting, so that the voltage per phase is only half of the line voltage, and the starting current and torque are reduced to one-quarter the value they would have if full voltage were impressed at the

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motor terminals. After the machine has run up to speed, the switch is thrown over to the running position, when each phase receives its full pressure. In the case of three-phase motors they are designed for running normally on delta connection, the starting being effected by switching on to the line with the windings connected in Y grouping. By this means the voltage per phase at starting is only 58 per cent. of the line voltage. The starting current and torque are, of course, also reduced; for instance, taking the 33-h.p. machine to which reference has already been made, the starting current would be only one-third of that taken if motor were switched straight on, or 1·5 times full-load current. The starting torque being proportional to the square of the voltage would be reduced to one-third of its value at full load. The author has used these methods for two- and three-phase machines up to 50 h.p. with excellent results. The switch used is of the air-break type for motors up to 20 h.p. on a 500-volt circuit. Above this size it is good practice to use an oil-break switch. Power users are at last beginning to realise the effect of shafting and other frictional losses on their bills for current, with the result that, in new equipments at all events, high-class roller bearings are taking the place of the old solid pattern. The saving in power effected by the adoption of roller bearings is stated by the makers to be from 10 to 25 per cent., and they claim that the extra initial cost will be returned in the first year's operation by the saving in power alone. Returning to the subject under consideration, mention may now be made of what is probably the commonest method of starting squirrel-cage machines, namely, the use of the so-called compensator or auto-starter. The arrangement is equivalent in effect to a step-down transformer. When the switch is placed in the starting position, the voltage across the motor terminals is only a fraction of the line voltage. After the motor has reached normal speed, the switch is thrown into the "Running" position, and the motor is then supplied at the full-line voltage. Each phase of such a compensator is provided with several taps, so that a number of sub-voltages may be obtained, any one of which may be selected for permanent connection to the switch for starting the motor, according to individual requirements. The three coils of the three-phase winding are connected in "Y," the line to the three free ends of the coils, and the starting connections of the motor to the taps. To meet various requirements, compensators for standard motors of 5, 10, and 15 h.p. are usually provided with taps for starting the motor at 40, 60, and 80 per cent. of the line voltage, with respective line currents equal to 16, 36, and 65 per cent. of the current that would be taken by the motor if no compensator were used. For larger motors compensator taps should be provided giving potentials equal to 40, 58, 70, and 85 per cent. of the line voltage, and respective currents equal to 16, 34, 50, and 72 per cent. of the current that would be taken by the motor if it were started direct from the line. The proper tap for giving maximum starting effort without causing an objectionable voltage variation in the supply circuit may readily be ascertained by trial, and permanently connected, at the time of installation. A defect of the ordinary pattern of compensator is that the motor may be switched straight on to the line, thus causing a rush of current, which it is the object of the compensator to avoid. The switch can be, however, provided with a latch, so arranged that the lever at "Off" can be thrown only into the starting position, and can be thrown from thence into the running position only by a quick throw of the lever. A number of motors may be started from one auto-transformer, thus saving the expense of installing individual compensators. A throw-over switch is provided for each motor to be started, and a three-pole compensator magnetising switch. Only one motor would be started at a time, and when all the motors are started the compensator magnetising switch would be opened. The chief objection to the compensator as a starting device is its excessive cost, this being usually about one-third the cost of the motor. Furthermore, it has been found that under actual working conditions cases frequently occur of coils being burned out, due to the switch being left in the "Starting" position. Some makers use a resistance in the stator circuit for starting up, but the method is not advisable, since the current is only reduced in proportion to the reduction in the voltage, while the torque is reduced as the square of the voltage. The foregoing covers the principal devices in use at the present time for starting-up class (*a*) motors. Numerous attempts have been made to increase the starting torque of this class of motor, while preserving its characteristic features of simplicity and robust construction. Among the more interesting may be mentioned:—(1) Boucherot's* three methods—use of component rotors, movable stator, and phase transformer; (2) Hobart* (utilisation of skin effect); (3) Zani* (use of inductance coils). More recently Hunt† has devised a cascade arrangement.

* Hobart's *Electric Motors*, pp. 266—291.
† *Journal, Institution of Electrical Engineers*, vol. xxxix, p. 648, 1907.

Clutch Starting.—None of the above methods, however, with the possible exception of the last-named, appear to have attained to any degree of commercial importance, in this country at least; and, in the author's view, the problem ought to be approached from the opposite standpoint—that is to say, that, instead of designing the motor to suit the conditions, arrangements should be made to permit the installation of the ordinary simple squirrel-cage machine. As an example of what is meant, the case of a mortar-mill drive may be mentioned, a class of drive which, as most engineers know, is somewhat troublesome, both in regard to the starting and overload conditions. The machine was situated in a very dusty position in a foundry, and, after taking all the circumstances into consideration, it was decided to adopt a friction clutch in combination with suitable single reduction spur-gear, and a class (*a*) motor with star-delta starter. A word or two is necessary in regard to the clutch, which is of the "coil" type. The shaft, which is driven by the motor, has keyed upon it a cylindrical drum, which is hardened and ground. Coiled round this cylinder is a steel coil attached to a casting, which either carries a gear-wheel or belt pulley, or if the clutch is used as a coupling it is keyed on to a separate shaft. When it is desired to put the clutch in gear, a loose collar is moved towards the coil by means of a lever, operated either by hand or screw; this in turn actuates a hooked lever, which presses on the tail of the coil, causing it to wind gradually and tightly round the cylindrical drum. The advantages of this clutch are that it is easily made for all powers, even up to 2,000 h.p., and by operating the starting lever by means of a wheel and screw there is not the slightest shock when it is put into gear.

Reference has already been made to the advantages of the squirrel-cage motor for mining work. Difficulties in the way of its application to the various power requirements of a coal-mine can generally be overcome by suitable mechanical arrangements. Take, for example, the case of haulages. The three systems in general use—that is, direct haulage, main and tail haulage, and endless-rope haulage—can all be operated quite satisfactorily by means of squirrel-cage machines in combination with suitable clutches. Of these three systems the last-named is the easiest to operate in this way, because it is not necessary to start and stop at frequent intervals. The speed of the motor can also be kept constant, since the gear is usually designed for a uniform rope speed of about two miles per hour. The best position for the clutch is direct on the haulage drum, because the motor can then be quickly relieved of its load should the tubs chance to come off the road. Practical mining engineers are agreed that clutches give a control over the haulage which is unattainable by other means. The various types of pumps in use for mining purposes can also be readily arranged for driving by this class of motor. In the case of three-throw pumps, a by-pass valve can be fitted, thus enabling the motor to start up light. With respect to centrifugal pumps, which are now coming so rapidly to the front for high-lift duty, it is quite a simple matter to make provision for starting the motor under light load. All that is necessary is to insert a sluice valve in the rising main near to the discharge side of the pump. By closing this valve, starting may be effected with about one-quarter to one-third of full-load torque. The author has used this method with motors of the squirrel-cage type up to 100 h.p. As regards coal cutting machinery, this class of work is probably the most difficult to tackle by any type of motor, not merely on account of the requirements at starting, but also because of the excessive vibration and overloads, and rough usage generally, to which such machines are subject. The squirrel-cage motor is peculiarly suited for these conditions, and is now largely used for driving the various types of coal-cutter. As regards the starting arrangements, some makers rely on the ordinary compensator only, while others adopt a suitable device to enable the motor to start up light. In the application of class (*a*) motors to the driving of textile plant, the motors are connected direct to the ring spinning frames by means of clutch couplings, and handles operating the clutches are placed in convenient positions for the attendant.

Slip-ring Motors.—In some cases, however, it is found that the ordinary form of low resistance rotor does not meet the requirements. The starting torque of an induction motor is increased by an increase in the resistance of the rotor windings. Hence by making the rotor bars of higher resistance, the specific starting torque may be increased. To take, for example, the 33-h.p. motor, to which reference has already been made, by making the rotor with 66 per cent. higher resistance, the starting current would be reduced by 3 per cent., and the starting torque would be increased to 1·75 times full-load torque. The increase in the resistance of the rotor naturally means a lower efficiency, but the difference is such as in many cases to be well worth the advantage gained in respect to the starting qualities of the machine. In the case under discussion, the efficiency would be reduced by 2 per cent. The power factor would be slightly increased, so

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that the reduction in the apparent efficiency—which is the really important point—would be slightly less than 2 per cent. This leads to a consideration of class (*b*) motor. The rotor coils are usually Y connected, and their terminals taken through a hollow shaft to collector rings on which rest carbon brushes supported by the usual spring holders. By means of a rheostat external to the motor suitable resistances can be inserted in each phase at starting. The starting torque with this type of motor can be anything up to about twice the full load value, but in special cases up to three times. The starting current corresponds to about full-load current when starting with full-load torque, and proportionally more when starting with greater torque. In those cases in which no speed regulation is required, provision is usually made to short-circuit the winding in itself, instead of through the brushes and rheostat leads, so soon as the motor has reached normal speed. In some cases a brush-lifting device is also provided with the object of reducing the wear and tear on brushes and rings. In the author's view, however, the latter refinement is unnecessary for most ordinary purposes, and usually gives more trouble than it is worth. It will be seen from the foregoing considerations that the adoption of the squirrel-cage type of motor, whenever the conditions permit, would be entirely in accordance with the dictates of good engineering. Of course there are certain cases where it is not feasible to adopt this type, notably for crane work, although even here the author has seen successful examples of crane driving by means of squirrel-cage machines. When all is said and done, however, the choice of type, except in private plants, is subject to the approval of the supply authority. It therefore becomes necessary to ascertain to what extent the consumer is enabled to take advantage of the superior qualities of class (*a*) motor. Accordingly the author obtained the rules of the principal companies and corporations supplying polyphase current in the United Kingdom with respect to this point. One would naturally expect that the maximum size of class (*a*) motor allowed would be dependent in large measure on the station plant capacity, because in a private plant the total capacity of squirrel-cage motors, and the individual capacity of any one squirrel-cage motor, should bear a relation to the generating plant such that each squirrel-cage machine can be stopped or started at any time during normal working without interfering with the running of the other motors on circuit.

It is interesting to notice, however, that this consideration does not seem to have much influence on the restrictions imposed, for one company with a station plant capacity of 6,000 kw. allows a class (*a*) motor of 100 b.h.p. against 50 b.h.p. in the case of another company, with a plant capacity of 20,000 kw. A third company with a plant capacity of only 1,000 kw. allows a motor of 20 b.h.p. Two local authorities do not allow class (*a*) motors over 5 h.p., and it is often specified that motors must start on a loose pulley. The maximum permissible starting current is generally given as one and a quarter times full-load current. As a matter of fact, however, the author has found that the rules of the various power companies need not be too rigidly interpreted. The power companies are more favourably disposed towards the adoption of class (*a*) motors than are the various local authorities. Moreover, the author ventures to affirm that local authorities are in a great many cases overburdened with rules and regulations, which must inevitably hinder the development of power supply. The question is of importance at the present juncture, in view of the inquiry held by the Home Office to deal with the rules and regulations concerning the application of electrical energy in factories. The power companies seem to be able to get along comfortably with a set of rules embraced by a single sheet of foolscap. The local authority, on the other hand, appears to require protection to the extent of a bound volume of 30 or 40 pages. Among anomalies in the way of rules which the author has encountered, reference will be made to two only:—(1) The power factor of any motor *must not fall below* 0·8. (2) Before any application for power *can be accepted*, the name of the maker of the motor must be stated. (The italics are the author's.) The power factor is, however, a function of the load. Rule (1) as it stands is equivalent therefore to the demand that the motor shall always be operated at a given output, which of course is absurd. With respect to rule (2), it is surely not within the province of the supply authority to interfere in this connection, and in any case the author fails to see that the rule serves a useful purpose.

Before leaving the subject of power factor the author would like to emphasise the importance of choosing a motor which shall not be too large for its work, because the power factor falls off very rapidly with reduction in load. One of the points, therefore, to which attention should be given is to endeavour to operate each motor at its rated output. In fact, no harm is done to a high-class machine by an occasional overload. The overall power factor for an installation depends on the amount of attention which is given to the foregoing considerations. In actual practice it is customary to assume a figure of 0·8 for general industrial plants and 0·75 for mining installations, although this must of necessity be a variable figure, dependent entirely on local conditions. The author's experience tends to show that it takes a load of a very steady nature, together with a very well laid-out plant, to attain a figure of 0·80 in actual everyday operation. This is probably only attained under the most favourable circumstances in a textile or similar plant.

In conclusion, the author ventures to affirm that electrical engineers in general are too apt to attempt a solution of each and every problem by electrical means, and without sufficient consideration of the case in its mechanical aspects. As proof that his own practice is in accordance with his precepts, he would mention the case of a large foundry and engineering works for the electrical equipment of which he was responsible. Out of a total of some 40 motors, aggregating about 500 h.p., only four, or 10 per cent. of the total, were of the slip-ring type, the others being adapted to the various requirements by the mechanical arrangements outlined in the paper.

POWER TRANSMISSION BY HIGH-TENSION CABLES

In a Paper read before the Elektrotechnischer Verein, Berlin, on February 11th last, Richard Apt (of the Allgemeine Elektricitäts Gesellschaft) gave a *résumé* of the present state of our knowledge with regard to high-tension cables, and discussed the question as to whether power transmission by insulated cables at high pressures and over long distances were possible. The following is an abstract of the Paper and discussion, from the full report in the *Elektrotechnische Zeitschrift*.

Until now, the three-phase system has been almost exclusively employed for power transmission, partly because there was no single-phase motor which could compare with the three-phase motor as regards efficiency and suitability for heavy work, and also partly because, for a given amount of power transmitted, the three-phase system requires the least amount of copper in the transmission line. In consequence of this, the usual type of high-tension cable now manufactured is the three-phase three-core type.

One disadvantage of the three-core type of cable is that at high pressures the section of core is very limited, as the overall diameter of the cable, on account of the large amount of insulation required, easily reaches the value of 3½ in., at which size the author considers the limit of weight and flexibility is reached. From this consideration the author comes to the conclusion that it will not be advisable to make use of three-core cables at working pressures above 20,000 to 30,000 volts, but that three single-core cables will, in such cases, give a more satisfactory result.

The author then proceeds to give a summary of the theory of single-core insulated cables. Starting from O'Gorman's theory of the potential gradient, he shows how, for a given maximum stress in the dielectric, the thickness of the dielectric depends not only on the working pressure, but also on the radius of curvature of the copper core. As a consequence, there is, for any given pressure, a section of core for which the total cost of the cable will be a minimum. Several methods have been proposed for obtaining a uniform stress in the dielectric surrounding the conductor; that known as grading the insulation, proposed and patented by O'Gorman (see Electrical Engineering, January 9th, 1908, page 37) is the only one which has been used in practice.

In the case of single-core cables there are, besides the copper losses, auxiliary losses due to eddy-currents in the lead sheaths. The author gives a short summary of the investigations made by M. B. Field in order to determine the value of these losses, and points out that, in cases of long transmission lines with a low periodicity, these losses would be negligible in comparison with the copper losses. Besides the copper losses and the above-mentioned eddy-current losses, there are the losses due to hysteresis in the dielectric. So long as the dielectric is not overstrained, these losses are proportional to the square of the pressure and to the first powers of the capacity of the cable and the periodicity. These losses can be calculated, and are in general not large enough to affect seriously the economy of the system. An important loss, however, is that due to the no-load

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capacity current, which at high pressures becomes very considerable.

Although the large power transmission schemes have been almost exclusively carried out on the three-phase system, there are a few cases of power-transmission in Switzerland and France on the Thury high-tension direct-current series system. The simple transmission line required for the latter system, and

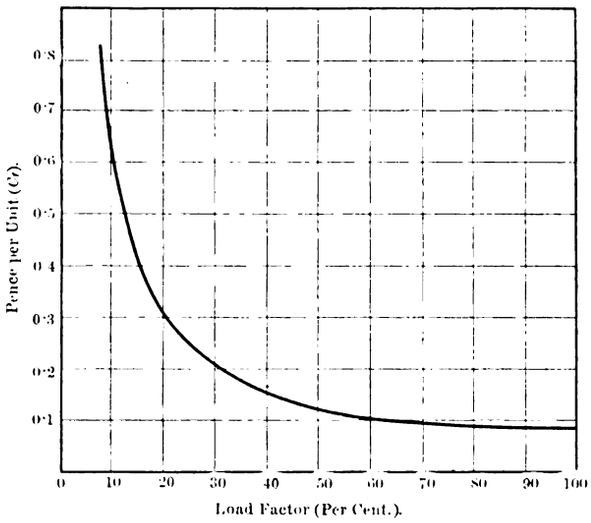


Fig. 1.—Cost of Transmission by Cables at Various Load-Factors.
(70,000 Kw. at 40,000 Volts over 87 Miles.)

the total absence of disturbances and limitations due to inductance and capacity, compensate largely for the higher cost and complication of the generating plant and sub-stations. Other disadvantages which must be remembered are the difficulty of enlarging an existing installation and the necessity for automatic regulation. However, considering that the effects of capacity and inductance are the chief factors limiting the practicable distance of transmission by alternating currents, the direct-current series system may come more to the front in the future for very long distance transmission. Again, for a given working pressure, the maximum stress in the dielectric is less for direct-current than for alternating current; and consequently the insulation in the former case need not be so thick as in the latter.

The possibility of the electrification of the main-line railways on the single-phase system, introduces this system as a desirable method of transmission. Although a three-phase transmission line requires only 75 per cent. of the amount of copper necessary for a single-phase line, the saving in copper is, under certain conditions, quite offset by the extra expenditure on the insulation and lead when high-tension cables are considered, particularly if sets of three single-core cables are to be used instead of three-core cables. Taking as an example the case of the transmission of 10,000 kw. over a distance of 62 miles at a pressure of 30,000 volts between conductors, and assuming a power factor of 0·85, and a total drop in pressure of 10 per cent., a section of 0·71 square inch per conductor would be required for the single-phase system, and a section of 0·355 square inch per conductor for the three-phase system. On account of the high working pressure, single-core cables would be used in each case. If the middle and neutral points respectively of the two systems are earthed, the pressure between core and lead covering is for the single-phase system 15,000 volts, and for the three-phase system 17,300 volts. Comparing the total costs for the two systems, inclusive of the cables, the materials for the underground construction and the cost of installing the same, the single-phase system works out 8 per cent. cheaper than the three-phase system in the case considered.

In order to show that a long transmission by means of high-tension insulated cables is within the limits of practicability, the author gives the following example:—A three-phase line for the transmission of 70,000 kw. over a distance of 87 miles at a pressure of 40,000 volts between conductors. If the system is star-connected, and the neutral point earthed, the pressure between the core and the lead covering in each of the single-core cables is 23,000 volts. For a total drop in pressure of 13 per cent., the necessary cross-section per conductor is 1·8 square inch. This is too large a section for one cable, so three sets of three cables should be used, each cable having a copper section of 0·6 square inch. The total number of cables, including one as a reserve, is thus ten. The cost of the whole 87 miles of cable and underground construction can be taken as approximately £1,200,000 or £13,800 per mile.

The cost of energy per unit at the generating station can be denoted by C_g, and this can be expressed as the sum of the fuel costs and the other generating costs per unit. The fuel costs are practically proportional to the load on the generating station, and therefore the fuel costs per unit (C_f) will be fairly constant, whatever the load-factor. The other generating costs (interest on capital cost of station, wages, maintenance, &c.) are nearly constant, and consequently these costs per unit (C_s) will vary inversely as the load. Denoting the value of the load-factor by p, the following equation expresses the relation between these quantities:—

$$C_g = C_f + \frac{C_s}{p}.$$

For the purposes of the present investigation, the fuel cost per unit (C_f) can be taken as 0·156d., and the other costs (C_s) as 0·036d. per unit. By substituting these values in the equation above, the total generating cost per unit can be readily obtained for any particular value of the load-factor p.

The cost per unit at the receiving end of the line is equal to the cost per unit at the generating end, divided by the average efficiency of the line. The cost of the units lost in transmission is thus divided over the number of units delivered, and paid for by the consumers. To this value of the cost per unit must also be added the indirect costs of transmission, which consist of the interest on the capital cost, maintenance, &c., of the transmission line. These last will be inversely proportional to the load factor p. Denoting this cost by C_l and the average efficiency of the line by η, then the cost per unit at the receiving end of the line (C) is expressed as follows:—

$$C = \frac{C_g}{\eta} + \frac{C_l}{p}.$$

If the interest on the capital cost is taken as 4·5 per cent., the sinking fund at 3 per cent. and maintenance and depreciation at 1 per cent., then the total annual expenditure on the line alone is 8·5 per cent. of the capital cost of £1,200,000, or £102,000. Dividing this by the number of kilowatt hours delivered at unity load-factor in one year, the value of C_l is obtained, thus:—

$$C_l = \frac{102{,}000 \times 20 \times 12}{365 \times 24 \times 70{,}000} = 0{\cdot}04\text{d.}$$

The average efficiency of the line must be calculated for each value of the load-factor, and all the line losses must be included. The following table shows how the cost per unit at the generating and receiving ends of the line is affected by the value of the load-factor. The last column gives the cost per unit of transmission (C_t) which is the numerical difference between C and C_g.

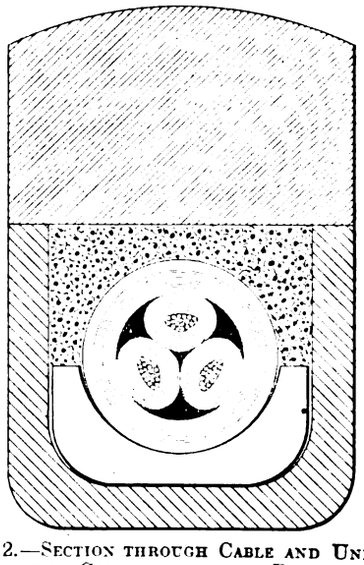


Fig. 2.—Section through Cable and Underground Construction for Durham.

p.	η.	C_g.	C.	C_t.
100%	81%	0·192d.	0·278d.	0·086d.
90%	82%	0·195d.	0·284d.	0·089d.
50%	86·5%	0·228d.	0·348d.	0·120d.
10%	70%	0·516d.	1·152d.	0·636d.

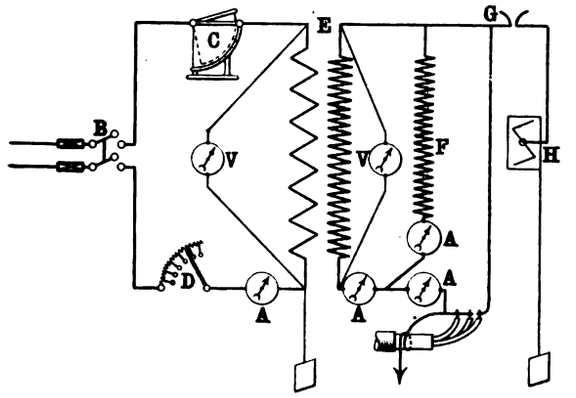
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These values are plotted as a function of the load-factor in Fig. 1. From this curve it can be seen that the cost of transmission is less than one-tenth of a penny per unit with high values of the load-factor.

Dr. Apt includes in his Paper a description of that portion of the high-tension cable line of the County of Durham Electrical Power Distribution Company, Ltd., which was laid by the Allgemeine Elektricitäts-Gesellschaft. The line consists of over 60 miles of 20,000 volt cable. These cables, which are of the ordinary three-core lead-covered type, were supplied in two sizes, 0·05 and 0·10 square inch sections per core respectively. The stranded cores are sector shaped, and are insulated with paper, a further thickness of insulation round all three cores being provided.

Each length of cable was tested at the works for 24 hours at 30,000 volts and 15 minutes at 50,000 volts. Test pieces, which were coiled to a diameter of twelve times the diameter of the cable, were required to withstand a pressure of 80,000 volts for two minutes. The cables were laid in earthenware troughs, which were filled in with asphalt mixture, as is shown in Fig. 2. After laying, the whole length of cable was put under a test pressure of 40,000 volts between the cores and the lead covering for half an hour. A telephone cable and a cable containing the pilot wires are laid in the ground directly under the trough containing the main cable.

The current is supplied from the power station at Carville at a pressure of 6,000 volts, to the two chief sub-stations at Gateshead and Yarrow, where it is transformed up to the pressure of 20,000 volts for the high-tension network. Some of the single lengths of cable are over 7·5 miles long, and the capacity current at 40,000 volts and 40 ~ is about 5 amperes per mile. The testing at this high pressure was carried out with the aid of a choking-coil as follows:—The choking-coil was connected across the high-tension winding of the testing transformer, as is shown in Fig. 3. The leading current taken by the cable was thus compensated for by the lagging current taken by the choking-coil, and consequently the transformer had to supply the losses only. The whole cable network has been in operation for about a year, and has given entire satisfaction.



A. Amperemeter.
B. Double Pole Switch and Fuses.
C. Liquid Resistance.
D. Regulating Resistance.
E. Testing Transformer.
F. Choking Coil.
G. Over Voltage Safety Device.
H. Liquid Resistance in Series with Earth Connection of Safety Device.
V. Voltmeter.

Fig. 3.—Diagram of Connections for High-Pressure Test on Cables.

In conclusion, Dr. Apt states that he does not agree with the results obtained by Mr. R. D. Mershon in an investigation in which he came to the conclusion that the longest practicable distance for electrical transmission was about 500 miles. In Dr. Apt's opinion, no general limit could be fixed.

In the discussion to the above Paper, at Berlin, Mr. Schrottke thought that the very high capital cost of an underground transmission line, in comparison with that of an overhead line, would generally lead to the adoption of the latter. He had calculated the cost of an overhead line, corresponding to the underground line taken as an example by Mr. Apt, and estimated the cost of the line alone to be some £400,000, or one-third of the cost of the underground line. He had, however, estimated for a single 66,000-volt steel tower transmission line, with towers 70 ft. high, spaced 650 ft. apart. Each tower would support 12 copper conductors (four three-phase circuits), each conductor having a cross-section of 0·155 sq. in. The working costs work out at less than half the corresponding costs for the underground line. As regards the dangers of breakdown, Mr. Schrottke pointed out that the conductors swing synchronously in the wind, and would not come in contact. He also thought that the danger of damage by lightning had been exaggerated. The capacity current was a very serious drawback to a cable line. He had calculated the capacity current for the 140 km. example given, and estimated that each set of three cables would require a 10,000 K.V.A. generator to charge them up to the potential of the line at 25 ~. Compensation by means of choking coils would, he thought, be too expensive. The capacity current of a corresponding overhead line would be not more than one-twentieth of the above amount.

Dr. Apt in reply agreed that where possible an overhead line would be constructed in preference to an underground line, in consequence of the high cost of the latter. To emphasise the reality of the danger of breakdown due to lightning, he mentioned the case of a large mining company in South Africa which constructed an underground line for transmission from their central station to the mine, in spite of the higher capital cost. The generating station which supplied the town of Johannesburg over an overhead line, experienced frequent breakdowns due to the line being struck by lightning, in spite of the fact that protective devices were provided.

The discussion was continued by Mr. Lichtenstein, who did not agree with Dr. Apt that three-core cables should be replaced by single-core cables for pressures over 30,000 volts. As a result of some experiments which he had made in the laboratory of the Siemens-Schuckertwerke, he was convinced that satisfactory three-core cables could be constructed for pressures of 30,000 to 40,000 volts, having a normal section of conductor, and a permissible value of the overall diameter. He thought that the three-core cable had considerable advantages over the set of three single-core cables, even at these high pressures.

The American Bell Telephone System.—The annual report of the American Telephone and Telegraph Co., still known commonly as the "American Bell," states that at the close of last year there were 3,839,000 stations connected, with a total of 8,610,592 miles of wire. There were 5,997,000 exchange and toll calls during the year. During the year $52,921,400 was spent on construction, and 768,340 stations were added. The total number of exchanges and branch offices is 5,108, representing an increase of 219 for the year. A total of 88,274 employees are in the service of the company. In addition to the expenditure on new construction already mentioned, $36,626,667 was spent out of revenue on maintenance and re-construction. Arrangements have been made with the Western Electric Co. by which this manufacturing company is now free to supply telephonic apparatus to any purchasers, instead of being bound as hitherto to sell in America only to the Bell group of companies.

Compressed Cotton Brake Blocks.—In the course of a general review of the working of the London Underground Electric Railways in the *Railway Gazette*, attention is called to the recent substitution on these lines of brake blocks of a special form of compressed cotton instead of metal. A good deal of trouble has been experienced with metal blocks, owing to the accumulation of large quantities of pulverised steel on the track and conductor rail insulators. To obviate this, brake blocks of cotton fibre have been adopted on the new London tubes, where they have been completely successful, though when used in the open parts of the District line defects have been observed which are now being investigated. The blocks consist of five layers of heavy woven cotton impregnated with resin and asphalte. Their coefficient of friction is considerably higher than that of cast steel blocks, and in use it is necessary to train the motormen to make a somewhat lighter application than with the metallic blocks in order to avoid sticking and skidding, but when the train line pressure is reduced by 10 lb. satisfactory results are obtained. Trouble was at first experienced by the flowing of the sheets outwardly away from the wheel flanges so that, occasionally, parts fell on the permanent way, and, owing to the impregnation, clung to the rail where they usually dropped, giving rise to false reports of broken rails. Cotton fibre has no grinding effect on the wheel tyre, but it has the slightly bad effect that it does not keep the wheels trued, and inexperienced motormen are liable to produce a series of small flat spots due to short-time skidding. The blocks having no cutting action, the tyres remain somewhat rough to an extent that can be detected in rough riding. This is a small defect inasmuch as it can be easily obviated by training the men. On the other hand, the absence of grinding action has a highly beneficial result in the saving of tyre wear, and the consequences of it to which we have already referred. The average life of the cotton composition brake block in the tubes is found to be on trailers about 20,000 miles, as against 13,000 miles with metallic blocks. The cotton fibre blocks have not so far been successful on the open parts of the Metropolitan District line, as shown by experiments made on their South Harrow branch, probably owing to damp. These become "clammy" in the language of the men in charge, and there appears to be difficulty in releasing the brake, showing a want of uniform adhesion and some erratic actions. The brake blocks have the appearance of having absorbed some moisture, although it should be possible to overcome this fault.

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AN ELECTRIC CAR TESTING PLANT

An elaborate electric car testing plant, which forms part of the equipment of the electric railway engineering laboratory at the Worcester Polytechnic Institute, in America, is described in the *Street Railway Journal*. The apparatus, which was designed by Prof. A. S. Richey, is connected to the lines of the Worcester Consolidated Street Railway Co., and is modelled upon the locomotive testing plants at Lafayette, owned by Purdue University, and at Altoona, owned by the Pennsylvania Railroad Co. The general scheme is that of holding the car under test over a set of supporting wheels which correspond to the track. These supporting wheels bear the weight of the car and turn with the car wheels, the car body being coupled to a rigid end post. Wind resistance, linear inertia, &c., are provided in an effective manner by means of flywheels and electric brakes, as will be described.

Four sets of stands are provided, each one carrying a pair of bearings and a supporting shaft. These four stands rest on and are bolted to parallel heavy I-beams which are embedded in the concrete foundation. Each of the shafts carries a pair of steel-tyred supporting wheels. The bearing surfaces of the supporting wheels are turned to the same section as the head of a 100-lb. rail, and each pair of wheels is spaced on the shaft just track gauge distance apart. The stands, with shafts and supporting wheels, may be shifted on the foundation I-beams to provide for cars of various truck and wheel base, a final fine adjustment being provided by a movement of the bearing pedestals on the stands by shifting screws. Thus far the arrangement is patterned directly after the locomotive testing plants which have been mentioned. The arrangements for imitation of inertia, wind resistance, &c., are entirely different, however.

No arrangement has been used with the locomotive testing plants for the imitation of inertia, as it would be exceedingly difficult to imitate safely the inertia of the entire mass of the moving train for the movement of which the locomotive is designed. As the motors on a single electric car, however, are generally designed to handle but the one car, flywheels may be designed which will correctly imitate such inertia, and this has been done in the present case. Each of the supporting shafts carries a flywheel. These flywheels are made up of boiler plate in order to provide strength against the high values of centrifugal force at high speeds, and also in order to provide an easy method of changing flywheel weights to suit cars of different weights. Individual interchangeable boiler plate discs, varying in thickness from ¼ in. to ¾ in., are provided. By making up flywheels of different thicknesses, it is possible to imitate correctly the linear inertia of single-truck cars weighing 8, 10, 12, or 15 tons, or double-truck cars weighing 15, 20, 25, 30, 35, or 40 tons. The flywheels enable breaking tests to be made, as well as motor tests.

The form of friction brake which has been used in connection with locomotive testing plants has here been replaced by electric brakes, consisting of standard G. E. 57 motors mounted on and geared to the shafts between the supporting wheels. These motors act as generators, the fields of all four being in series and separately excited. Their armatures, however, are connected in parallel to a resistance load. While this resistance load is variable, it is only varied to care for extreme changes which may be desired, as a better regulation is obtained, within limits, by varying the field of the exciting generator, this varying in turn the fields of the brake generators and their voltage. It may easily be seen that power to overcome wind resistance and resistance due to track grades may be taken up by the braking effect of these generators, at the same time being entirely separate from the power used to overcome inertia, which is correctly stored in the flywheels as kinetic energy as momentum is acquired, to be dissipated in friction as the car slows down either through drifting or braking. At the same time, the entire tractive effort is shown by the pull on the drawbar of the car under test.

The arrangement of brake generators above described performs another important function, that of keeping all supporting shafts rotating at similar speeds at all times. The electric car is not commonly provided with connecting rods between drivers, consequently some corresponding device must be used between the supporting wheels, else the various car wheels would be running at various speeds on test; especially would this be true while the car motors were in a series connection. The series connection of brake generator fields, separately excited, and the parallel connection of brake generator armatures, whether on or off the resistance load, solved the problem quite satisfactorily. Various schemes for bevel gear, connecting rod, belting or rope drive connection between the supporting axles were proposed and discarded, chiefly because of difficulties in shifting stands to accommodate various wheel bases.

For shifting cars on and off the test stand, channel iron supports for special rails are temporarily bolted to the inside of the supporting wheels and to the ends of the track rails at the door of the laboratory. These channels are supported by wedges which fit the hubs of the supporting wheels, and are also blocked up between stands for additional strength. These channels support special rails which carry the car on its flanges until the car wheels are over the supporting wheels, where the tread of the car wheel rests on top of the supporting wheel, the stands having been correctly spaced for the wheel base of the car and the height and position of the special rail having been adjusted to suit the flange section of the car wheel previously. Arriving at the proper position, the car is held rigidly in place by a coupling to an end post. The channel irons are then unbolted from the supporting wheels, and the supporting wedges removed, allowing the full weight of the car to be borne by the supporting wheels. An arrangement is provided for supporting the channels independently and clear of the supporting wheels while a test is in progress, a quick shift bringing them back into position for carrying the car off the stand upon the completion of a test. The drawbar and post arrangement for holding the car in position will be replaced, eventually, by a traction dynamometer for measuring the tractive effort of the car under test.

ELECTROCHEMISTRY AND ELECTROMETALLURGY

A process for the recovery of nickel from oxide and silicate ores is described by William Koehler in *Electrochemical and Metallurgical Industry* of April. The usual smelting and refining processes employed for the winning of nickel are not readily applicable to the garnierites, which contain nickel-magnesium silicates, oxides, &c. This class of ores is largely found in New Caledonia, North Carolina, and Oregon. Sepiolite or meerschaum is a mineral which usually has the formula $H_4Mg_2Si_3O_{10}$, but the magnesium is often replaced by copper or nickel. For example, an analysis of an ore from North Carolina showed it to contain 17·84 per cent. of nickel. The method employed to obtain the nickel from such an ore is briefly one of chlorination, roasting to decompose the more unstable chlorides, leaching and electrolysis to recover the nickel.

The metallic chlorides are by no means equally stable, some being very readily split up when roasted in a current of steam. For example, it is not possible to obtain anhydrous aluminium, iron, or magnesium chlorides by evaporating the solutions to dryness, because they are hydrolytically decomposed with formation of the oxides, $2AlCl_3+3H_2O=Al_2O_3+6HCl$. On the other hand, a solution of nickel chloride may be evaporated down without decomposition. It follows, therefore, that if we are dealing with a mixture of nickel chloride and iron chloride, on heating such a mixture with steam, and by a careful regulation of the temperature, only the iron chloride would be decomposed, with formation of ferric oxide. On leaching out this product a solution of nickel chloride, containing practically no iron, would be obtained.

The chlorination may be carried out in a variety of ways, such as heating the ore in a rotary kiln and passing over chlorine gas, or by the action of ferric chloride, but Koehler prefers to heat it with hydrochloric acid, as by this method no foreign material is added, and it is easier to manipulate than roasting in presence of chlorine gas. After chloridisation, the product is placed in a rotary kiln and heated to a temperature which must be below the decomposition point of the chloride of the metal to be recovered, steam and air at the same time being passed over it. The hydrochloric acid from the decomposable chlorides is thus recovered, and can be again used.

After this treatment the mixture is leached out with water,

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when a solution of nickel chloride is obtained. This solution is then electrolysed, using insoluble anodes of carbon, the nickel is deposited out at the cathode, and chlorine obtained at the anode. The process has been carefully tested at one of the leading electrolytic copper refineries in the United States, and they report it to be metallurgically sound, and advise the erection of a plant to work it commercially. En passant, it is mentioned in the article that the Brunner Mond Alkali Co. produced from November, 1905, to October, 1906, 2,595,382 lb. of zinc and 8,360,660 lb. of bleach by the electrolysis of zinc chloride by the Hoepfner process. It should also be mentioned that the electrolysis of nickel chloride upon a commercial scale is not new. The International Nickel Co., for example, are producing nickel by this method. In the same number of *Electrochemical and Metallurgical Industry, loc. cit.*, J. R. Crocker contributes an article upon Diaphragms. It is written mainly from an historical and suggestive point of view; suggestive because the author remarks in the first paragraph, "extended and expensive experiments have been made to find the ideal conditions, or the ideal material, but the field is still open for improvements, and many diaphragms at present in use are in somewhat of an experimental state." Porous plates of earthenware are first described, these unfortunately are imperfectly permeable; therefore it has been attempted to locate liquids between two separate partitions. This works all right, provided the liquid diaphragm can be kept in a definite and steady position, but owing to chemical action, mechanical shocks, &c., this is in practice an extremely difficult matter.

As to diaphragm materials, these are exceedingly varied. Asbestos in one form or another is very largely employed, but even with this material there are very considerable practical difficulties. If natural asbestos is employed in an alkaline solution, it soon becomes non-conducting; this is probably due to precipitation throughout the material of non-conducting material; this stops up the pores, and consequently electrolytic conduction can no longer take place. The asbestos is therefore frequently treated with acid, pressed, rolled, and rinsed with water until the salts are removed. Very often the asbestos is mixed with lime, and is then treated with a solution of sodium silicate. This converts the lime into insoluble calcium silicate, and causes the diaphragm to be less subjected to disintegrating action and also to the action of the electrolyte or the products produced upon electrolysis.

Another form of diaphragm cell which has been employed for the electrolysis of fused salts is made of a steel casing, in which another steel case can be fitted concentrically. Between the outer and inner casing, both of which are perforated, a diaphragm mixture of Portland cement and asbestos, or of cement and powdered glass, or burnt magnesite, can be employed.

Bichromatised gelatine has also been employed. A sheet of asbestos is soaked in gelatine or glue and potassium bichromate. It is then exposed to the action of light; by this means an insoluble compound is produced, which is said to form an efficient diaphragm. Even slabs of soap have been suggested and actually employed.

It is well known that percarbonates and perborates, when added to water, yield solutions of hydrogen peroxide. The whole of the peroxide is, however, never yielded up, because an equilibrium is produced. This is due to the fact that perborates, for example, can be produced by the addition of hydrogen peroxide to sodium borate. The Consortium für Elektrochemische Industrie of Nürenberg have patented a process by means of which they can extract the whole of the hydrogen peroxide, German Patent 195,351 (March, 1908). The process consists of adding ether to the solution. The ether extracts the whole of the hydrogen peroxide and thus prevents an equilibrium being set up. The solution, after extraction, only contains carbonates or borates, and by being re-electrolysed the percarbonates or perborates are reproduced. This then gives a method for preparing hydrogen peroxide indirectly from water by electrolytic oxidation. No direct method is at present known.

The directors of the British Aluminium Co. have again declared a dividend of 7 per cent. on the ordinary shares, and carry forward a balance of £36,000, after they have cancelled funding certificates to the amount of £8,900. There has, however, been a decline in profits as compared with 1906. This is attributed to the slump in copper which occurred last July and to the consequent demoralisation in the metal markets. There is no recovery in the price of aluminium to record; therefore the metal has been taken into stock at a much lower price than in previous years. On the other hand, an improved demand has recently set in, and should this be maintained the prospects of the company are rosy.

In the *Times Engineering Supplement* of last week there is an interesting article by Mr. S. Walter upon the "Artificial Production of Rubies and other Gems." Artificial rubies are now being manufactured, and the gems placed upon the market are indistinguishable from those found in the Burmese mines. They are identical in colour, hardness, density, and in refractive power to the natural stones. Their chemical constitution is the same, that is, they are practically pure alumina coloured by traces of chromium and iron oxides. They possess the same power of phosphorescing under the influence of the cathode rays as the natural stone, and they are practically flawless. Now natural rubies usually contain flaws, which always show crystalline structure. The artificial rubies contain flaws which are caused by the occlusion of minute bubbles of gas—they are therefore ellipsoid in structure. Indeed, this is practically the only way in which the natural and artificial rubies can be distinguished. Rubies and sapphires have been produced in the electric furnace, but they are manufactured by allowing the oxy-hydrogen, or, better, the oxy-acetylene flame to play upon powdered ruby cuttings. The cuttings are placed upon a fire-clay platform, which is kept rapidly rotating while the jets from four oxy-acetylene flames play upon them. The mass soon becomes semi-liquid, when the fine ruby powder is added to it, so that the mass gradually increases in size. The maintenance of homogeneity is a matter of great importance, because it is only by effecting this that a bright crystalline gem will ultimately be obtained. When of sufficient size, the molten mass is removed and dropped into a carefully prepared bed of previously heated sand, and allowed to cool slowly. The resulting gem, after cooling, is ready to be cut, and has all the appearance of the natural stone. Cathode rays have recently been employed for melting highly refractory metals; possibly they might be conveniently employed for the production of artificial gems, at any rate, as the operation is carried out in a vacuum there would, we should imagine, be less likelihood for the formation of flaws due to the occlusion of gas.

ELECTRICAL SCIENCE

British and American

Effect of Thermal Treatment on Magnetic Properties.—It is fairly generally known, and was pointed out by Ewing many years ago, that the process devised by Ewing and called "demagnetisation by reversals" is not quite the equivalent of demagnetisation by annealing. The fact is that with most materials the magnetic susceptibility is higher after the annealing process than it is in the same specimen after the process of demagnetising by reversals. Thus, if a rod of iron be annealed from a high temperature and its *I H* curve obtained, and then demagnetised by reversals and again submitted to measurement, the second *I H* curve lies below the first curve. In the April *Proceedings* of the Royal Society of Edinburgh J. G. Gray and A. D. Ross extend our knowledge of these matters. They employed thin rods of various ferro-magnetic materials, and made their observations by the magnetometer method. They pushed their fields up to 125 C.G.S. units, and used for annealing all temperatures from 900° C. downwards. They found in all cases that specimens submitted to thermal treatment are in a sensitive state as regards magnetisation compared with the same material submitted to demagnetisation by reversals. The effect is produced to a slight degree in some cases by temperatures as low as 100° C., but gets larger as the maximum temperature approaches 700° C. After this latter temperature there is little alteration in the sensitiveness produced by annealing. The rate of cooling from the higher temperatures, if not very rapid (as, for instance, by quenching), has little influence on the magnitude of the effect. The sensitiveness is permanent, that is, does not diminish with the mere lapse of time, but mechanical agitation reduces the sensitiveness. Of course, magnetic treatment produces great changes in the magnetic character of the annealed material. For instance, if the *I H* curve for a newly-annealed piece be drawn as the field is increased to, say, 10 units, diminished to −10 units, increased again to +10 units, and so on cyclicly, the ascending loops fall lower and lower and the final *I* is about 20 per cent. lower than the initial *I* at field 10. In general, cyclic reversals of field between definite limits bring the magnetic susceptibility, &c., to lower values for fields lying between those limits. But so long as the field is not changed in sign the sensitive state persists almost unimpaired. The effect of the magnetic treatment is always shown most prominently at that field value where the permeability is greatest, and tends to zero as fields giving saturation are approached. The authors found that the most striking effects are given with hard steel, though similar properties are found in cast-iron and cobalt. The effect is almost absent in soft iron.

The Nature of Gamma-Rays.—At the last meeting of the Physical Society, a Paper by W. H. Bragg and J. P. V. Madsen was read. The former physicist has for some time been urging that the ether-pulse theory of Röntgen rays, and of the gamma-rays from radioactive substances, might, after all, be wrong.

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and has been advocating a theory of his own. This theory supposes that the gamma-rays, whose principal property is that of being undeflected in magnetic or in electric fields, are streams of uncharged particles--possibly neutral pairs of positive and negative corpuscles. In the present Paper, the authors suggest that in a Röntgen tube the cathode particles that strike the anti-cathode pick up there a positive particle, become neutral and are called X-rays (or Röntgen rays), encounter "absorbing" matter and lose their positive particles, thus figuring as secondary cathode rays. They suggest, further, that throughout all these changes the negative electron maintains almost invariably its original speed. This last point seems to them borne out by the fact that the secondary cathode particles due to Röntgen rays have the same speed, nearly, as the original cathode rays in the tube, and by the analogous fact that the secondary cathode rays due to gamma-rays have the same speed, very nearly, as the beta-particles issuing from the same radio-active material. Apart from these speculations, however, the Paper gives a preliminary account of an experimental investigation which appears to the authors to show finally that the gamma-rays from radioactive matter are material in nature and not ether-pulses. The authors base their argument on the premiss that the secondary radiation excited in an atom by a passing wave or pulse must be symmetrically distributed with regard to a plane passing through the atom perpendicular to the direction of motion of the pulse, and that, therefore, the secondary radiation produced by gamma-rays passing through a very thin plate of matter, should be exactly the same on the two sides of the plate in amount, in quality, and in distribution. Their experiments, corroborating those of Wigger, show that this symmetry does not exist. The present authors' experimental method consists in making the top and the bottom of an ionisation chamber of a pair of thin plates of, say, aluminium and lead. If the secondary radiation produced by these plates under gamma-rays from radium is perfectly symmetrical, it ought not to be possible to discover in which direction the rays are going through the chamber by the mere comparison of the consequence of inverting the pair of top plates with that of inverting the pair of bottom plates. As a matter of fact the direction can be discovered with ease, especially if plates be used of such great difference in atomic weight as aluminium and lead. For example, in one experiment the thickness of each plate was a little less than two millimetres. Inversion of the top plates made a difference of one per cent. in the ionisation current through the gas in the chamber. On the other hand, inversion of the bottom plates made a difference of 44 per cent. According to the authors, the ether-pulse theory of the gamma-rays cannot possibly account for this difference.

The Fundamental Law of Electro-magnetic Induction.—Two statements of the law of induction, discovered by Faraday, are widely used, one due to Faraday himself stating that the induced E.M.F. in a conductor is proportional to the rate at which the conductor is cutting lines of magnetic induction; the other, commonly called Neumann's law, stating that the induced E.M.F. in a circuit is equal to the rate of diminution of the magnetic flux through the circuit. In the March *Proceedings* of the American Institution of Electrical Engineers, C. Hering raises the question whether these statements are really equivalent, as commonly supposed. To show that the statements are decidedly not equivalent he has designed and performed the experiment illustrated here. The conducting loop L, formed of two flexible strips, whose ends are pressed into contact at the joint J, is in series with the galvanometer G. On moving the loop over one limb of the magnet N S, from the dotted position to that shown in full in Fig. 1, an E.M.F. is induced. If now the loop is moved as shown in Fig. 2, from the dotted position to that shown in full, the electrical circuit being kept continuous through the substance of the magnet, there is no induction

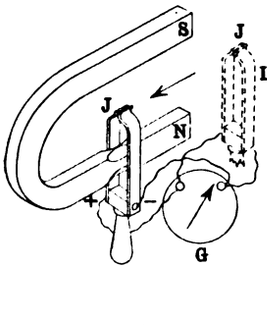


FIG. 1.

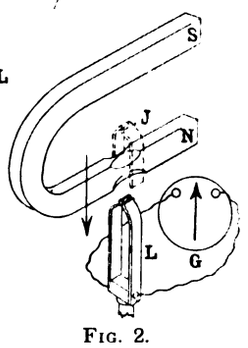


FIG. 2.

whatever of electromotive force. Now according to the "rate of change of flux through circuit" rule there ought to be an E.M.F. induced equal and opposite to that created in the operation shown in Fig. 1. The author urges, therefore, that the true statement of the fundamental law is that of Faraday. It is the material of the conductor of the current, and not merely the circuit itself, which must cut the flux to cause electro-magnetic induction. The converse of this phenomenon has long been known. For instance, in a Faraday disc unipolar machine used as a motor it is neither the circuit nor the current which is rotated through the disc, but it is the disc itself on which the forces act. The author suggests in the Paper a form of continuous-current generator, based on the above experiment with a magnet. The machine proposed has, however, the same limitations as the usual unipolar ones, in that two sliding contacts moving at high speed are required for each element of the circuit which passes through the flux.

Continental

Photoelectric Properties of Selenium.—The debatable question whether metallic or amorphous selenium is the vehicle of photo-electric sensitiveness is discussed by C. Ries in the *Physikalische Zeitschrift* for April 1st. Schrott favours the metallic variety in this respect. But the author points out that when amorphous selenium is heated from 170 to 210° C. it increases in sensitiveness up to 195° and then decreases. At 195° the temperature coefficient of resistance is negative, which clearly indicates a non-metallic structure. Above 200° there is a positive temperature coefficient. The effect of prolonged heating varies according to the temperature. Above 200° C. it diminishes the sensitiveness, whilst below 200° it increases it. When the temperature coefficient of resistance is positive the sensitiveness is negative, *i.e.*, illumination produces, like heat, an increase of the resistance. The author calls this variety of selenium the β-form. The other crystalline variety, which is obtained by prolonged heating at 195° and rapid cooling, may be called the α-form. It has a negative temperature coefficient of resistance and a positive sensitiveness. Light and heat produce a diminution of resistance.

Zeeman Effect.—P. Zeeman himself has applied Fabry and Pérot's interferometer to the observation of the Zeeman effect, and describes his arrangement and results in the *Physikalische Zeitschrift* for April 1st. The interferometer consists of two half-silvered glass plates mounted at a certain distance from each other in strictly parallel planes. This strict parallelism is secured by pressing the plates against round steel buffers by means of springs. The slight compressibility of the steel buffers allows of an extreme accuracy in the adjustment. Zeeman prefers the arrangement in which the distance between the plates is always kept the same. The appearance in the telescope is a set of concentric rings, each showing the succession of colours belonging to the spectrum. On exciting the magnetic field the rings towards the red contract and those towards the violet expand. When the field is strong an expanded violet ring may coincide with a contracted red ring. The second coincidence of this kind occurs at a field of about 15,000 units, and is particularly favourable for exact measurements.

Representation of Electric Lines of Force.—A number of methods have been proposed with the object of making the course and distribution of electric lines of force evident to the eye. The readiness with which magnetic lines of force are made visible has led to the practice of beginning with them, and of treating electrostatic fields by analogy. Seddig's suspension method, though cumbersome, is perhaps the best hitherto devised for electric force. A new and better method is proposed by C. Fischer in the *Physikalische Zeitschrift* for April 1st. He grinds gypsum in a mortar, and so obtains a collection of minute rhombic plates, which are sifted and sorted into various sizes. This crystalline dust is spread on a glass plate, and the electrodes are discs of tinfoil stuck on the glass. The lines mark themselves out on tapping the plate, just as the magnetic lines of force traced with iron filings. The p.d. must not be too high, or the crystals are repelled from the electrodes. The course of the lines of force in various electrical combinations and apparatus may be studied by cutting out pieces of tinfoil representing various sections of the apparatus and sticking them on glass as before. The individual crystals set themselves with their longer axes along the lines of force.

Positive Electrons.—J. Becquerel has succeeded in obtaining some further evidence pointing towards the existence of positive electrons inside atoms, though not, apparently, separable from them. It is given in the *Comptes Rendus* for March 30th. Reversed Zeeman effects have been found in crystals and solutions containing rare earths (Becquerel), in the second hydrogen spectrum and the flame spectra of alkaline earth haloids (Dufour), and in sodium vapour (Wood). Becquerel has now found a similar effect in the spark spectrum of yttrium. This was obtained by sparking over a solution of yttrium nitrate contained in a magnetic field of 20,000 units. There are two groups of lines in the orange part of the spectrum, with terminal lines at wave-lengths 597 and 613·1 respectively. The latter consists of seven lines, and these show the ordinary Zeeman displacement and polarisation. The group at 597 consists of eight lines, and in all of them the effect is reversed. The displacement is the same in all the lines, but is rather less than the displacement of the D-lines of sodium. There is always the alternative explanation of a local reversal of the magnetic field, but if that were accepted it would be difficult to account for the absence of an influence of temperature. The author inclines to the supposition of the existence of positive electrons revolving within the atom.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published April 16th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1906 Patent

29,086. Sir Oliver Lodge. A method of exciting the primary of a Ruhmkorff induction coil by means of the "induction kick" from another inductance coil. The inductance coil is first connected to a generating circuit, then disconnected and discharged through the primary of the Ruhmkorff coil. This operation can be performed by a rotating commutator or other two-way switch. The self-induction of the inductance coil should be one to two henries for a Ruhmkorff coil with a self-induction of one-tenth to one-quarter of a henry. To prevent sparking, capacities are shunted across the inductance and also across the generating circuit. Three claims, five figures.

1907 Patents

7,926. H. S. Hatfield and F. M. Lewis. In order that flame carbons, that is, carbons impregnated with metallic salts, may be burned in an enclosed arc lamp and the life of the carbons thus be lengthened, it is necessary to provide a rapid circulation of the gases in order that the volatilised chemicals shall not be deposited on the globe. (See also Electrical Engineering, February 27th, page 299.) The present invention relates to an improved construction of the side circulation tubes and the supports for the globe, by which the globe is more readily removable for cleaning and for renewing the carbons. The lamp itself is hung in the tubular frame by means of a universal joint, and the globe is connected at the bottom to the hollow frame by means of a flanged tube pressed up against the neck of the globe by a spring. The gases circulate down the tubular frame and up through the globe. Ten claims, four figures.

8,388. British Thomson-Houston Co. (*General Electric Co.*). When arc lamps having electrodes of dissimilar material, for example, carbon and titanium carbide, are operated on an alternating-current circuit, a certain amount of rectification takes place. With several lamps in series, and operated from a constant current transformer, this results in an extremely poor power factor. By connecting half the total number of lamps reversely with respect to the others, the tendency to rectify is overcome. One claim, one figure.

8,629. A. H. Human. For dealing with intermittent or suddenly changing loads in electrical driving, it has been customary to use an auxiliary machine coupled to a flywheel in which energy may be stored up during periods of light load. The present invention renders the use of such an auxiliary machine unnecessary, and can be applied to either continuous current or alternating-current machines. One element of the driving machine, say the armature, is rigidly attached to the driving shaft, and the other element (the field magnet system in the case of a continuous-current machine) is mounted loosely on the shaft, and can rotate about the armature in either direction. The armature and shaft are free to rotate in one direction only. Current is supplied to the machine in such a way that the armature tends to rotate in the direction in which it is prevented from rotating. The heavy field magnet system therefore rotates in the opposite direction, and is allowed to attain a high speed. If the shaft is then needed to drive the load, the electrical conditions between the two elements are altered, the current in the field magnet being increased so as to make the machine act as a generator. As a result the armature and shaft rotate in the same direction as the field system, and the whole will then gradually slow down, doing useful work. An improved arrangement, by which rotation of the driving shaft in either direction can be obtained, is also described in the specification. Two armatures mounted on the same shaft are used in this case, the field-magnet systems rotating in opposite directions. Five claims, two figures.

16,865. A. G. Brookes. (*Asbestos Wood Co.*). A process of manufacturing an insulating material. Asbestos or asbestiform fibre is associated with water and magnesium oxide under pressure and the porous refractory material so obtained, which contains a proportion of magnesium hydroxide as a free oxidising agent, is impregnated with a liquefiable oxidisable hydrocarbon such as ozocerite or any other pitch or asphalt containing ceresin wax. The impregnation is done in a vacuum chamber, and the material is then dried at a temperature of about 80° C. for some days. Four claims. No figures.

17,704. D. Marzi. An improved loud-speaking telephone apparatus, in which the vibrating diaphragm is arranged separate from the magnet system. An oscillating lever which is acted upon at one end by the magnet system imparts its oscillations, considerably magnified, to the diaphragm which may be of any suitable material. According to this invention the rod oscillates in a magnetic field between two poles of equal intensity, one of which is strengthened while the other is weakened at the passage of the current. This ensures that the rod acts positively on the diaphragm in both directions. In a transmitter the short arm of the lever is fixed to the diaphragm; in a receiver the long arm. The windings in which the line current circulates can be on the magnet or on the oscillating rod. Four claims, six figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1907 Patents

4,813, Haydon & Williams. Dynamo-electric transmission of power.
7,642, Lake (*Parker Clark Electric Co.*). Filaments for incandescent lamps.
7,712, Lake (*Ingersoll Rand Co.*). Electro-pneumatic track channellers.
8,036, Craig. Production of ozone from oxygen or air.
8,153, British Thomson-Houston Co. (*General Electric Co.*). Electric motor control systems.
8,974, Nimmo. Train-signalling apparatus.
10,071, British Thomson-Houston Co. (*General Electric Co.*). Supports for the filaments of incandescent lamps.
11,022, Hirst & Leoscher. Lightning arresters.
11,854, Gibbons. Telemotor apparatus.
13,044, Webb. Insulators for telegraph and telephone wires.
14,101, British Thomson-Houston Co. (*Allgemeine Elektricitäts-Ges.*). Control of winding gear.
17,147, Southam. Electrically-operated fountains.
17,781, Jones. Electric arc lamps.
17,783, Meyer. Electro-magnetic reversing coupling.
17,972, Siemens & Halske Akt.-Ges. Manufacture of electric lamps.
18,033, Bodell. Apparatus for locking electric light glow lamps to holders.
18,406, Ewart. Electric switches.
19,027, Chaumat. Electrolytic process for the preparation of indigo dyes.
19,975, Siemens Bros. & Co. (*Siemens & Halske Akt.-Ges.*). Apparatus to control railway points.
22,745, Siemens Bros. & Co. (*Siemens & Halske Akt.-Ges.*). Telephone exchanges.
24,135, Allgemeine Elektricitäts-Ges. Alternating current commutating machines.
24,769, Wolhaupter. Insulated railway rail joints.
25,430, Bollée. Vertical motors.
25,832, Wolhaupter. Insulated railway rail joint.
25,833, Wolhaupter. Insulated railway rail joint.
26,531, Ges. für drahtlose Telegraphie. Receiver for wireless telegraphy.
26,647, Palmer. Electric alarm clocks.
26,925, Unterberg & Helmle. Insulation of magneto-electric sparking apparatus.
28,212, Hoffe & Jelfs. Electrical locking apparatus for railway signals.

1908 Patents

328, Lertourné. Electric motors.
549, Trumpler. Electrical heating apparatus.

Complete Specifications open to Public Inspection before Acceptance.

1908 Patents

3,583, Seibt. Radio-telephony.
6,050, Siemens & Halske Akt.-Ges. Process for hardening tantalum.
6,051, Siemens & Halske Akt.-Ges. Process for hardening tantalum.
6,245, Westinghouse Metal Filament Lamp Co. Metal filament electric lamps.
6,587, Eiséer & Holmström. Microphones.
6,737, Felten & Guilleaume-Lahmeyerwerke Akt.-Ges. Non-inductive resistances.
6,764, Soc. Ch. Legrand et Cie. Electrically-controlled locks for carriages.
6,765, Engel. Contact device.
6,767, Soc. des Télégraphes Multiplex (Système E. Mercadier). Mono-telephone relay transformer.
6,895, Siemens & Halske Akt.-Ges. Electrical indicators.
7,045, Noe (Cepath). Dynamo-electric machines.

Expiring Patents

No patents of electrical interest expire during the current week.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ld.	10	7	7½	10¾—11¾	
Do. 4½% Cum. Pref.	10	4½	4½	10—11	
Do. 6% Cum. Second Pref.	10	6	6	10¼—11	
Do. 4½% Debenture, Red.	Stock	4½	4½	102—105	+2
Bromley (Kent) E.L.& Power Co., Ld.	5	5½	5¼	4½—5 xd	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	96—99	
Brompton & Kensington E. S. Co., Ld.	5	10	10	7¼—8¼	
Do. 7% Cum. Pref.	5	7	7	6¾—7¼	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4*	98—101	
Ch. Cross. W. E. & City E. S. Co.	5	5	5	3⅝—4⅛	
Do. 4½% Cum. Pref.	5	4½	2½	4½—4⅝	
Do. 4% Deb. Red	Stock	4	4	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½	4—4½	
Chelsea Electric Supply Co., Ltd.	5	4½	4½	3⅛—3⅜	
Do. 4½% Deb. Red	Stock	4½	4½	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6	9¾—10½	
Do. 6% Cum. Pref.	10	6	6	11¾—12¾	
Do. 5% Deb. Red	Stock	5	5	123—126	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	101—104	
City of Durham E. P. Dis. Co.	5	4	2	3—3⅜	
Do. 5% Pref.	5	5	5	4¼—4¾	
County of London Elect. Sup. Co. Ld.	10	5	5	7⅜—8¼	
Do. 6% Cum. Pref.	10	6	6	10¾—11¼	
Do. 4½% Deb. Red	Stock	4½	4½	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	98—101	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	¼—1¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	57—62	−1
Folkestone Elec. Supply Co., Ltd.	5	5½	5¼	4½—5	
Do. 5% Cum. Pref.	5	5	5	4⅞—5⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½	6¼—8¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½	92—95	
Kensington & Knightsbridge E. L. Co.	5	10	10	7¾—8¾	
Do. 4% Deb. Red	Stock	4	4	96—99	
Kens. & Notting Hill E.L. Cos. Db. Rd.	Stock	4	4	97—101	
London Electric Supply Corporation	3	4	2½	1—1⅛	
Do. 6% Pref.	5	6	6	4½—5	
Do. 4% 1st Mort. Deb. Red	Stock	4	4	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6⅔	4¾—5⅛	
Do. 4½% Cum. Pref.	5	4½	4½	4¾—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D	100 & 500	4½	4½	96—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4⅞	9¼—10½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	8⅝	5⅝—6⅛	
Do. £2 Pm.	5	8	8⅝	5⅝—6⅛	
Do. 5% Pref. (fully paid)	5	5	5⅝	5⅛—5⅜	
Do. 10/- Pm.	5	5	5⅝	5⅛—5⅜	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7⅞	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7⅞	5⅝—6⅜	
Do. 4% Deb. Red	Stock	4	4⅞	93—95	
St. James and Pall Mall E. L. Co. Ld.	5	10	10⅞	7¼—8¼	
Do. 7% Non-Cum. Pref.	5	7	7⅞	6¼—7	
Do. 3½% Deb. Red.	Stock	3½	3½	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—1½	
Do. 4% Deb. Red	Stock	4	4⅞	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4⅞	2⅜—2⅝ xd	
South Metropolitan E. L. & P. Co.	1	2½	1/-	1—1⅛	
Do. 7% Cum. Pref.	1	7	7⅞	1⅝—1⅞	
Do. 4½% 1st Deb. Red	Stock	4½	4¼	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5⅞	1⅜—2⅛	
Do. 5% Cum. Pref.	5	5	5⅞	1⅝—2⅛	−¼
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10⅞	7¼—8	
Do. 4½% Cum. Pref.	5	4½	4½	4¾—5¼	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4⅞	89—92	
Central London	Stock	4	3⅞	75—78	
Do. 4% Preferred	Stock	4	4⅞	83—85	
Do. Deferred	Stock	4	2⅞	54—57	
Do. 4% Debentures	Stock	4	4⅞	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4⅞	81—84	
City and South London Cons.	Stock	2⅜	4¼	39—41	
Do. 4% Perp. Deb.	Stock	4	4⅞	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5⅞	113—116	
Do. 5% Perp. Pref. 1895	Stock	5	5⅞	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5⅞	110—113	
Great Northern & City Pref. "A"	10	4	11¾d.	¾—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4⅞	6—7	
Do. 4% Perp. Deb.	Stock	4	4⅞	87—90	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1⅞	43½—44½	+½
Do. 3½% Preference	Stock	3½	3½	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½	73—76	+1
Metropolitan District	Stock	nil	—	12—13	+½
Do. 6% Perp. Deb.	Stock	6	6⅞	108—113	
Do. 4% Deb.	Stock	4	4⅞	no price	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5⅞	39—43	
Whitechapel and Bow 4% Deb.	Stock	4	4⅞	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-	⅝—¾	
Do. 5% Cum. Pref.	1	5	5⅞	⅝—¾	−⅛
Do. 4½% Deb. Red.	Stock	4½	4½	89—94	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½	93 96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	+⅛
Do. 6% Cum. Pref.	10	6	6*	4—4½	
Do. 5% Perp. Deb.	Stock	5	5⅞	93—96	+1
Do. 4½% 2nd Deb.	Stock	4½	4½	72—76	
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4½—5	
City of Birmingham Trs. Co. 4%. 1st Mort. Deb.	100	4	4⅞	97—100 xd	−1

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%			
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	95—98	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	⅞—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	1⅜—1⅝	
London United Trs., Ld., Cm. Pf.	10	5	5%	6½—7⅜	+½
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	85—90	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	⅜—⅝	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	95—98	
National Elec. Construction Co. Ltd.	1	10	2/-	⅞—1⅛	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	¾—1	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9½d*	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	⅜—½	
Do. 4½% Deb. Red	Stock	4½	4½%	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4½—5½	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	6%	¾—1½	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1½	
Do. 6% Cum. Pref.	5	nil	—	3—3½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	55—58 xd	
Do. 6% Pref. Ord.	Stock	6	30/-*	98½—100½xd	
Do. Def. Ord.	Stock	1¾	1%	13½—14	−½
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3¼—3½	
Do. 10% Cum. Pref.	5	10	10%	8½—9½	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4½	4/-*	13½—14 xd	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99—101	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	99—101	
Do. do. (Mauritius Sub.)	25	4	4%	100—102	
Eastern Ext. Australasia & China	10	7	7/6	12⅞—13⅜	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5⅜	7%	130—135	
Do. 3½% Pref.	Stock	3½	3½%	84—87	
Do. 4% Mort. Deb.	Stock	4	4%	101—104	
G. N. Tel. Co. (Copenhagen)	10	20	20%	31½—33½	
Indo-European Telegraph Co. Ltd.	25	13	65/-	55—58	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅜—½	+⅛
National Telephone Co., Ltd., Pref.	Stock	6	6%	107—109	
Do. Deferred	Stock	5½	6%	108—110	
Do. 6% Cum. 1st Pref.	10	6	6%	10—12	
Do. 6% Cum. 2nd Pref.	10	6	6%	10—12	
Do. 5% 3rd Pref.	5	5	5%	5⅜—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	98—100	
Do. 4% Deb. Red.	Stock	4	4%	101½—103½	
West African Telegraph Co. Ltd.	10	4	4%	10—10½	
Western Telegraph Co., Ltd.	10	7	7%	13½—13¾	
Do. 4% Deb.	Stock	4	4%	99—102	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	6%	⅞—1⅛	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅜—3⅝	
Do. 6% Pref.	1	6	7½d	1⅛—1⅜	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	6½—6⅝	
Do. 6% Cum. Pref.	5	6	6%	5⅝—6¼	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	94—99	+1
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—⅜	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	3/16—⅜	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	74—79	−1
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	59—64	−1
Callender's Cable and Const. Co., Ld.	5	15	15/-	10½—11½	
Do. 5% Cum. Pref.	5	5	5%	5⅛—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106½—108½	
Consolidated Electrical Co., Ltd.	1	3	3½%	⅞—1⅛	
Crompton & Co., Ltd.	3	5	5%	1⅝—1⅞	−⅛
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1½—1⅝	
Do. 6% Cum. Pref.	1	6	6%	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
Edison & Swan United "A." £3 paid	5	4½	2/6	¾—1	
Do. do (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	½—⅝	
Do. 7% Cum. Pref.	2	7	—	1½—1⅝	
Do. 4% 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10½—11½	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	30½—32½	−½
Do. 4% Deb. Bds. Red	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson, Ord. Shres	1	nil	5%	1—1⅛ xd	
Do. 6% Cum. Pref.	5	nil	6%	3⅜—3⅝ xd	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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THE EFFECTS OF LAYING CABLE DIRECT IN THE GROUND

(By a Correspondent)

MODERN practice in the manufacture of cable has gone very largely in the direction of insulating the conductor with paper strip impregnated with resin or other oil, and moisture is kept from the installation by means of a lead sheath. It is highly important, therefore, that in the first place no pin-holes or other fissures should allow water to percolate to the insulation of the cable, and, secondly, that nothing should attack the lead to eat it away.

The presence of tramway systems involving heavy return currents has caused a good deal of trouble with regard to electrolysis, and, for this reason, some systems of lead-covered cables which have been laid direct in the earth have proved a considerable nuisance. In one case some paper cables which were originally laid direct in the ground with concrete over the top, a board being placed over that to indicate the position of the cable to a navvy with a pick, were connected to services, also lead covered, by means of a tee piece consisting of a joint box filled with bitumen; there was no provision for bonding, and, to prevent the bitumen from running out at the ends of the box, these were stopped with clay. The soil in which these cables were laid was hard clay with an admixture of chalk, and was fairly dry. When the boxes were taken off, the lead in some cases was thin and hard and had a white deposit on the places where the clay had been put around it to stop the bitumen from running out. Moreover, the lead on the main had a white pitted appearance, which the workmen described as "smallpox," and when it was handled a white dust was left in the hand. The cable also left its shape in the earth with a white film of deposit. There was a considerable number of faults in the cable, which may have been the cause of the hardness of the lead. These boxes were taken off and the joints sealed in bitumen with troughing, and the lead bonded with copper wire soldered to it. This got rid of electrolysis effects.

One big mistake in connection with lead-covered cable is to make the services tapped off such a main of rubber. This gets over any local trouble at the entrance of the house, but is liable to concentrate the bad effect of electrolysis on the main itself. Theoretically, the best solution is to run the whole system up solid in troughs with bitumen, but so far as can be ascertained this has never been done completely, and it would be a very difficult thing to do.

A suggested system is as follows:—In using lead cables these should be laid solid and insulated as far as possible, the cables being well juted and a light network woven over this juting, consisting of wire having as high a conductivity as possible. Iron wire or some aluminium alloy might be used. This outer sheath could then be earthed wherever possible, and should not only form a strong protection against stray currents but should keep the jute in place. This arrangement would get over the trouble not infrequently found in drawing in cable in conduit or iron pipes, of the jute rucking up, leaving the lead sheathing uncovered.

The alternative to running up the installation solid and insulating it, is to reduce the lead to earth potential as much as ever possible by bonding and earthing it at every possible point. At joint boxes and inspection boxes the bond should be carried between the different sections of cable entering the box by means of a copper wire passing to the box cover, this cover and the box being then effectually earthed. Where wrought-iron pipes are used as conduits it will be found that moisture accumulates very much, and if lead-covered cable is drawn into such pipes the water will form an effective conductor from the lead sheathing to the iron of the pipe, which will be at earth potential.

These notes may be of some use in directing the attention of some other engineer to the best expedient to be adopted in his particular set of troubles.

LOCAL NOTES

ARBROATH: *Electric Lighting.*—Considerable progress has been made in the erection of the works of the Arbroath Electric Supply Co., and it is expected that a supply will be given by the end of June. An agreement has been entered into with the Town Council for public lighting.

ABERDEEN: *Tramways.*—It has been decided that in future the sum of £70 per annum instead of £140 per annum be paid to the Electricity Committee for services rendered by the electrical engineer to the tramways department.

BARNES: *Electricity Finances.*—On the recommendation of the Finance and General Purposes Committee, part of the sum now in the treasurer's hands (£1,500) is to be transferred from the District Fund and placed to the credit of an account to be called the electricity revenue account.

BECKENHAM: *Municipal Electrical Association.*—At the last meeting of the Council a long discussion took place upon a recommendation that the electrical engineer be authorised to attend the annual convention of the Incorporated Municipal Electrical Association. The arrangement suggested as to the engineer's expenses was that he be allowed up to £10, which should be added to his salary for the current year. Several councillors objected to the proposal on the ground that it would be a waste of money, and doubt was expressed whether the auditor would pass the amount when it came before him. Mr. Dykes, in supporting the recommendation, said that the papers read at the convention of the Incorporated Municipal Electrical Association were thoroughly practical, and perhaps still more useful were the informal discussions that the members had amongst themselves. In the result the committee's recommendation was adopted by 8 votes to 4.

BELFAST: *Cavehill and Whitewell Tramways.*—A conference has been held between the Tramways and Electricity Committee and the directors of the Cavehill and Whitewell Tramways Co. to consider the position created by the rejection of the Bill for the acquisition of the company's undertaking by the Corporation. It is stated by the local papers that a working agreement has been arrived at which will shortly be placed before the Corporation for confirmation.

The proposal under consideration is as follows:—"The Corporation to rent so much of the company's undertaking as defined in the agreement for a period of four years, and to pay by way of rent therefor 3½ per cent. per annum on the proposed purchase price of £60,000; also to pay into the credit of a joint account to be opened in the name of the Corporation and the company 2 per cent. per annum, if earned, on the same amount (these two items of 3½ and 2 per cent. making together the interest and sinking fund which the Corporation would have had to find to pay the interest on and pay off the £60,000 purchase-money in thirty years), the annual payment of 2 per cent., if earned, with accumulations, to become the property of the Corporation if they decided to, and were empowered to, acquire the undertaking before the completion of the four years; and, in the event of their deciding not to purchase, or being unable to obtain power to purchase, as aforesaid, this sum to become the property of the company."

BIRMINGHAM: *Proposed Home Office Regulations.*—At a meeting of the Birmingham Chamber of Commerce last week, the recent inquiry into the proposed Home Office Regulations regarding the use of electricity in factories and workshops was discussed, the Secretary stating that with evidence based on theory alone the Home Office had attempted to impose a most unreasonable burden upon the industry. A motion by the Chairman that the General Purposes Committee be instructed to report as to the powers of interference placed in the hands of the Home Office under the Factories and Workshops Act, 1901, was seconded and carried.

BOURNEMOUTH: *East Cliff Electric Lift.*—The new electric lift on the east cliff at Bournemouth was opened on Thursday.

BRIGHTON: *Electricity Charges.*—The revisions in the charges for electric lighting referred to recently have now been placed before the Council in detail. Mr. J. Christie, the electrical engineer, expressed the opinion that some revision has become necessary in consequence of the increased price of coal which represents approximately two-thirds of the total costs. He claims, however, that the new rates will not operate harshly upon the consumer in consequence of the more economical lamps now available. It is proposed that the new rates should come into force on July 1st. For ordinary lighting purposes in hotels, clubs, churches, &c., the charge will be 3d. per unit, for shops and private houses 4d. per unit, and for arc lamps on independent mains with separate meters 3d. per unit. A special tariff has also been prepared for large consumers over 20,000 units per annum, by which the price is reduced to 1d. per unit when the consumption exceeds 40,000 units per annum. For power heating and cooking through separate meters, without restriction as to time, the charge is 1½d. per unit, whilst with a time switch cutting off supply between 5.30 p.m and 8 p.m. during January and December, the charge will be 1d. per unit After the next June meter reading consumers now being supplied upon maximum demand system will have the option of continuing at the following revised rates:—For the first hour's average daily use of maximum demand, 6d. per unit and 2d. per unit for all consumption in

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excess. The above charges only apply within the Borough of Brighton. For lighting outside the borough without restriction as to time the charge will be 4½d. per unit, and for power heating and cooking 2d. per unit. One month's notice of the change will be given to the consumers. No new consumers will be taken on the demand indicator system

COLWYN BAY: *Tramway Extension.*—Mr. S. Sellon, the managing director of the Llandudno and District Electric Tramways Co., has written to the Council intimating that he will be prepared to continue the tramways to Rhos on condition that the Council do not make the acquisition of certain land a condition precedent to the extension. The Town Clerk has replied that the Council do not require this land to be purchased, and urged the company to pay the Council the agreed sum of £3,000 for the necessary road widenings.

CROYDON: *Supply Outside Borough.*—The Corporation is to supply current to house premises outside the Borough boundary and within the area of supply of the South London Electric Supply Corporation, Ltd., subject to an agreement by which the Corporation pay a nominal sum per annum by way of rent, and covenant to remove their cables upon one month's notice to do so.

DUNFERMLINE: *Electric Lighting.*—The offer from Messrs. Gibbings & Chauntler, of Liverpool, to undertake to prepare an electric lighting scheme for the Council is to be considered by the Council, and if necessary it will be forwarded to Sir Alexander Kennedy for report.

EAST HAM: *Tramways.*—The Council has decided to purchase from the North Metropolitan Tramways Co., subject to the consent of the Board of Trade, all portions of the Romford Road lines belonging to the company (exclusive of depôt and all rolling stock) at the sum agreed upon between the Council and the company, viz., £8,000.—The Borough Treasurer has recently been in communication with the Surveyor of Taxes relative to the amounts payable to the Inland Revenue in respect of income tax on the electric lighting and tramways profits for the year 1907-8, and the Finance and General Purposes Committee has directed him to endeavour to obtain an allowance for depreciation in respect of the whole capital expenditure on each undertaking.

FINCHLEY: *Electricity Finance.*—At the meeting of the Council recently, at which the half-yearly rate was fixed, the Chairman of the Finance Committee said that the electricity undertaking was estimated to produce a gross revenue of £12,888. After allowing for interest accrued, but not payable in the year under review, it will repay a sum of £6,893 in connection with its sinking fund charges, an amount which, in a private concern, would enable a very handsome dividend to be paid. After making due provision for necessary depreciation and reserve fund the net surplus of the undertaking for the twelve months was expected to be £100.

HASLINGDEN: *Tramway Intercommunication.*—It was reported to the Haslingden Electricity Committee on April 15th that arrangements had been completed for the through running of electric cars from Accrington to Rawtenstall. It has been decided that arrangements be made for Accrington to run its electric cars to Haslingden immediately the track, standards, and overhead equipment are ready—this as a temporary measure until Haslingden is able to obtain current from the generating station about to be erected in this locality. It is not expected that this station will be ready for at least nine months.

ILFORD: *Tramway Intercommunication.*—At the last meeting of the Urban District Council a letter was received from the Board of Trade inquiring if the Council would attend a conference with the Barking authority on the subject of the interrunning of the trams, to be presided over by a chairman appointed by the Board of Trade. It was stated that the Board of Trade had no power to compel either authority to consent to any particular arrangement, but it was resolved that the conference be attended.

LEYTON: *Motor Hiring.*—At the last meeting of the Council the opinion was expressed that if the Council would let motors on hire, this would have the effect of bringing many tradesmen on to the electric supply mains. The Chairman of the Electricity Committee pointed out that the Council had no powers to borrow money in this connection, and would have to pay for them out of revenue. He thought the best way to induce new consumers was to reduce the price of electrical energy.

LIVERPOOL: *Telephone Charges.*—The Finance Committee of the Corporation has reported upon an agreement made between the Corporation and the National Telephone Co., in June, 1896, in which the charges for unlimited service were set out as follows:—For the first connection within one mile of any exchange, £10 per annum; for each quarter mile or portion of quarter mile beyond the first mile, £1 5s. per annum; for the second connection and each additional connection within one mile of any exchange, £8 10s. per annum; and for each quarter mile beyond the first mile, £1 5s. per annum. In return for the right to apply the measured rate to all new subscribers, the National Telephone Co. have agreed to allow existing subscribers to continue their agreements, and to allow them to transfer to new offices, if necessary, and still continue their agreement and not insist on the measured rate, in the event of a subscriber requiring additions to existing installations. The Finance Committee of the Corporation report that, the Company having agreed to these terms, they recommend the Corporation to agree also on their part.

LONDON: *Paddington. Street Lighting.*—The Borough Council, at a special meeting, decided the interesting question of the lighting of a portion of Harrow Road which has been under consideration for some considerable time. The Metropolitan Electric Supply Co., Ltd., and the Gas Light & Coke Co. lighted, as an experiment, certain lengths of the thoroughfare for the purpose of comparison between the present and the proposed gas schemes with the proposed electric flame arc lamp scheme. The cost of the present system of gas lighting is £198 per annum (*i.e.*, 66 lamps at £3). The Gas Light & Coke Co. offered an improved system on the following terms:—66 lamps at £4 12s. 6d., or £305 5s. per annum, the initial cost being nil. If the lamps were taken over from the company at the end of five years the Council would pay £164, but in the event of the proposed arrangement lasting for ten years, the lamps would become the property of the Council without payment. The lamps would consist of two kern burners in improved lanterns. The Metropolitan Electric Supply Co., Ltd., offered an improved system of 24-flame arc lamps at an average of £13 each, *i.e.*, £312 per annum. The initial cost would be about £170, and the offer was made on the understanding that the arrangement would be in force for seven years. The Works Committee recommended the acceptance of the offer of the Metropolitan Electric Supply Co., Ltd. The Finance Committee observed that the proposal opened the question of electric lighting for the whole borough, which would involve additional expense. After considerable discussion the recommendation was lost.

Woolwich: New Tramways.—A trial trip has been made upon the new tramways from Beresford Square to Plumstead Church. This line effects a junction with the Bexley Urban District Council tramway undertaking.

KINGUSSIE: *Electric Lighting.*—Estimates for an electric lighting scheme have been placed before the Council, the cost being £3,000, but it has been decided to leave the matter over for the present.

KIRKINTILLOCH: *Tramways.*—The Town Council has received a letter from the Glasgow Corporation intimating that the Glasgow Tramways Committee do not see their way to recommend the extension of the tramway system to Kirkintilloch. The general opinion of the Glasgow Corporation Tramways Committee is that for the present the tramway system should not be further extended outside the city boundary.

LOWESTOFT: *East Anglian Light Railway.*—A sub-committee of the Tramways Committee recommend that the Council should come to some decision with regard to the East Anglian Light Railway and put forward three possible courses of action:—(1) The Council to construct and work the line; (2) the Council to construct and lease the line; (3) to sell the concession outright. After some discussion a resolution was passed, sending the report back for reconsideration.

LONDONDERRY: *Municipal Electrical Association.*—At the meeting of the Corporation, on the 16th inst., the question of sending delegates to the annual conference of the Incorporated Municipal Electrical Association at Nottingham in June next was discussed. A councillor strongly objected to the sending of two delegates on the score of expense, adding that he had never met a member of a deputation who was able to point to one particle of good resulting. Mr. R. V. Macrory, the Electrical Engineer, was called in and questioned on the utility of these conventions. He said that as the result of a conversation at the last conference he was enabled to save £37 per annum on one boiler. It was finally decided to send the engineer.

MIDDLESEX: *Tramway Extensions.*—An extension of the Metropolitan Electric Tramway system from Harrow Road to Wembley has been opened.

MUSSELBURGH: *Public Lighting.*—In reference to the recent complaints with regard to the street electric lighting, which is carried out by the Musselburgh & District Electric Light & Traction Co., the Town Council has decided that in the event of no perceptible improvement being shown during the next quarter, the lighting bill shall not be paid, and that the Borough Surveyor shall be instructed to prepare an estimate of the cost of re-erecting the gas lamps.

ROCHDALE: *Tramway Accounts.*—The electric tramways gross receipts for the past year are £56,557, an increase of £2,000 on the preceding year. Working expenses rose from £29,505 to £33,043. The deficiency on the working for the year is £2,102, which, with £1,946 arrears on sinking fund, gives a total deficiency to be provided out of the rates of £4,048. The electricity department's income for the year was £20,378, an increase of £3,092. Expenses were £11,014, an advance of £2,552. Gross profits £9,364, against £8,824. There is a surplus of £4,299, and £2,000 will be devoted to relief of the rates.

ROCHESTER: *Tramway Extensions.*—The Rochester lines of the Chatham and District Light Railway Co. were put into operation on Thursday.

ST. ANNE'S-ON-SEA: *Tramway Electrical Energy.*—The Blackpool, St. Anne's, and Lytham Tramways Co. has made an application to the Urban District Council for a revision of the charges now made for supplying the undertaking with

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electrical energy. The application has been referred to a sub-committee of the Electric Lighting Committee.

STAFFORD: *The Electrical Undertaking.*—At the last meeting of the Town Council, the Chairman of the Gas and Electricity Committee stated that for the past five weeks the output of electricity showed an increase of 12½ per cent. compared with the corresponding period of last year.

SWINDON: *Electricity Works.*—In view of the proposed extensions of plant at the electricity works, the electrical engineer has been authorised to visit some electricity works where steam turbines are in use, and to report to the Electricity and Tramways Committee.

TORQUAY: *Torbay Road Tramways.*—Successful trial trips have been made upon the extension of the Dolter system in Torquay, along Torbay Road.

WHITEFIELD: *Electric Lighting.*—In reply to an inquiry from the Town Clerk, the company which has acquired the Urban District Council's electric lighting order state that the delay in erecting the works has been brought about by the recent state of the Money Market, but that all arrangements have now been concluded for raising £150,000 capital.

WINNIPEG: *Telephone Purchase.*—A Reuter telegram states that the Minister of Public Works for Alberta officially confirms the announcement that the Alberta Government has purchased the Bell Telephone system in the province for $675,000.

WORTHING: *Electricity Undertaking.*—The account of the finances of the Corporation for the past half-year shows that the electric lighting undertaking has resulted in a loss of about £20. The Deputy Mayor stated that the expenditure had been greater than was anticipated, owing to the faulty working of the condensing plant, and that an application had been made for a loan for the provision of an up-to-date plant.

YARDLEY: *Electricity Supply.*—Since the Urban District Council entered into an agreement with the British Electric Traction Co. for the purchase of the power station at South Yardley not much progress has been made with regard to the supply of electricity in this district. A full report on the subject, however, is promised very shortly. The purchase price of the power station has been fixed at £15,000, less £2,500 for depreciation, and the Council will have to remove at its own cost all the plant from the company's premises to the new power station, which is to be erected at Hay Mills. Should the plant not be removed within twelve months from the date of the Board of Trade consent to the agreement, a rent of £50 per annum is to be charged.

YEOVIL: *Revocation of Electric Lighting Order.*—The Board of Trade has revoked the Yeovil Electric Lighting Order, 1903.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ABERTILLERY.—The Local Government Board has communicated with the Council to the effect that the Board is not satisfied that the establishment of an electric lighting installation in accordance with the scheme recently formulated, would be a financial success. The Council has decided to ask the Local Government Board to receive a deputation on the matter.

AUSTRALIA.—The Board of Trade correspondent at Melbourne (Mr. M. Hirsch) has forwarded particulars of a call for tenders for the supply to the Deputy Postmaster-General at Melbourne of 2,800 jacks in strips of 20; 1 mile of 64-wire switchboard cable; 50 three-conductor cords, 7 ft. long; 96 three-part plugs; and 66 listening and ringing keys. Tenders will be received by the Deputy Postmaster-General, Melbourne, up to 3 p.m. on June 9th.

The Board of Trade are notified by the London representative of the Australian Commonwealth (Capt. R. Muirhead Collins, C.M.G.) that tenders will be received at the office of the Deputy Postmaster-General, Perth, until noon on Monday, September 7th, for the supply of the following telephone material, viz.: 650 wall sets, 150 table sets, 800 protectors, 90 extension switch and bell sets, complete, 30 switchboards for four lines, 20 switchboards for six lines, 5 switchboards for twelve lines, 5 switchboards for twenty-four lines, 20 wall sets for party lines, and 10 table sets for party lines. Tenderers must state the country in which the articles tendered for have been made or produced, and, in the case of manufactured articles, where the material has been made or produced. Tenders must include customs duty, if any. A deposit, equal to 5 per cent. of the amount of the offer, will be required to qualify any tender. Specifications, conditions, and forms of tenders may be obtained at the Commonwealth of Australia Offices in London, 72 Victoria Street, S.W.

AYR.—Extensions to the electricity works are to be carried out at an estimated cost of £15,050.

BELGIUM.—H.M. Consul-General at Antwerp (Sir C. Hertslet) has forwarded a copy of a specification issued by the Municipal Authorities of that city in connection with a call for tenders for the supply and fixture of two electric lifts in premises belonging to the Municipality in the Place de Meir, Antwerp.

BLACKPOOL.—A Local Government Board inquiry was held last week into an application by the Corporation for sanction to borrow £5,000 for the purposes of the electricity undertaking. The greater portion of this sum will be for mains. Mr. C. F. Furness, the Electrical Engineer to the Corporation, stated that whereas in 1903 the profit on the electricity undertaking was £2,352, it has steadily increased year by year, and for the last complete financial year the profit was £8,229.

DUNDEE.—Tenders are invited for the following:—(*a*) steam, exhaust, feed water, and drain piping system, with two steam-driven feed pumps and two hotwell tanks for main generating station; (*b*) equipment of circulating water pump room, including two electrically-driven vertical-spindle centrifugal pumps, in connection with the main generating station; (*c*) circulating water-pipe system (about 1,500 feet long), in connection with the main generating station; (*d*) overhead travelling cranes for main generating station and two sub-stations. Full particulars from the City Electrical Engineer, fee £3 3s., returnable, and tenders to the Town Clerk by April 27th.

ECCLES.—Tenders are invited for: (1) a Lancashire boiler and superheater; (2) a 210 kw. steam generating set and exciter. Particulars from the Borough Electrical Engineers (fee £2 2s., returnable), and tenders to the Town Clerk by April 27th.

GLASGOW.—Tenders are invited by the Lunacy District Board for the supply of stores for twelve months ending May 16th, 1909, including electric lamps and fittings. Full particulars from the Inspector and Clerk, 266 George Street, Glasgow, and tenders by April 24th.

The Corporation invite tenders for the supply of main cables, small cables and wires, electricity meters, and arc lamp carbons during the twelve months ending May 31st, 1909. Full particulars from Mr. W. W. Lackie, the Corporation Electrical Engineer (fee £2, returnable), and tenders by April 27th.

GOVAN.—Tenders are invited for the supply of the following stores for the year ending May 15th, 1909: Oil, waste, and engine-room stores; cables; cable accessories; bitumen and compound for joint boxes; electricity meters; house service fuse boxes; wrought-iron tubes and fittings; cast-iron pipes; arc lamp carbons; coal; joint boxes; motors; motor starters and D.P. switches. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by April 27th.

HASLINGDEN.—Tenders are invited for overhead tramway lines with tangential suspension, telephone system, and tower wagon. Particulars from the consulting engineers, Messrs. Handcock & Dykes, 1 Victoria Street, Westminster (fee, three guineas, returnable), and tenders to the Town Clerk by April 25th.

HESTON AND ISLEWORTH.—The District Council, at its last meeting, were informed by the Finance Committee that the loan of £1,400 for laying a new electricity feeder for the Hounslow district could be provided out of the redemption fund, and they would recommend that application be made to the Local Government Board for an Order to enable this course to be taken, provided the Electricity Committee were willing to pay interest at 3½ per cent. on the advance.

KIEL (GERMANY).—It is stated that among the new works to be carried out at the Kiel shipyard during the current financial year is an electric power station.

LONDON: *London County Council.*—Tenders are invited for the wiring and fitting for electric lighting of a tramway car shed at Mare Street, Hackney. Particulars from the Clerk, fee £2 2s., returnable, and tenders by May 12th.

Tenders are invited for the supply and delivery of (*a*) 175 double-deck, roof-covered, electric car-bodies; (*b*) 175 pairs of maximum traction swing bolster trucks; (*c*) 175 complete electrical equipments for operation upon the overhead trolley, surface contact, and underground conduit systems of electric traction. Full particulars from the Clerk to the Council (fee £2 2s. returnable), and tenders by May 9th.

Poplar.—The Electricity Committee invite tenders for the erection of a sub-station building at Millwall in brick, ferro-concrete, or corrugated iron. Full particulars from the Borough Electrical Engineer, fee 5s., not returnable, and tenders to the Town Clerk by April 29th.

In regard to the Borough Council's extensions to the electricity undertaking at an approximate cost of £27,209, the Borough Engineer has reported that it is essential the extensions should be completed by the end of October next, and in order that there may be no delay, the Finance Committee has submitted an estimate, and has also decided that application be made to the L.C.C. for a loan of not exceeding £24,000, subject to the Borough Council subsequently resolving to carry the scheme into effect, and to revision of the amount of the loan in accordance with tenders which may be accepted. The estimated amounts chargeable to capital account are:—Millwall sub-

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station, land and buildings, £800; mains, £5,552; machinery, £16,560; house connections, £250; meters, £250; contingencies, £365. The expenditure chargeable to revenue account in respect of dismantling, removing, and re-erecting converter, dismantling a generating set, reclaiming and relaying feeders, and connecting feeder to northern sub-station, is £3,432, subject to revision on ascertained cost of the work. To this sum has to be added £1,400, cost of displaced set, less the amount to be realised by sale thereof, which it is proposed should be fixed at a minimum of £700, making a total of £4,132, to be written off the amount of the existing working balance and the current year's profit.

LOWESTOFT.—The Electricity Committee recommend that application should be made to the Local Government Board for a further loan of £1,000 for "free" wiring purposes.

RAWTENSTALL.—Tenders are invited for the supply, delivery, and erection of steel tramway poles, overhead line equipment and accessories. Full particulars from the Consulting Engineers, Messrs. Lacey, Sillar, and Leigh, 2 Queen Anne's Gate, Westminster, and 78 King Street, Manchester (fee £3 3s., returnable), and tenders to the Town Clerk by May 4th.

ROCHDALE.—The Board of Guardians recommend that a new storage battery be installed at the workhouse.

TENDERS RECEIVED AND ACCEPTED

ABERDEEN.—The tender of Messrs. Milne, Voss & Co., for six additional car top covers at £130 each has been accepted.

AUSTRALIA.—The Victorian Postmaster-General's Department has accepted the following tenders :—1,000 cords, two conductor, for metallic circuits, British Insulated and Helsby Cables, Ltd.; 6,000 yards cords, single conductor, 4,000 fuses, and 2,000 lead strips and attachments for Meidinger main battery, the India Rubber, Gutta Percha, and Telegraph Works Co., Ltd.; 200 conversers for wall telephones with cord, plug, and jack complete, 1,000 ear pieces for receivers, and 4,000 fuses and holders, Messrs. J. Bartram & Son (Melbourne); 1,000 indicators, 100 ohms resistance, and 500 metallic circuit jacks, Messrs. R. B. Hungerford (Sydney); 2,000 insulators, 50 switches, and 1,500 incandescent lamps, Messrs. J. A. Newton & Co. (Melbourne).

BELFAST.—The tender of Messrs. J. S. Scott & Co., for 170 gun-metal key-hole covers for tramway feeder pillars, has been accepted.

CALCUTTA.—Three replies were received by the Corporation in response to its advertisement asking for tenders for street lighting. The *Calcutta Statesman* says that the present contract for lighting the city with gas expires in April, 1911, and in order to have sufficient time to consider the new tenders, offers were called for by January 1st of this year. Three tenders were received, namely, from the Calcutta Electric Supply Corporation, the Oriental Gas Company, and Messrs. Hughes and Stirling. At a special meeting of the Corporation last month, it was stated that the tender of the latter firm was not treated seriously, as it was contingent upon the Corporation giving an order for the erection of a refuse destructor. The offer of the Calcutta Electric Supply Corporation was to light the centre of the city extremely well, and the suburbs rather poorly. A total of 10,673 lamps were to be installed, of which 9,276 would be 35 c.p., 902 would be 70 c.p., and 495 of 1,500 c.p., and the charge for a 20 years' contract was to be Rs.6,54,556 (£43,637) per annum. An amended tender has since been received, in which are included 150 arc lamps of 1,500 c.p. and 9,177 of 70 c.p., at an annual cost of Rs.5,82,281 (£38,818). The 70 c.p. lamps would be metallic filament lamps, and it was stated that the engineer to the Corporation was not impressed with this type. In rejecting the tender of the Electric Supply Corporation, the Electricity Committee stated their reasons were (1) that the light proposed to be given was less and the charge more than that proposed by the tender of the Gas Company, and (2) that as the Corporation has the option of purchasing the Supply Company in October, 1919, it would probably double the purchase price if this contract were given to them. The Gas Company's offer was for 9,225 lamps with a maximum of 60 c.p. and minimum of 20 c.p., in addition to 84 special lamps of 700 c.p. The annual cost under the Gas Company's tender will be Rs.5,11,758 (£34,117). Considerable discussion took place upon the tenders, and, after a debate lasting nearly two hours, the matter was adjourned for three weeks for a poll of the ratepayers to be taken.

CROYDON.—The Corporation has accepted the following tenders for Electricity Works requirements :—Coal and ash conveyor, Babcock & Wilcox, Ltd., £1,154; coal and ash bunkers, Weber Concrete Construction Co., Ltd., £681 14s.; builders work, Electricity Works Department, £205 17s.; switchboard flooring, St. Pancras Ironworks Co., Ltd., £144. The following tenders have been accepted for the supply of coals to the Electricity Works :—Large Welsh coal, Cory Bros & Co., Ltd. (for three months); large hard steam coal, J. H. Gilman & Co. (from May 1st to March 31st next); small nut coal, J. H. Gilman & Co. (for six months).

EAST HAM.—The Electric Lighting and Tramways Committee has decided to accept the following tender of Mr. W. R. Reynolds for fixing and supplying the necessary installations (exclusive of lamps) in connection with the hiring of arc lamps by consumers :—For 2-lamp installation, £2 17s. 6d.; for 4-lamp installation, £5 15s.; for 6-lamp installation, £8 12s. 6d. A letter has been received from Messrs. E. Foster & Co., stating that owing to the reduction of price at the colliery they are prepared to reduce their price for the supply of 1,500 tons of Ibstock fine slack coal during the ensuing year from 10s. 6d. to 10s. per ton. The accepted tender of Messrs. Foster & Co. was for 10s. 6d. per ton. The Committee has decided to accept the tender of Messrs. Thos. Moy, Ltd., for 500 tons of yard slack coal at 11s. 6d. per ton, and that of Messrs. M. H. Abbott & Co. for 365 tons at 11s. 6d. per ton.

HESTON AND ISLEWORTH.—The District Council has received the following tenders for the wiring and fitting of the Isleworth Bath for electric lighting :—E. A. Hellyer & Co., £17 15s.; G. Weston & Sons, £17; T. Hiscock, Hounslow (accepted), £17.

HOLLAND.—A concession has been granted by the Dutch Government to the Amsterdam and North Holland Electric Tramway Company to construct and operate a system of electric railways in Holland. The system comprises about 50 kilometres of route running from Amsterdam north through Zaandam to Krommenie, from Zaandyk to Wyk-aan-Zee, and Wormerveer to Purmerend. The Amsterdam and North Holland Electric Tramway Company has entered into a contract with the Holland Development Company, 278 Heerengracht, Amsterdam, to construct the entire system.

NELSON.—The tender for the supplying of the electrical fittings to the Council's new school has been let to Messrs. Carter & Co., of Nelson.

LEEK.—The tender of T. Grace, of Leek, at £1,598, for the engine and dynamo foundations for the extensions to the generating station is recommended for acceptance.

LYNN.—The tender of Messrs. Chamberlain & Hookham, Ltd., for the supply of 50 meters, has been accepted.

SWINDON.—The tenders of Messrs. Babcock & Wilcox, Ltd., for a superheater, at £175, and that of Messrs. Aiton & Co., for feed pipes, at £137, have been accepted.

TASMANIA.—The Postmaster-General's Department has accepted the following tenders :—One mile of paper insulated and lead-covered cable at £50 7s. 10d., British Insulated and Helsby Cables, Ltd.; 200 three-inch cast-iron pipes, at £9 19s. 4d. per ton, Messrs. Mauri Bros., and Thomson (Sydney).

COMPANIES' MEETINGS AND REPORTS

BABCOCK & WILCOX.—The report for the year 1907 shows a net profit of £309,769, to which has to be added the balance brought forward, viz., £25,895, making a balance of £335,664. After deducting the interim dividends on the preference shares and ordinary shares, there is a balance of £266,264. The directors recommend a dividend of 3 per cent. on the preference shares, less tax, 8 per cent. on the ordinary shares (free of income tax), and a bonus of 4 per cent. on the ordinary shares (free of income tax). In addition, there is to be placed to the reserve fund the sum of £100,000, and to the dividend equalisation fund, £25,000, leaving a balance to be carried forward of £38,664. The extensions of the works referred to in last year's report have been completed and are in working order, and have enabled the increase in the business during last year to be dealt with. The volume of orders on hand at December 31st, 1907, and carried over for execution in 1908, is considerable. The meeting is to-morrow.

CITY OF BIRMINGHAM TRAMWAYS.—The report for 1907 shows a surplus, after providing £12,000 for interest on debentures and £12,083 the dividend on preference shares, of £35,772, from which is deducted the sum of £2,104, being the interim dividend of 5 per cent. on the ordinary shares, leaving a balance of £33,367. The directors recommend a dividend on the ordinary shares of 5 per cent. per annum for the six months ended December 31st, together with a bonus of 5 per cent., making 10 per cent. for the year amounting to £6,314; to trans-

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ferring £27,353 to reserve fund, increasing that fund to £459,121. The expenditure on capital account during the year amounted to £8,696, and includes part of the cost of reconstructing the Stratford Road tramways in Yardley for electric traction. A sum of £21,676 has been received from the sale of old rolling stock and of the overhead equipment and cables in Coventry Road and John Bright Street to the City of Birmingham, and has been credited to capital account. The traffic receipts compared with the previous year show a reduction of £131,000, due to the termination on December 31st, 1906, of the leases of the steam tramways in Birmingham and the sale, as at that date, of certain of the tramways in King's Norton and Handsworth. The shrinkage in the receipts has been slightly less than was anticipated. The expenses have been proportionately reduced, and £12,200 less was paid for rental of lines than in the previous year. Owing to the competition of the Corporation tramways, and the excessively heavy cost of repairs and maintenance of the motor omnibuses and the prevalence of bad weather, the result of the past year's working of the omnibuses has been very unsatisfactory. On October 5th last the motor omnibuses were withdrawn from service. The company has joined the British Electrical Federation.

BRITISH ALUMINIUM.—The report for 1907 shows a profit of £120,481. From this has to be deducted debenture stock interest (£28,515), and the expenses of issue of new capital, amounting to £7,227, and there has also been appropriated in reduction of the cost of the company's temporary factory at Kinlochleven £10,764. Depreciation absorbs £20,000, leaving, with the balance brought from the previous year, a balance of £88,523. It is now proposed to pay a final dividend on preference shares, balance of interest on funding certificates for the year 1907, interest at 5 per cent. per annum on amounts paid up on conversion shares and 1908 conversion shares, and a final dividend at the rate of 7 per cent. on ordinary shares, making 7 per cent. for the year. There will then remain the sum of £45,489, of which £8,986 has been utilised in purchasing and cancelling 2,196 funding certificates, leaving £36,502 to be carried forward. In comparison with 1906 there has been a decline in the profits, which, the report thinks, may be attributed to the slump in copper last July, and to the resulting demoralisation in the metal markets generally. There has been no recovery in the price of aluminium, so the metal has been taken into stock at a much lower price than in previous years. Customers, however, have latterly been ordering much more freely, and an improving demand may now be counted on. The temporary aluminium works at Leven only began producing during the last week of December, and those at Stangfjord in January last, so that the company derived no advantage from them during the year. Progress continues to be made with the development of the permanent power scheme at Kinlochleven, but there is now no prospect of any power being derived from this prior to the summer of next year, when the various sections of the work should be completed to enable the production of aluminium to be started. The development of the Orsières power scheme is being proceeded with, and a contract has been entered into for the construction of the first portions of the hydraulic section of the works. The construction of the Martigny-Orsières Railway, which was commenced last year, is proceeding satisfactorily. Towards meeting the large capital expenditure which these extensions entail, issues have been made of 40,000 1908 conversion shares of £10 each, 39,070 of which have been subscribed, and of 20,000 "A" 6 per cent. preference shares of £5 each, all of which have been taken up.

DUDLEY, STOURBRIDGE AND DISTRICT ELECTRIC TRACTION.—The report for 1907 shows gross receipts for the year of £46,254. After deducting all expenses, including repairs and maintenance, and placing £2,000 to renewals account, there remains £11,898. Deducting the dividend on the preference shares accrued to December 31st, 1907, and adding the balance of £1,050 brought forward from last account, the sum of £7,948 remains available for allocation, which the directors recommend should be applied as follows:—To sinking fund £1,000, to depreciation and reserve £1,000, dividend of 5 per cent. per annum on the ordinary shares £5,000, carried forward £948. The amount available for distribution is apparently less than in 1906, owing to the directors having decided to charge a larger amount to renewals account before arriving at the balance, rather than appropriating it after ascertaining the balance. The appeal to the House of Lords by the Corporation of Dudley against the decision of the Court of Appeal on the special case as to the basis for the purchase of Light Railway No. 5 was decided against the company. The effect of the decision is that the company will receive £16,028 less than had the railway been purchased under the Light Railways Act, but the rent to be paid under the lease will be correspondingly reduced. Efforts are now being made to complete the sale, and to settle the terms of the lease. It is proposed to enter into an agreement with the Birmingham and Midland Company and the Shropshire, Worcestershire, and Staffordshire Electric Power Company to sell to the Power Company the generating stations at Hart's Hill, Amblecote, and Lye. As a condition of the sale of the generating stations, arrangements will be made for obtaining a supply of power from the Shropshire company at favourable prices. The arrangement for the management of all the tramways in the Black Country by the Joint Committee has continued to work satisfactorily, and the agreement with the other companies operating in the district has been continued for a further period. The following statistics are given in the report for the years 1907 and 1906 respectively:—Passengers carried, 8,305,052 and 8,432,544; average receipts per passenger, 1·32d. and 1·18d.; average working expenditure per passenger, 0·89d. and 0·78d.; proportion of expenses to receipts, 61 per cent. and 60 per cent. The meeting will be held in London to-day.

HAVANA ELECTRIC RAILWAY.—The report for 1907 states that the net earnings were $924,951, from which must be deducted fixed charges $558,877, leaving $366,074, and after paying dividends amounting to 5½ per cent. on the preferred shares there remains a surplus of $91,074. The earnings per car mile indicate that the maximum earnings upon the present track mileage is being approximated, and that additional mileage will soon be required to properly handle the increased traffic incident to the normal growth of the city. An application for extensions of route has been made.

ORIENTAL TELEPHONE & ELECTRIC.—The report for the year ended December 31st, 1907, shows that, including £1,036 brought forward from last account, and after deducting the interim dividends of 3 per cent., paid November 1st last on both the preference and ordinary shares, and making the necessary provision for redemption of the debenture stock of the company, the amount to be dealt with is £15,839. The directors recommend that this sum be appropriated as follows, viz.:—A final dividend of 3 per cent. (less income tax) for the year on the preference shares, £1,500; a final dividend of 5 per cent. (free of income tax) on the ordinary shares, making 8 per cent. for the year, £8,965; to reserve account, £3,500; carrying forward £1,873. The directors deeply regret to have to record the death on the 24th of last month of their esteemed chairman, Sir Auckland Colvin, K.C.S.I., K.C.M.G., &c., who occupied that position for ten years, rendering most valuable services to the company during that time. The directors issued in June last £50,000 4 per cent. redeemable debenture stock (part of an authorised issue of £200,000), partly for the requirements of the company's own exchanges, and partly to assist the subsidiary companies. The changes in the company's own systems by means of underground cabling have now been completed, but extensions to the scheme as originally laid out have become necessary. The increased business anticipated in last year's report, as a consequence of these important alterations, has made itself felt, and all the chief exchanges show an improvement for the year. At Rangoon, land had to be purchased for a new sub-exchange, which has since been constructed and is now in working order. In Mauritius, the Government has under consideration a scheme whereby it is hoped that the scope of the company's business will be extended to the whole of the island. The Indian local companies have declared the same dividends as for the year 1906, viz., the Bengal Telephone Co., Ltd., 5 per cent., and the Bombay Telephone Co., Ltd., 6 per cent., and the amounts have been included in the revenue account. The Telephone Co. of Egypt, Ltd., has declared a dividend of 10 per cent. for the year on both its preferred and deferred shares, which has also been brought into the account. That company is engaged on further extensions as well as on work connected with adapting the freehold premises they purchased in Cairo, in March, 1907, to the company's requirements. The telephone trunk lines between Cairo and Alexandria, and Cairo and Tantah, continue to be well patronised by the public and by that company's exchange subscribers. Installations of additional provincial telephone lines for the Government of H.H. the Khedive are still in progress, and it is anticipated that this branch of the company's business will take still further extensions. The Ministry of Public Works in Egypt granted to that company last year an authorisation for the installation of telephone lines in the province of Fayoum, in Upper Egypt, for a period of 35 years from December 17th, 1907; work in connection with it is now in progress. To provide the means to carry out these contracts, the directors have taken up a further 8,000 preferred shares of £5 each in the Telephone Co. of Egypt, Ltd. The China & Japan Telephone & Electric Co., Ltd., at Hongkong and Kowloon has also had a prosperous year subsequent to the reconstruction of their system, and propose to declare a first dividend shortly on their ordinary shares. The meeting will be held on the 29th inst.

PRIMITIVA GAS & ELECTRIC LIGHTING.—The report for 1907 states that the balance of revenue account and interest received from the German Transatlantic Electricity Company amounts to £105,348, to which has to be added £72 transfer fees, and £16,612 brought forward. After meeting interest on debentures, London expenses, directors' fees, interim dividends, and placing £6,221 to general reserve account, there is a balance of £33,881. A final dividend of 4s. 6d. per share, free of income tax, making 7 per cent. for the year, is recommended on the ordinary shares, leaving £15,881 to be carried forward.

SLOUGH & DATCHET ELECTRIC SUPPLY.—The report for 1907 shows a total capital expenditure of £44,886, the amount expended during the year being £1,494. The connections in 8-c.p. lamps equivalent amount to 13,072, and the number of units sold was 250,248, compared with 253,041 for the

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previous year. The amount available for distribution is £2,756. After setting aside £750 for depreciation and £300 for directors' fees, a dividend of 3½ per cent., less tax, is recommended, and the balance carried forward. Mr. H. L. Prior, the Chairman, at the meeting last week, regretted that the balance-sheet was not so good as the directors would have wished. The Board were keeping a watchful eye on capital expenditure, and did not mean to supply any area unless they saw a prospect of a safe return. The net revenue account was not quite so satisfactory as that of the previous year, mainly owing to the high price of coal, which cost 4s. a ton more than during 1906, and the reason for the sale of current having gone down somewhat was the increasing use of Tantalum and Osram lamps. After some discussion, the report and accounts were adopted.

WINDSOR ELECTRICAL INSTALLATIONS.—The report for 1907 states that the number of lamps and motors installed now amounts to the equivalent of 42,171 eight c.p. lamps, of which 3,498 represent motors. The total capital expenditure now amounts to £83,954, an increase during the year of £1,427. Including £170 brought forward from last account, the net revenue account shows a balance of £4,929, to which has been added £250 from the dividend equalisation fund. Deducting debenture interest (£835), depreciation, renewals, and reserve fund (£1,000), dividend on 5 per cent. preference shares (£950), and directors' fees (£300), there is a balance of £2,094, out of which a dividend of 4 per cent., less tax, on the ordinary shares is recommended, carrying forward £194. At the meeting last week, when Sir William Shipley, the Chairman of the company, presided, the report and accounts were adopted. In his speech the Chairman referred to the effect upon the undertaking of the increasing use of metallic filament lamps, and said the Board was of opinion that these lamps would do for them what the incandescent mantle had done for the gas industry, viz., not only make electric light cheaper, but more popular.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS.—The report for 1907 shows a total revenue of £25,125. After deducting debenture interest, repairs and maintenance, and providing £1,000 for the renewals fund, there remains a profit of £2,622. Adding the sum of £544 brought forward, there is an available balance of £3,166. The directors recommend that there be placed to depreciation and reserve fund £500, and after paying a dividend at the rate of 1½ per cent. per annum on the ordinary shares there remains to be carried forward £269. In view of the fact that £9,086 will be received from the Dudley Corporation as the purchase price of the tramways in Dudley, hereafter to be leased to the company, the directors have not thought it necessary to set aside any amount to sinking fund in this account. The capital outlay during the year amounted to £1,135, and was chiefly in respect of the equipment of rolling stock with the Lorain equipment to enable the through services into Wolverhampton to be effected. In connection with the tramways in Dudley the arbitration proceedings have now been completed and negotiations are taking place as to the terms of the lease to be granted by the Dudley Corporation. On the completion of the purchase £9,086 will be received from the Dudley Corporation as the price of this company's lines in Dudley. The company has joined the British Electrical Federation. The company has continued to benefit during the past year from the operation of its tramways as part of the system worked by the Birmingham and Midland Tramways Joint Committee. An agreement has been entered into with the other companies of the joint committee for providing a central car shed and repair shop at Tividale for the execution of repairs, &c., on the basis of each company paying a rent proportionate to the number of cars owned on January 1st, 1907. The parcels and goods traffic service has given satisfactory results during the past year, and there has been a considerable increase in the number of parcels handled. The following statistics are given in the report for the years 1907 and 1906 respectively:—Passengers carried, 4,381,837 and 4,102,374; average receipts per passenger, 1·36d. and 1·39d.; average working expenditure per passenger, 0·95d. and 0·89d.; proportion of expenses to receipts, 68 per cent. and 64 per cent. The meeting will be held to-day.

NEW COMPANY

CALMONT, KING & CO.—This company was registered on April 15th, with a capital of £3,000 in £1 shares, to carry on the business of electrical engineers, &c. The subscribers are:—M. Wolff, E. Browne, A. J. Mardlin, R. E. Jones, A. J. Winser, H. E. Patterson, R. Dickens. No initial public issue. The first directors are A. J. Mardlin, E. Browne, and M. Wolff (all permanent; special qualification, 300 shares).

PAMPHLET RECEIVED

ELECTRIC BLOWING EQUIPMENTS.—We have received a leaflet from Messrs. Veritys, Ltd., containing views of about 36 battleships, on board which their electrically-driven blowing equipments have been fitted.

MISCELLANEOUS CITY NOTES

THE LONDON ELECTROBUS CO.—We have seen an advance copy of a prospectus which is being issued by the London Electrobus Co. inviting subscription for new capital, divided into 240,000 ordinary shares of £1 each and 12,000 deferred shares of 5s. each. We have already given full particulars of the working of these omnibuses (ELECTRICAL ENGINEERING, Vol. II., page 903), and some of the figures in the prospectus as regards what has already been accomplished, and what may reasonably be expected when the number of omnibuses in service is increased, may be of interest. From the commencement of working in July, 1907, up to April 14th last, 970,271 passengers have been carried and 95,482 car miles run, and the average takings per mile have reached the excellent figure of 13·069 pence. A report by Sir Douglas Fox & Partners places the working expenses at 9½d. per car mile, including depreciation, when the proposed full number of vehicles are in operation, and the figures for the costs up to now fully bear this figure out, so that, if expectations are realised, there should be an ample margin of profit. The company now propose to place 150 "Electrobuses" on the streets, each running on the average 80 miles per day for 300 days per year. The whole success of electric omnibuses depends upon the capabilities and cost of upkeep of the accumulators, but some of the doubts which were felt on this score at the inception of the undertaking have been effectually dispelled by the fact that two well-known battery firms are maintaining the batteries and attending to the charging at an inclusive contract rate of 2d. per car mile.

COLOMBO ELECTRIC TRAMWAYS AND LIGHTING CO.—The directors recommend a dividend of 4 per cent., free of income-tax, for 1907, placing £5,111 to reserve and renewals fund. The sum of £13,000 has been taken from the reserve fund to write down the track renewals fund, and £1,000 to extinguish the mains and plant improvement account. The sum of £935 is carried forward.

RIO DE JANEIRO TRAMWAY LIGHT & POWER.—The *Financial News* states the Rio de Janeiro Tramway Light & Power Co., Ltd., has concluded arrangements with some leading banking houses in Paris and Brussels for placing £1,750,000 (one-half) of the issue of new five per cent. debentures, £400,000 of these debentures having been paid in full. A public issue of £900,000 will be made simultaneously in Paris and Brussels on May 12th, and the balance, £850,000, of the above amount reserved for Paris and Brussels, will be offered in the autumn.

TELEPHONE COMPANY OF EGYPT.—A further dividend of 6 per cent. upon the deferred shares, making 10 per cent. for the year, is recommended. The sum of £3,000 has been placed to reserve, and £10,433 carried forward.

APPOINTMENTS AND PERSONAL NOTES

Mr. Charles Burgess, of the Kirkcaldy Electric Tramways Department, has been appointed traffic manager for the Wigan Corporation Tramways. The salary is £200 per annum.

Mr. John J. Inniss has been on a business tour through China since last November. We understand Mr. Inniss has opened out a branch office in connection with his firm, Messrs. Inniss & Riddle, of Birmingham, at 40 Szechuen Road, Shanghai, where the firm will conduct their Chinese business as consulting electrical and mechanical engineers, machinery and general import merchants.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night, was £59 10s. to £60 per ton. (Last week, £59 to £59 10s.)

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—The statement of affairs of the bankruptcy of Messrs. Zobel & Sons, electrical engineers, of 153 Euston Road, London, N.W., show liabilities amounting to £1,990, of which £840 is in respect of trade creditors and the remainder in respect of cash claims. After allowing £60 for preferential claims the assets are expected to produce £627, leaving a deficiency of £1,656.

The liquidator in the winding-up of Messrs. D. Santoni & Co. (1906), Mr. R. G. Nordaby, having disposed of the business, requests all creditors against him as receiver to send particulars of their claims to 13-14 Abchurch Lane, London, by June 1st.

A meeting of the creditors in the bankruptcy of E. R. Smith, electrical engineer, 13A Heath Street, Hampstead, was held on the 16th inst., when a statement of affairs was presented which showed liabilities amounting to £1,516 5s. 11d., made up of the claims of trade creditors, £816 5s. 11d., and cash creditors, £500. The assets totalled £712 3s. 4d. After some discussion it was resolved to accept a composition of 10s. in the £ in cash. The chief creditors are Electrical Fittings Co. (£124), Armorduct Manufacturing Co. (£118), General Electric Co. (£84), and Edison & Swan United Electric Light Co., Ltd. (£60).

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ELECTRICAL ENGINEERING

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SUMMARY

The official nominations for filling the vacancies on the Council of the Institution of Electrical Engineers will be made this evening. Mr. W. M. Mordey will be proposed as President. Mr. C. P. Sparks and Frank Gill, the two who retire of the four Vice-Presidents, are proposed for re-election. As new ordinary members of Council, Mr. T. Mather, Major O'Meara, Prof. A. Schwartz, Mr. J. F. C. Snell, and Mr. G. G. Stoney are proposed in place of Messrs. Duddell, Judd, Mordey, Pearce, and Wordingham, and as Associate Member, Mr. J. E. Taylor, to succeed Mr. A. Campbell. We publish portraits and short biographies of the members nominated (Page 649.)

A new metallic filament lamp, made by the Stearn Electric Lamp Co., consists of a number of 20- to 25-volt tubular lamps grouped together on one holder to form a 100- or 200-volt unit. Each of the tubular lamps contains a substitutional resistance and a simple cutting-in device, so that if one of the tubes burns out the others are not extinguished. (Page 651.)

A new and conveniently arranged portable motor-generator for charging individual cells in large batteries has been put on the market. (Page 652.)

An entirely novel form of emergency brake has been introduced by Mr. P. J. Pringle, of Burton-on-Trent. A steel shoe or skid, shaped to enter the groove of the rail, is provided, which can be dropped in front of the car wheel, causing the wheel flange to mount the trailing end of the skid and so bring upon it the weight normally carried by the wheel. Tests have been made to show the great power of the apparatus. The brake is only intended for emergency stops, and as it cannot be applied gradually is somewhat violent in its action. (Page 653.)

Two fine examples of electric cranes are presented by a 10-ton double cantilever electric crane at one of the Lancashire and Yorkshire goods stations at Liverpool, and a 25-ton electric derrick crane at the North Wharf of the Clyde Navigation Trust at Renfrew. (Page 655.)

The discussion at the Institution of Electrical Engineers on Messrs. Handcock & Dykes' Paper on the effect of metallic filament lamps on the business of electricity supply, was resumed last Thursday. Mr. C. P. Sparks said that the standard of illumination would be raised, and he did not think the electricity supply business would suffer severely. He expressed disapproval of the maximum demand system and approval of the flat rate system of charging. Mr. C. H. Stearn exhibited the new lamps, referred to also in a separate article, and explained the system upon which

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they worked. Mr. Percy Still preferred the flat rate of charging for lighting. Mr. Leonard Andrews cited instances in which the drop in revenue due to the introduction of metallic filament lamps had been considerable. He thought the flat rate of charging inequitable, and said that good results, both as to consumption and load factor, had been obtained some years ago by charging 10s. per lamp demanded and 1½d. per unit. Mr. J. F. C. Snell had found that comparing incandescent gas burners with metallic filament lamps, gas at 2s. 6d. for 1,000 c.ft. was, light for light, equivalent to electricity at 3½d. per unit. He believed in the flat rate of charging. Mr. Robert Hammond gave figures showing the increase in units generated in London during the past few years; he was convinced that the falling off in output would be only temporary, and that the new lamps would be a magnificent thing for the industry. He approved the principle of the authors' and Mr. Long's system of charging. Mr. E. T. Ruthven-Murray said that the power factor of auto-transformers used for metallic filament lamps was as low as 0·7 on low loads, but rose to nearly unity on full load. He gave interesting figures with regard to small consumers on a company under the control of the North Metropolitan Electric Power Co. He suggested the use of a time-limit indicator with a non-replaceable contact that could be set by the consumer. Mr. W. M. Mordey suggested the term "wire lamp" instead of metallic filament lamp, and spoke strongly against the maximum demand system. Mr. Frank Gill, Mr. Leon Gaster, and Mr. R. B. Matthews also spoke. Col. Crompton (the President), in summing up the discussion, took the view that the new lamps would seriously affect some of the supply undertakings, and that a review of the methods of charging was necessary. He regarded the Norwich system as the one which would ultimately be adopted. Written communications were sent by Mr. J. Horace Bowden, Mr. J. E. Tapper, Mr. C. E. Skelton, and Mr. W. R. Cooper. (Page 657.)

The thirteenth annual convention of the Incorporated Municipal Electrical Association will be held in Nottingham from June 30th to July 3rd. The business meeting will be held on the morning of July 2nd, and the annual dinner in the evening of the same day. (Page 662.)

In the discussion of the Paper read by Mr. G. Stevenson before the Glasgow Local Section of the Institution of Electrical Engineers, on the application of polyphase induction motors for industrial purposes, most of the speakers disagreed with the author's view that squirrel-cage motors in conjunction with friction clutches were superior to slip-ring motors. (Page 662.)

A special form of electrically-driven conveyor for dealing with fruit cargoes has been installed at New Orleans, as well as some travelling band conveyors for ordinary freight. (Page 663.)

The report and balance sheet of the British Westinghouse Electric and Manufacturing Co. for the year ended December 31st, 1907, shows trading profits amounting to £92,383, and after deducting interest on debenture stock and upon temporary loans, &c., there is a balance of £11,341 to be carried forward. (Page 664.)

The annual report of Marconi's Wireless Telegraph Co. for the year ended September 30th, 1907, has been issued, and contains some particulars of the company's transatlantic and maritime business, as well as the operation of the associated companies abroad. A large station is being constructed in Italy at Coltano, with a view to communication with South America. It is announced that Mr. H. Cuthbert Hall, on relinquishing his position as managing director and retiring from the board, has been allotted 10,000 fully paid shares as well as receiving a payment in cash. (Page 665)

The new 100-ton electric locomotives for the Detroit River Tunnel are equipped with four 300-h.p. interpole motors arranged on an articulated frame (Page 667.)

A new multiple circular slide rule for steam engine calculations has been designed by Mr. H. A. Golding. (Page 668.)

At the meeting of the Faraday Society, held on Tuesday, three Papers were read and discussed. The Paper by Prof. Huntington and Dr. Desch, upon the planimetric analysis of alloys and the structure of phosphor-copper, described a neat and rapid method for arriving at an idea of the constitution of alloys. T. E. Weston and H. R. Ellis described experiments upon the formation of aluminium carbide, and Prof. Piltschikoff contributed a Paper upon technical electrochemistry in Russia. These Papers are abstracted in Electrochemistry and Electrometallurgy. (Page 669.)

Under Electrical Science, in the British and American Section, is a note on some recent experiments on selenium cells. In the Continental Section a description of an electric hygroscope, by J. Pionchon, is given, and some researches by Mayer and Salles on the electric transportation of colloids are described. The proposal for a wireless hour device for determining longitudes is further discussed (Page 669.)

Mr. G. G. Stoney gave a lecture at the Royal Institution on Tuesday on the development of the Parsons turbine as applied to generating sets. (Page 670.)

A petrol electric railway car, which has recently been completed in America on the Strang system, is described. The principal feature of the system is the employment of a battery to supplement the power of the battery at times of heavy load. (Page 670.)

Amongst the patent specifications published last Thursday is one by the Parker Clark Electric Co. relating to a method of depositing a layer of pure silicon on a graphitised filament. The silicon, having a lower specific resistance, runs at a higher current density and temperature than the central core. Another by the British Thomson-Houston Co. describes a system of motor control by which a wide and uniformly graduated speed variation may be obtained with the use of two motors. The same company has a specification relating to flexible supports for the filaments of incandescent lamps. A patent by A. E. Kieth for an automatic telephone exchange expires during the current week. (Page 671.)

The estimated expenditure upon the Edinburgh Corporation electricity undertaking for the current financial year is £70,230, compared with £65,040 last year. The surplus is put at £11,408. The Postmaster-General has decided to use the telephone ducts in Edinburgh for the purpose of the underground telegraph line.—The Erith Council has objected to the plans of the London County Council, which fix the terminus of the tramway to Abbey Wood at a point 80 ft. distant from the Erith Council's tramways.—The Plymouth and Belfast Corporations have declined to take part in a conference proposed by the Halifax Corporation for formulating a mutual scheme with regard to third-party tramway risks.—For the year ended March 31st the Bury tramway accounts show a net profit of £4,606, against £5,225 last year, and upon the electricity undertaking there is a profit of £3,950, against £2,947. (Pages 673 and 674.)

The Birmingham Corporation has made an application to the Local Government Board for sanction to borrow £251,285 in respect of their electric supply undertaking. Local Government Board inquiries have been, or will shortly be, held as follows:—Brighouse (£3,600), Burnley (£26,460), Colne (£4,170), Ilford (£27,000). Loans have also been sanctioned as follows:—Walthamstow (£17,189 and £222) and Wednes-

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bury (£8,000). The London County Council invite tenders for 2,000 tons, or alternatively 5,000 tons, of tramway rails and fastenings, and the Rawtenstall Corporation for steel tramway poles, overhead line equipment, &c. (Pages 674 to 676.)

At the annual meeting of the City of Birmingham Tramways Co. last week Mr. E. Garcke, the Chairman, in regard to a suggestion that the company should be placed in the hands of a liquidator, stated that no good purpose would be served by so doing, whilst they were able to earn more than 4 per cent. on their investments, merely for the purpose of redeeming the 4 per cent. debentures. The report of Messrs. Johnson & Phillips for 1907 shows a net profit of £42,981. The bulk of the revenue has been derived from their telegraph business. A dividend of 7 per cent. per annum upon the ordinary shares is declared, transferring £8,000 to reserve and carrying forward £6,873. At the meeting of the British Aluminium Co. on Friday the Chairman stated that the company had contracts for deliveries extending to 1910 upon the basis of current prices. (Pages 676 to 679.)

The new six-axle single-phase locomotive built by the Siemens-Schuckert Werke for the Seebach-Wettingen Railway is equipped with four 175 h.p. 15-volt series commutator motors of the same type as those in use on the electrified portion of the Midland Railway. (Page 679.)

The rapidity with which the metallic filament lamp has made its way and the enormous changes which it is already effecting in the electric lighting industry are remarkable. It is perhaps obvious that the first members of the general public to appreciate its advantages have been the large firms and business houses who are already electric light consumers. So great are the reductions that have been made in their lighting bills in some instances that a serious falling-off in revenue is actually feared by some people connected with the electricity supply industry We have already expressed the opinion that the effect in this direction will be far more than counterbalanced by the acquisition of new consumers attracted by the cheaper light. In this we have been supported by the majority of the speakers in the recent debate at the Institution of Electrical Engineers, the conclusion of which is fully reported in this issue. When any great advance is made in any industry it is seldom that one section will not suffer temporarily. The gain to the whole electrical world by the possibility of producing three times as much light as hitherto with the same consumption of electrical energy is almost immeasurable. Apart from the increased profit to the lamp makers, which they certainly fully deserve, the wiring contractors' business, which has recently been a bad one owing to over-competition, will receive an impetus that will once more put a premium on good and honest work, and the fittings industry will also be greatly benefited. In addition to this there will be indirect gains. An increased use of electricity for lighting will lead to its being more popularised, and the number of those who have learned its advantages for small power purposes will be largely added to. To some extent, therefore, the first loss to makers of electrical machinery by the present diminution in the growth of the central station load will be made good by an increase in the demand for motors. So far as the supply industry itself is concerned, street lighting should afford a means of rapidly making up for the decreased consumption of the large light users before the canvass of the small householders has had its full effect. By means of the new lamps miles upon miles of streets in all parts of the kingdom can be more efficiently and economically lighted than at present. Doubtless, there was much more to say on the subject of the effect of metallic filament lamps on the industry than there was time for during the two nights' debate at the institution in London. Dublin electrical engineers have also contributed their opinions, and the voice of Glasgow on the subject is to be heard next month. Yet there are still points upon which further facts and opinions will be welcome, and we are all ready for more information as to the lamps themselves. For this reason we trust that the Paper which Mr. Hugo Hirst has just sent in to the Institution will be discussed before the end of the session. Owing to the rapid strides that are being made it would be out of date if held over until next session by the Editing Committee of the Institution, but apart from this, few subjects of greater interest to electrical engineers could be found at the present time than the "wire lamp." The sugestion by Mr. Mordey that this name should be given to the metallic filament lamp is a good one, and we trust that the name will "catch on."

The question of whether a brake for pure "emergency" use should be added to tramcars working on hilly routes is likely to be revived by the success achieved by Mr. P. J. Pringle, of Burton-on-Trent, as the account of the tests published in this issue clearly proves. The provision of such a brake is in the nature of an accident insurance premium, as it is not available for service purposes. Mr. Pringle's brake is open to the general objection to such devices, viz., that when the emergency comes the motorman may forget the means provided to meet it, because its use calls for an effort of memory and intelligence at the moment when a man is least fitted to exercise them. The Pringle brake, however, appears to be better than previous devices, because it calls for no appreciable muscular exertion or complex action, and, as it retains a highly effective stopping power up to high speeds, there is greater time for the motorman to collect his wits soon enough to prevent a catastrophe or for the conductor to intervene with effect. To employ once more the insurance analogy, it is a premium paid to a sounder office, but one that is still not infallible. On a system with many severe gradients, it may be thought worth while to adopt this extra safeguard, but it does not in the least help to work the gradients, which must still be descended at low speeds, with the help of special hill brakes, by carefully trained men. We very highly appreciate the ingenuity by which Mr. Pringle has obtained a virtually higher coefficient of friction by the use of a wedge action, and it may perhaps be somewhat differently applied to produce a brake equally capable of use for service stops, hill coasting, or emergencies by graduated application, when it will have a far wider scope than in its present form.

Although the official nomination of candidates to fill the vacancies on the Council of the Institution of Electrical Engineers has been issued this year in time for members to put up alternative candidates, it is improbable that any advantage will be taken of the opportunity on this occasion. Mr. W. M. Mordey, who is proposed as President, is an old member who has

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served the Institution well and faithfully on the Council during the last twenty years. We have in the past owed many lively and instructive debates to his initiative, and as President he will doubtless do much to maintain the standard of the discussions at the Institution meetings. To some extent perhaps it will be regretted that it was not possible to have a Manchester man as President this year in order to invest the forthcoming electrical exhibition in that city with more official prestige and importance; but it happens that there is no Manchester engineer on the list of those who have served as Vice-Presidents, and according to the Articles of Association no member is eligible for nomination as President unless he has previously been Vice-President. When Mr. C. P. SPARKS and Mr. FRANK GILL have served their third year in this capacity and retire, we trust that this omission will be rectified. Manchester is now probably the most important centre of the electrical industry, and it is not right that it should have but three representatives on the Council, one of whom is an *ex officio* Councillor, as Chairman of the Manchester Local Section, and another (Prof. SCHWARTZ) must be regarded as rather the representative of the professorial side than of the Manchester industrial group. Dr. E. HOPKINSON thus remains as the only representative of Manchester manufacturers for next session on the Council list just issued. It is also to be regretted that Mr. S. L. PEARCE, the Manchester City Electrical Engineer, should be on the list of retiring members. Of the new members and associate members of Council, two are telegraph engineers, two fill educational posts with conspicuous ability, one is a leading consulting electrical engineer, and one a manufacturer. No exception can be taken to any of the names; all are those of men who have shown distinction in their branch of the electrical profession. Yet the large proportion of the membership interested in the heavier side of electrical engineering must watch the Council list carefully, remembering that the professors and telegraph engineers are already well represented among the Past-Presidents who have five votes on the Council. It is to be understood that the proposal of alternative candidates to those nominated officially is now actually invited by the Council, and any class of electrical engineers who may think that their claims for representation are not adequately recognised in the selection of the official candidates, have an obvious course of action.

Telegraph Traffic.—In consequence of the interruption of the cable between Cadiz and Teneriffe, telegrams to and from Brazil, Argentine, Paraguay, and Uruguay will be sent via Brest-Dakar, without alteration of tariffs. The Via Fao route has been broken between Bagdad and Bassorah, and there is also an interruption between Bangkok and Saigon beyond Battambang. The blizzard in the United States has caused havoc among telegraph and telephone lines, and similar trouble was caused in Essex by the recent snowstorm. It is reported that the Spanish Government intend laying a new cable between Cadiz and Teneriffe. According to *Tropical America*, the Mexican Congress has voted appropriations for improving the telegraph and telephone lines already in existence, and for establishing a number of additional ones. The most important of the new lines will be two telephonic connections between Mexico City and the capital of the State of Hidalgo. A telegraph line will follow the northern border, another will put into communication the States of Hidalgo and Tamaulipas, while the cities of Jaltipan and San Juan Bantista in the south-east are also to be connected.

Wireless Telegraphy.—A letter has been received by the Liverpool Chamber of Commerce from the Colonial Office, stating that a suggestion to provide short-distance wireless telegraph stations between British Colonies is receiving attention.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, APRIL 30TH.

Royal Society.

4.30 p.m. Meeting at Burlington House, Piccadilly, London. Among the Papers down for reading is the following:—"On the Hysteresis Loss and other Properties of Iron Alloys under very small Magnetic Forces," by Prof. E. Wilson, V. H. Winson, and G. F. O'Dell, communicated by Sir William Preece, K.C.B., F.R.S.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at 25 Great George Street, Westminster, London, when Prof. S. P. Thompson, F.R.S., will deliver the first Kelvin Lecture on "The Life and Work of Lord Kelvin." At this meeting a bust of Benjamin Franklin will be presented to the Institution on behalf of the American Institute of Electrical Engineers, by Mr. H. F. Parshall, the British Local Honorary Secretary of that Institute.

FRIDAY, MAY 1ST.

Royal Institution.

9 p.m. Evening Discourse on "The Scientific Work of Lord Kelvin," by Prof. J. J. Larmor, F.R.S.

TUESDAY, MAY 5TH.

Royal Institution.

3 p.m. Afternoon Lecture II. by Mr. G. Stoney on "The Development of the Modern Turbine and Its Application."

THURSDAY, MAY 7TH.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at the Society of Arts, John Street, Adelphi. Paper to be read:—"The Manufacture of Electrical Condensers," by G. F. Mansbridge.

Röntgen Society.

8.15 p.m. Meeting at 20 Hanover Square, London, W. Agenda:—Paper by Dr. Horace Manders on "Continuous Oscillations of Electricity and Their Application." Mr. R. S. Wright will show and explain the new "Vita" interrupter for obtaining an increased output from an induction coil without a corresponding increase of primary current.

FRIDAY, MAY 8TH.

Physical Society.

8 p.m. Meeting at the Royal College of Science, South Kensington. Mr. C. G. Whitehead will read a Paper on "An Examination of the Formulæ for the Grading of Cables."

Association of Engineers-in-Charge.

8 p.m. Annual Meeting at the St. Bride's Foundation Institute, Bride Lane, Fleet Street, E.C.

NEW PUBLICATION

"Journal of the Institution of Electrical Engineers, April, 1908." (London: E. & F. N. Spon, Ltd.) 5s.

Electrical Engineers' Volunteers.—Second-Lieutenant John L. Lewis has been promoted Lieutenant in the Severn Division.

Wireless Transmission of Photographs.—A demonstration of a system of transmitting photographs for press or police purposes by means of Hertzian waves, was given by the inventor, Mr. Hans Knudsen, at the Hotel Cecil, London, on Tuesday last. The photograph or sketch to be transmitted is prepared by giving the outline and shaded portions a rough surface. A metal point, which is given a reciprocating motion across the surface of the photograph, is agitated by the roughened surface, and is so connected to the trembler of an induction coil that Hertzian waves are given off by the transmitter whenever the point travels over a raised spot or surface. The receiver consists of a sensitive and quickly recovering coherer in circuit with a relay which causes another metal point to produce a series of marks on a lamp-black film on a glass plate, these marks corresponding in position with the roughened surface of the photograph. The metal point of the receiver has also a reciprocating motion, and runs synchronously with the transmitter, and after each cycle both transmitter and receiver points move slightly sideways. After each cycle the transmitter sends an extra series of waves, which operate a special coherer and relay. This latter starts the motion of the receiving point, and thus ensures that the two pieces of apparatus are working synchronously. A complete 5 × 4 in. photograph can be transmitted in about 15 minutes. By dusting the photographic negative before it is quite dry with a metallic powder, the dark raised portions of the gelatine film, being damp, retain the powder, and the necessary rough surface is produced. A sketch should be drawn with gum and the lines dusted with powder. In the present development of the system the pictures produced are wanting in sharpness of definition.

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THE INSTITUTION COUNCIL ELECTION

THE Council of the Institution of Electrical Engineers consists of the President, four Vice-Presidents, fifteen ordinary Members, three Associate Members or Associates, and the Chairman of each Local Section for the time being, and the Honorary Treasurer, who are *ex-officio* Members of Council. All these Councillors are not elected annually. The President, two of the four Vice-Presidents, five ordinary Members of Council, and one Associate Member or Associate retire each year. Under the Articles of Association the President and Vice-Presidents are eligible for re-election, but may hold office three years in succession. It is customary, however, to elect a new President each session, selected from the list of those who have held office as Vice-President. The retiring Vice-Presidents, if not re-elected in the same capacity, are eligible as ordinary Members of Council, and any new Vice-President must have served previously on the Council as an ordinary Member. The ordinary and Associate Members of Council in most cases remain on the Council for three years in succession, which is the maximum under the Articles of Association, and then retire. This year the following Councillors are retiring:—Col. R. E. B. Crompton (*President*), Messrs. Frank Gill and C. P. Sparks (*Vice-Presidents*), Messrs. W. Duddell, Walter Judd, W. M. Mordey, S. L. Pearce, and C. H. Wordingham.



Mr. W. M. Mordey.

The Council will to-night nominate members to fill their places, but it is understood that alternative nominations are invited from the membership, both for the office of President and Vice-President, if desired, and also for ordinary and Associate Members of Council.

The Honorary Treasurer retires annually but is eligible for re-election each year, and Mr. Robert Hammond, who has filled this office since 1902, is nominated for re-election in the usual course.

The official nominations, which will be made by the Council to-night, will be as follows:—

As President:
W. M. Mordey.

As Vice-Presidents:
C. P. Sparks and F. Gill.

[These are the two retiring Vice-Presidents, but as they have served only two years as Vice-Presidents, they are nominated for re-election.]

As Members of Council: T. Mather, F.R.S., Major W. A. J. O'Meara, C.M.G., Prof. Alfred Schwartz, J. F. C. Snell, and G. G. Stoney.

As Associate Member of Council: J. E. Taylor.

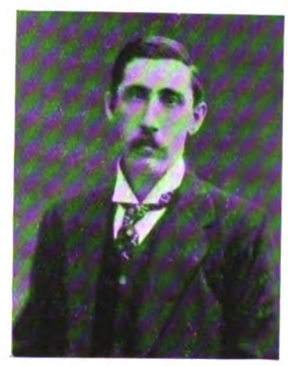
Mr. W. M. Mordey, whose portrait appears above, has been on the Council several times during the past twenty years, and has filled the office of Vice-President in 1904–5, 1905–5, and 1906–7. Prior to joining the Brush Electrical Engineering Co., in 1881, Mr. Mordey was in the Postal Telegraph Service, first in London, and then in Bradford. His first appointment with the Brush Co. was as Superintendent of the Testing Department, but he was later appointed Chief Electrician, in which capacity he continued until 1897, when he resigned and started in consulting practice. In 1900 Mr. R. A. Dawbarn joined him as partner. Mr. Mordey is a strong advocate of "one-phase" traction, and the Paper by himself and Mr. B. M. Jenkin before the Institution of Civil Engineers on this subject in 1902, which was awarded both the Telford and Stephenson Medals, is a complete exposition of the subject at that date. The following is a list of the Papers which Mr. Mordey has read before the Institution of Electrical Engineers:—"Some Prejudicial Actions in Dynamos" (1884); "Alternate-Current Working" (1889); "On Testing and Working Alternators" (1893); "A Detail in Parallel Working of Alternators" (1893), "Parallel Working with Reference to Long Lines" (1894); "Dynamoes" (1897); "Capacity in Alternate-Current Working" (1901). Mr. Mordey was awarded the Institution premium for his Paper on "Dynamoes."

Mr. C. P. Sparks, who, it is proposed, should serve a third year as Vice-President, has been on the Council during the years 1900–01, 1901–2, 1902–3, 1904–5, and 1905–6. Mr. Sparks was connected with Mr. Ferranti in his pioneer work from the very early days of electric lighting, and remained with the firm of Ferranti, Ltd., until 1899, when he became Engineer-in-Chief to the County of London Electric Supply Co., a position which he now holds. Mr. Sparks also practises as a consulting engineer, and has made a speciality of the application of electricity in mining work. He read a Paper before the Institution in 1906 on the "Electrical Equipment of the Aberdare Collieries of the Powell Duffryn Co."



Mr. C. P. Sparks.

Mr. Frank Gill, who has already served as Vice-President during the years 1905–7 and 1907–8, was also a Member of Council for the three preceding years. He is Engineer-in-Chief to the National Telephone Co. His successive appointments with the company have been as follows:—1890, Chief Electrician at Liverpool; 1893, District Manager for Blackburn and North-West Lancashire, and subsequently for Dublin and South Ireland; 1896, Superintending Engineer for Ireland; 1902, Engineer-in-Chief to the company. During his stay in Ireland, Mr. Gill read the two following Papers before the Local Section:—"Note on a Humming Telephone" (1901), and "Hydro-electric Phenomenon" (1902).



Mr. Frank Gill.

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Major W. A. J. O'Meara, C.M.G., R.E., Engineer-in-Chief to the General Post Office, entered the Army in 1881, and was gazetted to the Royal Engineers in 1883. He went through the Burmah War of 1885, and after being on the sick list for nineteen months, returned to duty. In 1890, whilst with the Second Division of the Telegraph Battalion, Royal Engineers, he surveyed for, and constructed the trunk telephone line through Kent in connection with the London-Paris Telephone Service. Major O'Meara was in Kimberley on the outbreak of the South African War, after the relief of which he joined the Army Headquarters, and accompanied Lord Roberts into Bloemfontein. Later on he took charge of all municipal matters at Johannesburg on the British occupation being effected, when Mayor, Town Council, and Town Clerk were dispensed with. In 1902, Major O'Meara retired from the Army on being offered the position of Assistant Engineer-in-Chief at the General Post Office, conjointly with Mr. Roberts, on the retirement of Mr. Hookey, the then Engineer-in-Chief. In April last year, Major O'Meara was appointed to succeed Mr. (now Sir) John Gavey as Engineer-in-Chief.



Photo. Reinhold, Thiele & Co.

Major W. A. J. O'Meara, C.M.G.

Professor A. Schwartz is Professor of Electrical Engineering at the Manchester Municipal School of Technology. He has contributed three Papers to the Institution of Electrical Engineers, all more or less upon kindred subjects. The titles of these were "Fuse Phenomena" (1908), "Flexibles and the Testing of Rubber" (1907), and "Low-tension Thermal Cut-outs" (with Mr. W. H. N. James in 1905). His Paper on "Fuse Phenomena," read before the Institution this year, described some experiments carried out at the suggestion of the Sub-Committee of the Engineering Standards Committee, occupied with the standardisation of fuses. Before his appointment to the Professorship at the Manchester Municipal School of Technology, he was lecturer in Electrical Engineering at the South-Western Polytechnic, Chelsea.



Prof. A. Schwartz.

Mr. J. F. C. Snell is in practice as a Consulting Engineer, and has acted for the London County Council in connection with their Electric Power Bills, and also for the Home Office on the recent inquiry. He started electric lighting work as assistant engineer to Colonel (then Mr.) R. E. B. Crompton, at the Kensington Court station, and also in connection with the erection of the Notting Hill Co.'s station, and the Stockholm City Lighting. After three years with Mr. Crompton, he joined the late Major-General C. E. Webber as confidential assistant, being engaged on constructional, parliamentary, and general consulting work. Three years later he was appointed, in 1893, by Professor Henry Robinson to superintend the construction of the St. Pancras Vestry Electricity Works, and remained as Resident Engineer in 1895, when the works were started. From 1896 to 1906 he was Electrical Engineer to the Borough of Sunderland, and in 1899 he was, in addition, appointed Tramways Manager. He was President of the Incorporated Municipal Electrical Association in 1903, and Chairman of the Newcastle Local Section of the Institution of Electrical Engineers in 1901–2. In January of this year he read a Paper in London on "Cost of Electrical Power for Industrial Purposes" before the Institution.



Mr. J. F. C. Snell.

Mr. G. G. Stoney, who was Chairman of the Newcastle Local Section in 1903–4, has been connected with the firm of Messrs. C. A. Parsons & Co. for many years. He has devoted much time to investigations in connection with high-speed dynamos for use with turbines, and his Paper on this subject, read before the Institution on April 2nd, in conjunction with Mr. A. H. Law, set forth the practice of his firm in this respect.



Mr. G. Stoney.

Mr. T. Mather, F.R.S., comes on to the Council as a full member for the first time, but he was Associate Member of Council in 1904-5, 1905-6, and 1906-7. During his long association with Professor W. E. Ayrton, F.R.S., Mr. Mather has carried out a large amount of work in connection with electrical instruments, and he is the author of a very large number of Papers read before the Physical Society and other institutions on this subject. He at present holds the position of Chief Assistant in the Electrical Engineering Department at the Central Technical College, and Examiner in the Electric Lighting Department of Technology in the City and Guilds of London Institute. As co-author with Professor Ayrton, he read the following Papers before the Institution in 1894:—"A Universal Shunt Box for Galvanometers"; "Transparent Conducting Screens for Electric and other Apparatus"; "An Astatic Station Voltmeter."

Mr. J. E. Taylor is Assistant Superintending Engineer in the Postal Telegraph Department, London. He has undertaken considerable research work in connection with wireless telegraphy, and has been associated with the experiments which have been carried out by the Post Office Engineers-in-Chief. He was joint author with Mr. W. Duddell, F.R.S., of a Paper read before the Institution of Electrical Engineers in 1905, entitled "Wireless Telegraphy Measurements."



Mr. J. E. Taylor.

Alternative nominations must be made by two Members, supported by eight other Members, and must be sent in to the Secretary by Thursday next, together with the written consent of the nominee to accept office if elected. Ballot papers are then sent out to every Member, Associate Member, and Associate of the Institution. The method of conducting the ballot is not laid down in the Articles of Association, but it may be presumed that it would be a postal ballot. In the event of no alternative nominations being received by Thursday next, the Council's nominees will be declared duly elected at the Annual General Meeting on May 28th.

The Chairmen of the Local Sections, who are *ex-officio* Members of Council, have not all been elected yet. They are chosen by the Local Sections themselves. Mr. W. W. Lackie, Electrical Engineer to the Glasgow Corporation Electricity Department, has been selected for Glasgow, and Mr. H. E. Yerbury, Electrical Engineer to the Sheffield Corporation Tramways, has been elected Chairman of the Leeds Local Section.

The following Members remain on the Council:—

Vice-Presidents.—Colonel H. C. L. Holden, F.R.S., and Dr. G. Kapp.

Members of Council.—S. Evershed, H. E. Harrison, Dr. E. Hopkinson, J. W. Jacomb-Hood, J. E. Kingsbury, M. O'Gorman, G. W. Partridge, W. H. Patchell, W. Rutherford, A. A. C. Swinton.

Associate Members of Council.—J. Hunter Gray and H. Human.

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THE NEW STEARN METALLIC FILAMENT LAMP

OUR readers will doubtless be glad to have a full description of the new metallic filament lamp which Mr. Stearn exhibited at the last meeting of the Institution of Electrical Engineers.

The principle is as follows:—The 100-volt Osram and similar metallic filament lamps consist usually of four metal filaments connected in series in one bulb: except in the case of the tantalum lamp the whole of the filament is not one continuous wire. These filaments are very fine—something in the order of one-thousandth of an inch diameter—and if there is a slight flaw in one of them, so that it burns out before its time, the whole lamp is rendered useless. Mr. Stearn conceived the idea of making up a lamp-unit consisting of four or five tubular lamps, each containing a single V-shaped filament and connected in series. Each of these tubular lamps requires from 25 to 20 volts, and is removable separately from the lamp body. The individual tubular lamps will cost about a shilling each, and, although the first cost of the whole unit with its body will be greater than an ordinary metallic filament lamp, Mr. Stearn estimates that the cost of renewals will be far less, as those filaments without flaws will burn far longer than the 750 hours, which is the present estimated life of the 100-volt lamps. Fig. 1 shows the 100-volt lamp unit, consisting of five 20-volt lamps, and Fig. 2 a 200-volt unit with ten lamps. In order to find out which lamp had burnt out in the original form designed, the porcelain body was provided with holes opposite each pair of contacts all round the circle of lamps, and the lamps could be short-circuited, each in turn by inserting a metal plug, until the broken filament was indicated by the group lighting up again. These holes are seen in the first two



FIG. 1.—A 100-VOLT LAMP UNIT. ABOUT TWO-THIRDS ACTUAL SIZE.

illustrations and in Fig. 4, which is a plan and section of the body with the cover removed. In Fig. 4, also, the spring contacts are seen which hold the lamp; the pins of the lamp pass through holes in the cover.

Although the same porcelain bodies are still used, there is an ingenious improvement in the lamp itself, made at the suggestion of Messrs. Handcock & Dykes.

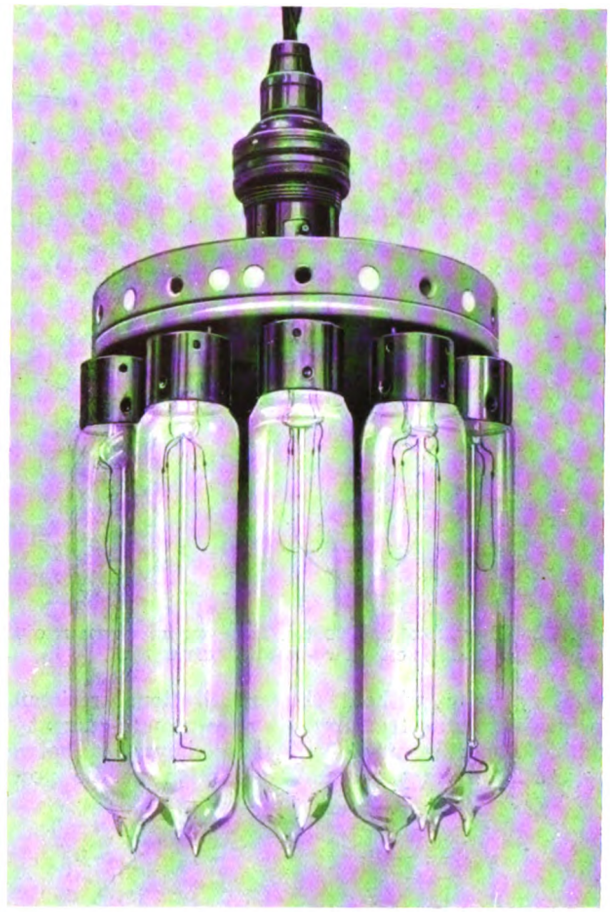


FIG. 2.—A 200-VOLT LAMP UNIT. SCALE ABOUT TWO-THIRDS ACTUAL SIZE.

By the automatic insertion of a substitutional resistance when any single lamp tube burns out, the remaining lamp tubes of the group are kept burning. This substitutional resistance is simply a short carbon filament within the lamp itself, clearly seen in Fig 3, in which the metallic filament is marked *M* and this carbon filament *C*. The carbon filament is connected in parallel with the metallic filament through a miniature spark gap contained in the lamp cap and consisting of two small pieces of metal, separated by two layers of an insulating material resembling tissue paper. The insulating material keeps the carbon filament out of circuit normally, but when any lamp tube burns out the potential across the spark gap rises from 20 or 25 volts to the full 100 or 200, the insulation is punctured, and the two pieces of metal are fused together, making a circuit through the carbon filament. This latter has the same resistance as the metal filament, so that the same current as before goes on flowing through the remaining lamp tubes.

Naturally, it is unnecessary with this arrangement for all the lamp tubes to be grouped together. The eight or ten 25- or 20-volt lamps on a 200-volt circuit can be distributed at various points in a room, or even in different rooms, and although they are on the same switch, the burning-out of one lamp will not cause the whole circuit to be extinguished. For this purpose the Stearn Electric Lamp Co., Ltd., of 47 Victoria

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Street, London, S.W., who are the makers of these lamps, also supply 25-volt lamps with substitutional resistances in bulbs of the ordinary shape. The company are also now making in the factory near London 20- to 25-volt metallic filament lamps of 8, 12, and 16 c.p. (with the trade name "Leuconium") in

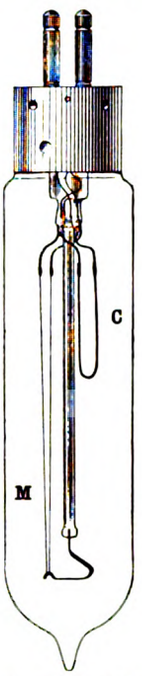


Fig. 3.—Elevation of Tubular Lamp with Substitutional Resistance. Two-thirds Actual Size.

ordinary bulbs without the substitutional resistance, for use with auto-transformers on alternate-current circuits. The efficiency of all these lamps is between $1\frac{1}{4}$ and $1\frac{1}{2}$ watts per standard British candle power.

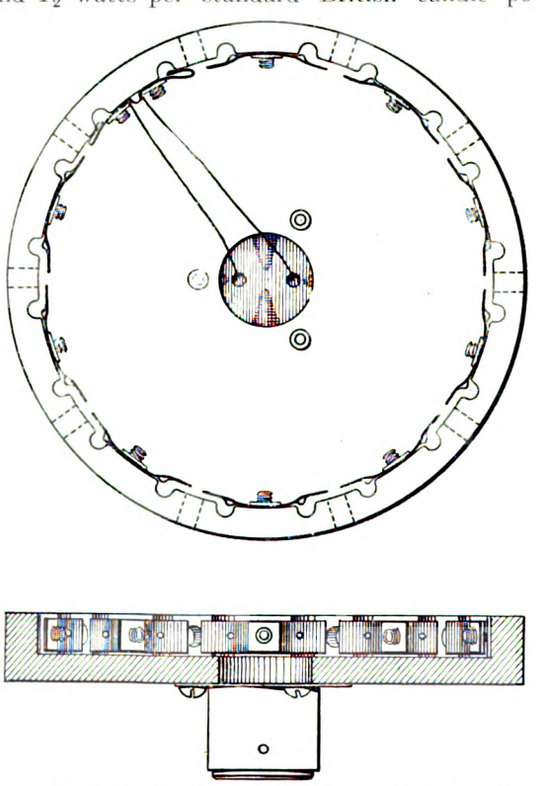


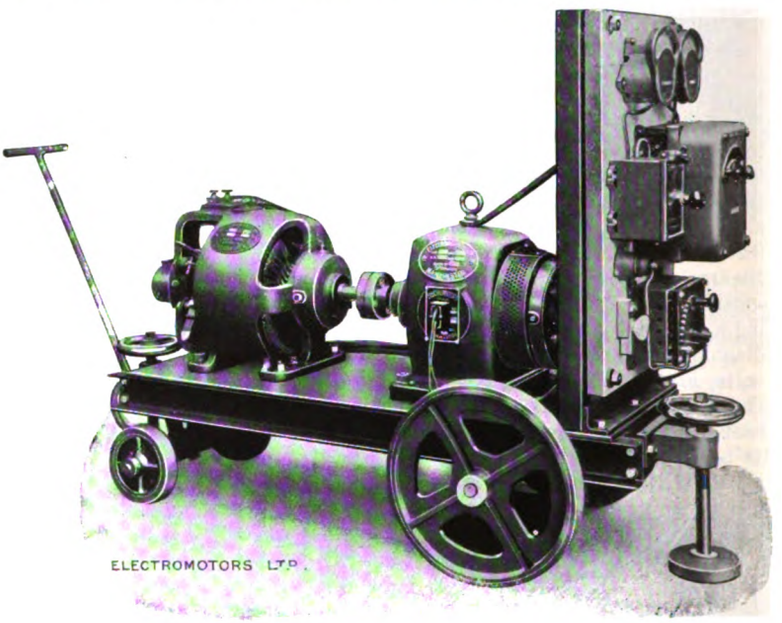
Fig. 4.—Plan and Section of Porcelain Body with Cover Removed. Two-thirds Actual Size.

The 20-volt tubular lamp gives about 10 c.p., and a group of ten on a 200-volt circuit will give 100 c.p. with a consumption of about 125 to 140 watts.

A PORTABLE CELL CHARGING SET

We illustrate herewith a new form of portable cell charger which has been manufactured by Electromotors, Ltd., of Openshaw, Manchester, for use in central stations for boosting up individual cells and similar purposes.

The set consists of a low-voltage dynamo, direct driven by an



Portable Motor-generator for Cell Charging.

ordinary semi-enclosed motor, suitable for the service of the station. Both motor and dynamo are mounted on a substantial wrought-iron truck, which is provided with front swivelling wheels, and with rubber tyres throughout. An anchoring arrangement is also provided to lock the set in any position that may be desired. At the back end, mounted on a substantial angle iron support, is a marble switchboard, carrying a suitable D.P. switch and fuses and starter for the motor, terminals, and a shunt regulator for the dynamo, capable of varying its voltage from 0 up to 6, a voltmeter, an ammeter, and a two-pin plug with flexible cable for plugging in at various points in the station. The set can be provided with two lengths of low-tension cable and special clamps for gripping on to any of the cell terminals. The whole arrangement is designed to occupy as little width as possible in order to enable it to pass between the rows of cells, and should be very convenient for attending to central station batteries.

Metropolitan Association of Electric Tramway Managers.—A meeting of this association was held at the Municipal and County Club, Whitehall, S.W., on Friday, April 24th, to receive and discuss the report of their Committee relating to the licensing of electric cars, &c. It was unanimously decidedly to press for a modification of such clauses of the Metropolitan Public Carriage Act, 1869, as were deemed necessary for present-day practice. The annual dinner of the association was held in the evening.

Coils of Bare Aluminium Wire.—The thin film of oxide which is always present on the surface of aluminium exposed to the atmosphere is of such high resistance that field coils are in use with no other insulation between adjacent turns but this film of oxide. Linen, paper, or other hygroscopic material about 0·1 to 0·4 mm. thick should be placed between the layers. In an article in a recent issue of the *Schweizerische Elektrotechnische Zeitschrift* it is stated that the insulation resistance and resistance to breakdown can be materially increased by immersing the finished coil for a few minutes in water or in an electrolytic bath of organic calcium salts. In the latter case the coil is made the positive, and a lead plate the negative, electrode. The coil is afterwards dried in an oven or by sending current through it until the temperature of the coil is about 120° C. The insulating film produced in this manner is said to have a dielectric strength of several hundred volts, and, further, it does not peel off the wire as do other metal oxides. So long as the coils are dried before being subjected to any high potential, the effect of moisture is, therefore, to increase the resistance to breakdown, and, consequently, coils of bare aluminium wire would seem to be particularly suitable for machines and other electrical apparatus working in damp places.

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THE PRINGLE EMERGENCY TRAMWAY BRAKE

THE general question of tramway brakes has excited much attention and discussion during the last two or three years, while the special subject of emergency brakes to meet the conditions of runaways and collisions has called forth a good many suggestions from the ingenious, most of which are distinguished by their impracticability and ignorance of the controlling conditions. Among men operating tramways and other similar enterprises there is a rooted objection to "emergency" contrivances of any kind. Mr. P. J. Pringle, the Borough Electrical and Tramway Manager of Burton-on-Trent, takes the other view, as regards tramway runaways, thinking that a purely emergency brake is needed, and has applied himself to devising one which he believes to be free from most of the faults which attach to these devices. We need not discuss the general question here. From the following description and statement of the results obtained our readers will be able to judge of the efficiency of the brake, and of the probability of its powers being utilised when the very urgent need for them arises.

The illustrations herewith will give a good idea of the mechanical arrangements, and the method of operation, which may be assisted by the following description. The operative part of the brake consists of shoes, or skids of iron or steel, shaped below to the profile of the upper part of the rail groove, but less deep, and provided above with a flange and an inclined groove matching the wheel flange. These skids are hung close up to and just in front of the car wheels by a slotted link under pressure from compression springs, so that when free the skid drops into the rail groove, while the wheel flange mounts the trailing end of the skid and so brings upon it the weight normally carried by the wheel. The skid is held "off" by a wire cord passing to a lever on the platform, and is put "on" by a hand-lever which, on pressure, lifts a detent out of the first lever, freeing the skids. It is a special feature of the arrangement that a breakage of the wire, or accidental release of the lever, puts the brake "on," and also that the skid is brought into action by spring pressure and weight applied directly to it, whilst the effective braking pressure is applied by the mounting of the wheel and does not depend upon the driver's exertion either to put the brake on or to take it off. In other words, the braking pressure is taken from the kinetic energy of the car, by lifting so much of it as is on the braked wheels. As at present arranged on a four-wheel car, only the rear pair of wheels are braked, but the operating platform lever has two knobs, the forward one marked "Forward Braking" and the back one marked "Backward Braking," so that in the event of

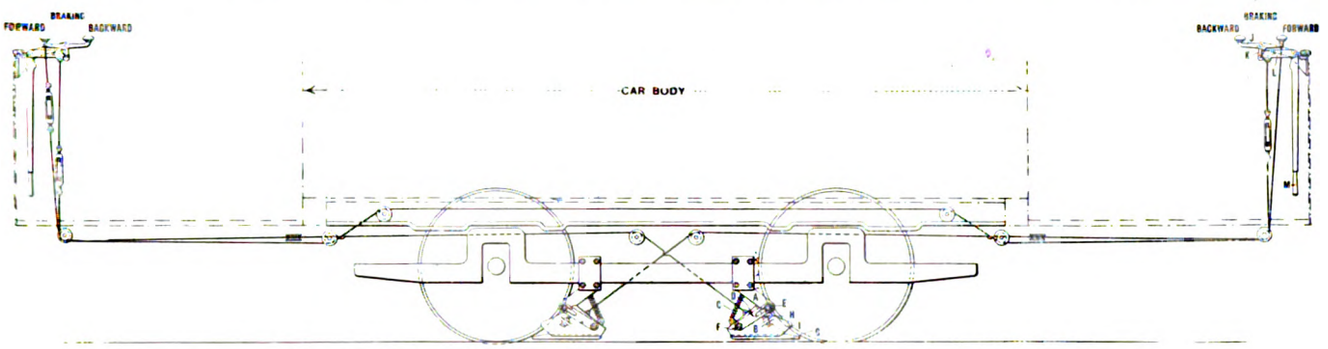


FIG. 1.—GROOVE SKID BRAKES AND GEAR FITTED TO A FOUR-WHEEL TRUCK.

A. Bracket Bolted to Truck Frame.
B. Block with Groove engaging Flange of Car Wheel, and shaped to hold the renewable Skid-bar *C* of Manganese Steel.
D. Link carrying Block *B*.
G. Compression Spring Pressing *B* towards the Rail.
H. Set Screw forming adjustable stop controlling the Swivelling of the Block.
I. Guide Plate embracing the Wheel and keeping *B* and *C* over the Rail.
L. Lever holding up Skid, through Steel Wire Cord.
M. Lifting Lever.
J. Operating Handle.
K. Catch holding L in the "Off Position" until Released by Pressure on *J*.



FIG. 2.—OPERATING GEAR AS FITTED ON BURTON-ON-TRENT CORPORATION TRAMWAY CAR.

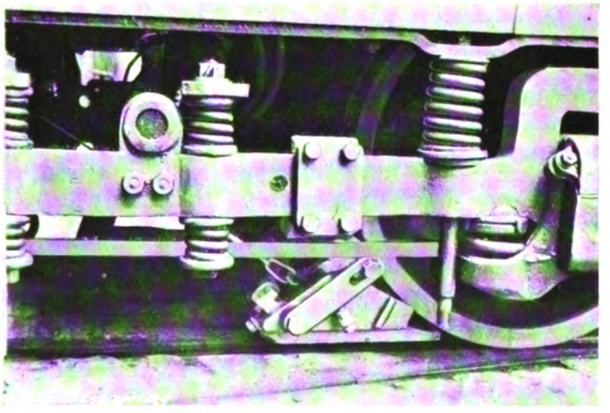


FIG. 3.—BRAKE OUT OF ACTION.

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a backward runaway the driver can brake the wheels which are then actually the rear wheels by direction of movement. Either pair can be braked from either platform, so that the conductor, or anyone on the rear

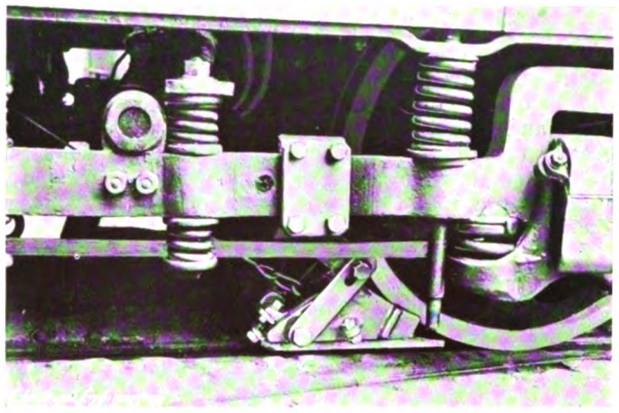


Fig. 4.—Brake dropped, but not engaged by Wheel.

platform of a runaway car, has the chance of using the emergency brake, whatever the mental or physical condition of the driver.

Apart from these details of rigging, it will be seen that Mr. Pringle's brake has two essential features. The first one, which we believe is quite novel, is that the skid or shoe enters the rail groove, and that the braking surfaces are on the sides of the groove and the skid, as the skid does not bottom in the groove; and the second, which has certainly been used to some extent previously in "run-back" skids, is that the braking pressure is got from the weight on a pair of wheels and not from any human or special mechanical store of power.

A considerable number of tests have been made in the presence of representatives of the Board of Trade, the technical Press, tramway men, and representatives of the Brakes' Committees of both Tramway Associations, with results of which some are tabulated below. The car used is a four-wheeled double-deck car, belonging to the Burton Corporation Tramway Department, of 3′ 6″ gauge, quite a normal car of the kind weighing probably between 9 and 10 tons unloaded. The tests were made on the Burton and Ashby Light Railway, on a straight gradient of about 1 in 12, in Hill Street, Swadlincote. Our representative witnessed a set of tests made with the rails wet and clean, the grooves running small rivers, the result of the snowstorm of the 23rd inst, and for comparison we print the results of a set taken on April 9th with rails dry and quite clean.

Tests made on April 9th, 1908. Rails dry and clean.

No	Speed in miles per hour at application.	Stopping distance in feet.	Stopping time in seconds.	Retardation in feet per second per second from stopping time.	Retardation in feet per second per second from stopping distance.	Remarks.
1	4½	3·75	0·8	8·22	5·8	
2	7	11·5	2·4	4·30	4·75	
3	10	28·0	not	taken	3·85	
4	10½	59·0	5·4	2·84	2·0	
5	10½	34·25	2·8	5·46	3·5	
6	10⅝	40·0	4·0	3·88	3·0	
7	12¾	32·5	3·6	5·18	5·3	
8	15	65·5	5·0	4·4	3·7	Wheels locked by rheostat brake.
9	18	66·0	5·8	4·6	5·3	Power kept on at full parallel.
10	18	84·0	5·2	5·0	4·1	
11	23	165·0	8·6	3·91	3·5	

Stop No. 8 was made after the wheels had been locked by a full application of the rheostatic brake. Stop No. 9 was made by the conductor, the power being left full on. These conditions represent contingencies which have led to certain runaway accidents.

On April 23rd with rails clean, but running with water, the following results were obtained:—

Tests made on April 23rd, 1908. Rails clean and wet.

No.	Speed in miles per hour at application.	Stopping distance in feet.	Stopping time in seconds.	Retardation in feet per second per second from stopping time.	Retardation in feet per second per second from stopping distance.	Remarks.
1	4¼	4·0	1·8	3·45	9·85	The shock on stopping made it very difficult to "clock" correctly on these stops.
2	7¼	14·0	3·0	3·5	3·96	
3	7⅞	13·9	2·8	4·0	4·6	
4	10½	23·5	2·6	5·9	5·0	
5	12½	38·0	3·4	5·37	4·4	
6	12⅞	68·5	6·8	2·73	2·53	One skid only used.
7	15½	62·0	4·4	5·15	4·1	Wheels locked by rheostatic brake.
8	15½	49·5	not	taken	5·15	
9	18¼	78·0	5·8	4·6	4·6	
10	21	153·0	9·4	3·26	3·07	Power kept on after skid dropped.
11	22	127·5	7·0	4·6	4·1	

In the above No. 6 was taken with only one skid in use, Nos. 7 and 8 were taken with wheels previously locked, and in No. 10 the power was kept on after the skid dropped.

The above results have been worked out for retardations deduced from both the observed stopping times and distances, and it will be seen that there is usually a difference between the results. As the speeds were taken from a tachometer driven off an axle, and the distances from chalk marks on the rails, the retardations deduced from the distances are the more reliable. This is especially the case at the lower speeds, when the shock at the application is much more violent than at the higher, and this makes correct timing of the very short intervals difficult. Otherwise discrepancies between the two sets of results show that the retardation is not uniform over the whole time, which is a natural result from the method of action of the brake. The figures show that a high-braking power is maintained up to speeds which would be uncontrollable runaway speeds with any form of brake acting only by the weight of the car upon the rail table, and suggest

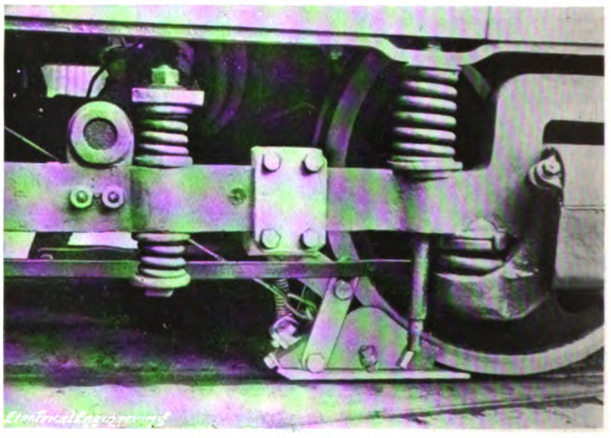


Fig. 5.—Brake in Action with Wheel mounted on Skid.

that for some reason or other the coefficient of friction between the sides of the groove and the skid is much higher, and does not fall off with speed so much as in the case of rail table, or wheel tyre, and an ordinary brake block. We believe that this would be a mistaken

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view, but considerably more testing will be necessary to establish the facts.

What has been done in this form of brake, whether by accident or design, is to get a kind of leverage by wedging. The sides of the groove being slightly inclined to the vertical, the skid is forced into it as a wedge, and the pressure between the two bodies is the weight on the wheels multiplied by the ratio between the vertical and the horizontal projections of the grooves—in other words, by the inclination of the wedge. Thus, using only half the weight of the car, the effective braking pressure is several times that weight. Mr. Pringle merits much praise for attaining this result by whatever road he reached it. There is another point in the action which is well marked in stops from low speeds. These stops are very violent and the retardation very high, whilst at higher speeds there is much less violence. The reason seems to be that the first effect of the application is to make the car mount upon the skids at the expense of part of its kinetic energy. At low speeds the retardation corresponding to this loss of kinetic energy is greater than at high speeds; it is, in fact, roughly inversely proportional to the speed.

The retardation due to the mounting of the wheels on the skids is the predominant action at low speeds, whilst at higher speeds the frictional action is the more important. The retardations observed seem to agree with these views, and some portion of the discrepancies between the retardations as measured by the distance and by the time may be due to differing proportions of the two actions. The mounting occurs in a very short space of time, and may be somewhat dependent upon momentary conditions of cleanliness, dryness, &c. Besides the stop tests tabulated, several others were made simulating various accidental conditions, running backwards as from a failure of power when climbing the gradient of 1 in 12, and attempting to start against the brake, when the wheels slipped, but the car remained stationary. Under all the circumstances tried the brake held with complete security.

As above stated, the brake is put forward as a pure emergency brake, and not a service brake in any sense. It will not serve in place of the ordinary slipper brake for descending hills, nor for controlling cars in heavy traffic. The car has to be backed off the skids before the latter can be raised. This is in no way against the brake as to its designed use, and, granted that an emergency brake is desirable, then Mr. Pringle's is certainly effective, and adds little to the weight or bulk of the equipment. Further tests will be needed to show its action on greasy rails, but the very heavy pressure between the active surfaces and the scraping action of the nose of the skid should remove the offending mud instantly.

We understand that Mr. Pringle has made many experiments with various materials, and has settled on a particular grade of manganese steel as giving the best results. This is doubtless mainly a question of strength and hardness, as the skid is severely stressed, and is subject to abrasive action which will alter its shape and therefore its efficiency. A hard material is, therefore, necessary for the retention of regular action. If we are right about the action of the skid, bottoming in the groove would be fatal to its effectiveness.

We have to thank Mr. Pringle and his assistant, Mr. Hall, for the opportunity given us to see these interesting trials, and Mr. J. Toulmin, the manager of the Burton & Ashby Light Railways, and Mr. Shaw, of his staff, for the facilities and assistance offered us.

We understand that Messrs. Mountain & Gibson, Ltd., have taken up the manufacturing rights of this brake, so that it will, doubtless, be on the market within a short time.

TWO NEW ELECTRIC CRANES

THE accompanying illustrations represent two examples of somewhat different forms of large electric cranes which have recently been erected. The double cantilever crane shown in Fig. 1 has been erected by the Lancashire & Yorkshire Railway Co. at their North Mersey and Alexandra Dock Goods Station, Liverpool. It has a maximum lifting capacity of 10 tons over a span of 172 ft., whilst the track which the crane travels upon is 28 ft. centre to centre, and is 540 yards long, thus covering the greater portion of the company's immense timber yard and giving greater facilities to the traders.

The total length of the crane is 188 ft., and the total height 63 ft. It will stack timber to a height of 30 ft., the height to the under-side of the cantilevers being 43 ft. The operator travels with the crab, thus having the load always in view—a matter of importance when working amongst timber stacks; consequently all the

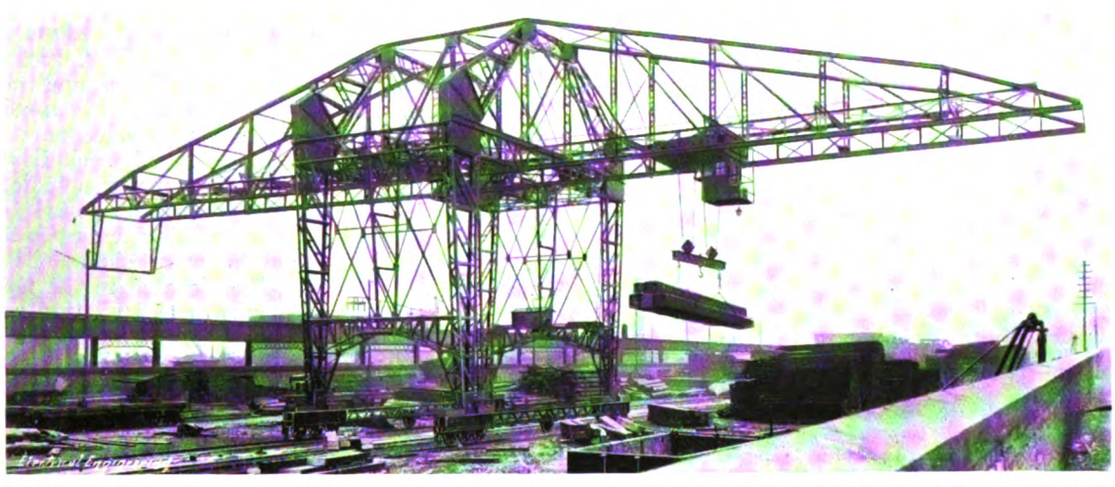


Fig. 1.—10-ton Double Cantilever Electric Crane, Lancashire and Yorkshire Railway, North Mersey and Alexandra Docks Goods Station, Liverpool.

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controllers for working the motors are placed in the operator's cabin. The crane legs are placed sufficiently wide apart to allow a 40 ft. log of timber to pass through from one side of the yard to the other without requiring to be twisted. The supply of power, which is at 600-volt continuous current, is taken from the third rail of the Lancashire & Yorkshire Railway Co.'s Liverpool and Southport electric railway. The crane collects the current from an overhead wire with two tramway-type trolley arms and wheels, which are fixed to the end of one of the cantilevers. The crane is also well lighted with arc lamps placed out on the cantilevers, and lights are also fixed underneath the operator's cabin, so as to travel about with it.

The speed of operating, when dealing with the full working load on the hook, is as follows:—Hoisting, 10 tons at 93 ft. per minute, taking 93 E.H.P.; crab traverse, 10 tons at 482 ft. per minute, taking 19 E.H.P.; and crane traverse, 10 tons at 435 ft. per minute, taking 100 E.H.P. The crane has been tested with 12½ tons throughout its motions, and has a margin for stability at one end of the cantilever of 50 per cent., *i.e.*, equal to 15 tons on the crane hook. The total

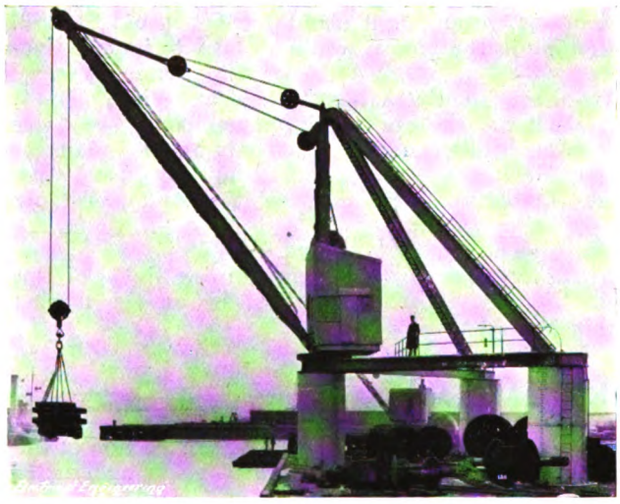


Fig. 2.—25-ton Electric Derrick Crane, Clyde Navigation, North Wharf, Renfrew.

weight of the crane, including the crab, is 160 tons. The crane has been made and erected by Messrs. C. & A. Musker, Ltd., Tue Brook, Liverpool, under the direction of Mr. George Hughes, Chief Mechanical Engineer of the Lancashire & Yorkshire Railway Company, to whom we are indebted for the photograph from which Fig. 1 is reproduced.

The 25-ton electric derrick crane illustrated in Fig. 2 has recently been erected by Messrs. Appleby's on the North Wharf at the Clyde Trust workshop, Renfrew. The crane is mounted on three circular steel-bound concrete pillars, so as to give 15 ft. headroom above level of the cope, and the foundations for these pillars are of concrete resting on piles. The crane derricks with full load from 20 ft. minimum to 45 ft. maximum radius. The lifting speed at 40 ft. radius with 25 tons is 12 ft. per minute, and with loads of 10 tons and under, 25 ft. per minute. The slewing speed with maximum load of 25 tons at 40 ft. radius is 245 ft. measured at snatch-block. The back stays are built up of steel plates and angles; the horizontal stays form a cross frame, where they join together and have large gusset plates top and bottom, the slewing spur-wheel and centre pin sole-plate being fitted on top.

The mast consists of two steel joists and braced laterally, and is supported on a live roller pathway 3 ft. 6 in. extreme diameter, and consisting of 16 forged case-hardened conical steel rollers 6 in. in diameter, working between roller path on sole-plate and path on mast-foot casting. The jib, 60 ft. between centres, is built up of steel plates and angles, the two sides being braced together laterally top and bottom by means of angles and gusset plates. The feet of the jib are fitted with cast-steel bosses, and the head is fitted with two 30 in. diameter cast-steel rope pulleys. The hoisting barrel is of cast-iron, 36 in. diameter, turned and grooved right and left hand to suit the hoisting rope, which is 3·89 in. circumference. The rope is fixed at each end of the barrel, passing from there over the jib-head pulleys, round the pulleys on the snatchblock to the jib head, the bight in the centre of the rope passing over a compensating pulley. Triple-spur reduction gear is provided, the main wheel and pinion being cast-steel shrouded gears. The other gears are cut from solid blanks, the spurs being of cast-steel, and the pinions cut from mild steel bars. In addition to the three reductions mentioned, a two-speed gear is coupled to motor drive, the ratio being 1·2. When lifting the full load of 25 tons, the slow speed is used, and gives a lifting speed of 12½ ft. per minute, but with the fast gear 10 tons may be hoisted at the rate of 25 ft. per minute. An automatic electro-magnetic brake is coupled direct to the motor, the brake drum being keyed to the motor spindle. This brake is applied by a weight immediately the current is cut off. In starting up the motor a solenoid coupled in series with it releases the brake. Combined with this is a centrifugal governor, which prevents the load, when lowering, attaining a higher speed than two and a half times the hoisting speed of the maximum load. A mechanical brake on the second motion shaft is applied automatically by the load and released by the motor. The motor is 30 B.H.P. running at 500 r.p.m., and is of the Westinghouse type. The derricking barrel is 36 in. diameter, and grooved right and left hand, and has main gears similar to hoisting barrel. Triple spur reduction is used here also, with automatic brake on the second motion, and operated from hoisting motor. This gear can be worked independently of the hoisting gear by means of clutches, and an additional hand brake is fitted on the second motion shaft for use when working at a fixed radius. When derricking, the hoisting or lowering gear is always in motion, an arrangement tending to keep the load level during the operation. The derricking gear is triple purchase, with six-part wire rope similar to the hoisting rope. The rope pulleys are 30 in. diameter, and a compensating pulley is provided to equalise the stress on the ropes. The slewing gear is driven through worm and spur-wheel gearing by a 10 B.H.P. motor. The worm is double threaded of forged steel, and the worm-wheel rim is of phosphor bronze with machine-cut teeth. Ball-thrust bearings are provided on the worm shaft. An automatic solenoid brake, similar to the hoisting brake, is fitted to the motor spindle. The slewing rack is of cast-steel, securely bolted to centre pin soleplate. An over-derricking device is fitted on the crane, and a radial indicator shows the slewing movement. The controllers, located in the machinery house, are fitted with a universal operating gear, and one lever only is necessary to work both. Change gear, clutches, &c., are operated by hand wheels placed conveniently close to the controllers, so that the crane-driver has every movement under control while watching the load. The machinery house is large enough to cover all the machinery except the derricking barrel, and is constructed of angle framing covered by corrugated sheeting, and is lined inside with wood boarding. Windows are fitted in three sides, and a sliding door at each end provides an entrance when the crane is in any position. A ladder up one of the pillars to a platform along one of the horizontal ties gives the means of approach to crane-house, and other ladders give easy access to all remaining parts.

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THE EFFECT OF METALLIC FILAMENT LAMPS ON THE BUSINESS OF ELECTRIC SUPPLY

THE discussion on Messrs. Handcock & Dykes' Paper on "Electric Supply Prospects and Charges as Affected by Metallic Filament Lamps and Electric Heating" was concluded at the meeting of the Institution of Electrical Engineers on Thursday. In the Paper figures were given as to the reduction in consumption, especially when employing auto-transformers and 25-volt Osram lamps. The authors proposed to reduce the effect on the station revenue by the introduction of a new system of charging, by which the consumer would be charged a fixed sum per annum, depending on the maximum current he requisitioned on signing his contract, and a certain charge per unit in addition. They proposed the employment of a "limit indicator," which would dim the lamps when the contract maximum was exceeded.

We gave a long abstract of the Paper, together with a full report of the discussion, both in London and Dublin, in our issue for April 16th, p. 581.

Mr. Arthur Wright opened the first day's discussion by deprecating such advertisements as "70 per cent. discount on your bills," instead of "three times the light for the same bill." He pointed to the enormous increase in business which would accrue through cheaper light and to the necessity of reducing the cost of service connections. At present it cost nearly as much per kw. to connect a house as to build a station. Mr. Hugo Hirst announced a Paper on the evolution of the metallic filament lamp, which he had just sent in to the Institution. Incidentally he stated that new Osram lamps could now be paired with old. He thought there was no need to resort to the panic measures suggested by the authors. Mr. Bottomley Smith did not approve of the proposed "contract demand" system of charging. Mr. W. R. Rawlings, as an electrical contractor, objected strongly to the Wright system of charging, and favoured the authors' system. Mr. F. M. Long described a system in use at Norwich, in which the consumer is charged an annual sum of 12 per cent. of the net assessment of his house *plus* 1d. per unit.

Mr. C. P. Sparks (Chief Engineer, County of London Electric Supply Co.), who opened the resumed discussion last Thursday, said that as a supply company engineer he welcomed the metallic filament lamp as being the greatest step forward in the supply business for the last twenty years. The authors had suggested that these lamps, consuming as they did only a third of the energy that carbon filament lamps used, were going to be a great handicap to the supply business. He did not take such a pessimistic view for several reasons. In the first place, any new development, such as metallic filament lamps, was only taken up gradually; the whole of their consumers could not change from the carbon lamp to the metallic filament lamp in a day, and the supply station engineers therefore had a period in which to develop. The second advantage, in his opinion, was the question of the standard of lighting. If the public was going to remain content with the present standard of lighting, it was true that the demand for electrical energy might fall off, not, perhaps, in the ratio of a third, but in the ratio of half what it was at present, but when such a new development as the metallic filament lamp was put forward the whole standard of lighting was improved. Twenty-five years ago the introduction of electric light improved the standard of illumination, and a further improvement was brought about by the incandescent gas mantle. The gas companies, by the introduction of the mantle, received an enormous impetus and became real competitors of the electrical supply companies. Electrical engineers now had put into their hands a weapon that enabled them effectively to compete with the gas companies and still further to raise the standard of lighting. The gas companies had already possession of a very much larger field at the time the mantle was introduced, and in consequence the introduction of the mantle did affect them to some extent, and their progress was arrested. But in the case of electric lighting many had only scratched the ground, and they had now the larger field opened to them through the introduction of the metallic filament lamp. There was an enormous number of small consumers that it would pay them to connect. Another word he would like to say with regard to the standard of lighting, was that in his opinion people were willing to pay a certain amount for illumination. If a man had been paying from £3 to £4 for lighting, he would still continue to pay in the vicinity of that figure, and the standard of lighting would be raised. There might be a certain set back in the case of companies having a purely private lighting business, but companies and local authorities supplying large areas with mixed classes of business, public and private, would, he felt sure, find nothing but increased prosperity from the introduction of these lamps. On the question of tariffs, while he had the greatest possible appreciation for the educational value of the Papers read by Mr. Wright from time to time, he did feel that they all owed Mr. Wright a grudge for ever having invented the demand indicator. Unfortunately many electrical engineers used the demand indicator some years ago—it was a kind of fad—but now it had become almost extinct. The complications and difficulties when these indicators were used on a large scale, were so great that he thought one of the chief reasons of late years that business had gone ahead had been the simplification of tariffs. Another feature of the demand indicator was that the most important item of the bill was controlled by an instrument which was of a very inaccurate type and in no way compared with the accuracy of the meter which measured the quantity. He thought that the only method of charging which would find favour, on a large scale, with the public was the flat rate. A very ingenious system was mentioned at the last meeting, by which the tariff was to charge a fixed amount on the rateable value of the property and a low price per unit. That was a sort of tariff that might be applied in a small town by a local authority, but a company would not be able to do anything of that kind. People were already sufficiently worried by rates in the nature of fixed charges, and they did not require any more of them.

Mr. C. H. Stearn (Stearn Electric Lamp Co., Ltd.) said that the most satisfactory method of transition from carbon to metallic filament lamps on alternating-current circuits was by the use of transformers. In this way they could adapt the voltage to the lamp instead of the lamp to the voltage, which was a very much easier thing to do, but the problem with direct currents was a very much more difficult one. There was no other way of using metallic filaments except in series, whether they collected a number of filaments in one bulb or whether they placed them in separate enclosures, and then collected them on a common base, or whether they distributed the small units at a distance from one another and connected them in series. If they had to collect all the filaments in one place, it seemed to him that if they placed each filament in a separate enclosure and then assembled them on a common base, they had a very much more economical method for the maintenance of the lamps than in placing them all in one bulb. These filaments were extremely delicate, being, as compared with the carbon lamps, about one twenty-fifth of the section for the same candle-power and the same voltage, and on the average of three times the length. The average life of the lamp was therefore enormously increased by the fact that each element could be renewed independently of the others, instead of the whole set of filaments having to be replaced if there was a slight flaw in one and it burnt out. In a test he made, a group of five 20-volt tubular lamps was placed on a porcelain receptacle on an ordinary 100-volt circuit. At 600 hours one filament broke. In ordinary circumstances it would have meant a renewal of the whole lamp, but in this case that element could be renewed, and on this being done the lamp went on for 2,000 hours before another element broke. That was renewed, and at 2,600 hours a third broke. Assuming 5s. as the original cost of the lamp, with the three renewals at 1s. each, this meant 2,600 hours for 8s. instead of 5s. for 600 hours, which would have been the case for a single lamp, as the first lamp went at 600 hours. If, instead of assembling these units on one base, they were distributed, say, over an electrolier or in different parts of a room, then they had a more efficient system of lighting undoubtedly, but they had these two great disadvantages: (1) if one element went out all went out, and if all the elements were collected on an electrolier they might be left in total darkness at any moment; (2) it was necessary to make a search to find which one had failed, and the more there were in series the greater became this trouble. It had been suggested to him by the authors of the Paper, that, if it were possible to utilise the rise of potential that occurred when a filament breaks, to short-circuit the broken lamp, the trouble might be overcome. Several methods were suggested and some experiments were made, and finally they hit upon the arrangement which he exhibited. Mr. Stearn then explained the lamp which is described elsewhere in this issue, and illustrated its working by means of a model.

Mr. Percy Still (Chief Engineer, Chelsea Electricity Supply Co.) thought the authors' suggested system of charging was a satisfactory one from the point of view of providing an adequate return upon the capital invested in making provision for the supply to each individual consumer. The convenience which it might provide in doing away with the necessity of using more than one meter in the case of consumers who wished to use the energy for different purposes was, also, he thought, a great

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point in its favour. In view of these and other advantages, it was, therefore, with great regret, after reading through the Paper, that he came to the conclusion that the system of charging was not practicable. It offered at least two very serious difficulties and objections. The arbitrary fixing of a contract demand by the electricity supply manager would be a difficult matter indeed, and he felt sure it would lead to constant and interminable discussion with the consumer. Whatever knowledge an electricity supply manager might think he had of his district, it was impossible to form an opinion from the number of lamps declared as to what proportion were likely to be generally used. The proportion would depend upon the particular habits of the consumer, upon the manner in which the installation had been wired, and upon whether it had been liberally lamped or sparingly lamped. The candle-power of the lamps, too, was a very uncertain quantity, because frequently the 8-c.p. lamps which were declared in the first place were subsequently altered to higher candle-power when the necessity arose. Also, the irregular use of heating apparatus, &c., would be another point which would add to the difficulties of fixing the contract demand. It was true that the authors proposed to use a limit indicator to get over these difficulties, but he felt sure that any such apparatus would not only be unsatisfactory in its working and expensive to maintain, but it would also lead to other serious difficulties with the consumer. A second objection which he could foresee to this system was that any system based upon a charge for contract demand, pre-supposed a fairly regular annual use of the supply by the customer. This might be workable in the case of shops and certain business premises, but in the case of private house lighting—certainly in the London residential districts—it would be an impossibility. Owners were frequently going away for long periods and at irregular times, they might sublet to a tenant with different habits, and many of the houses changed their ownerships fairly often in London. In the case of power supply to factories, of course, the case was very different, and a system based on a charge per kilowatt and a reasonable charge per unit, slightly in excess of cost price, might work very well, but for private house lighting he thought there was no doubt whatever that what the consumer wanted was a flat rate. The average consumer was not a mathematician, and he liked to be charged on the simplest possible system. But there was a very much better chance of doing business with a customer of that sort if he could be given a straightforward answer to his question as to what the price of the unit was, instead of having to go into an explanation of a complicated system of charging. In fact, this was the chief objection to the Wright maximum demand system. He did not agree with the statement in the Paper with regard to the "inherent absurdity" of differentiating between the charge for heating and lighting," but time would not permit him to pursue that point then.

Mr. L. Andrews (Key Engineering Co.) agreed that the metallic filament lamp was an excellent thing for all, and particularly for lamp-makers and wiring contractors, and ultimately for supply undertakings, but he did think there was something in the risk which the authors referred to. He read out a paragraph that appeared recently in Electrical Engineering (March 5th, page 368), in which it was reported that a certain Electricity Committee [Hastings] anticipated a deficiency of £3,581 for the year ending March 31st, 1908, and in their report the Committee stated that the reduced income from private lighting was almost entirely due to the lower consumption in consequence of the increased use of metallic filament lamps. It was interesting to note, he said, that the gross revenue of the undertaking was under £20.000 a year, and two years ago they made a profit on 15 months' working of between £2.200 and £2.300, so that there had been an annual falling off of about £5.000 in profits, which the Committee attributed to the metallic filament lamp. To this must be added the loss of the natural growth of the business, which growth for six consecutive years previously had averaged 18 per cent. per annum. This particular instance might be a special case, but he had discussed the matter with other central station engineers, and was told that in another town, whereas the normal increase was about 17 per cent., last year this was only about 4 per cent. These two cases showed that the remark made by Mr. Arthur Wright at the last meeting, that it depended a great deal upon the man and the way the problem was tackled, was true, and it also showed that the authors were somewhat justified in drawing attention to the matter. Coming to systems of charging, Mr. Andrews said that he considered a flat rate was very inequitable. For instance, it was impossible to sell current to a certain class of consumers at 5d. per unit and cover all charges, while, on the other hand, they knew it was quite possible, under certain conditions, to sell electricity at an inclusive rate of ¼d., and to make a good profit. The authors had referred to a system which was used at Hastings. This system charged 10s. per lamp demanded per annum, and 1½d. per unit. It worked remarkably well where the maximum demand system had been a failure, and he thought the reason was that every consumer understood it. Under the system at Hastings the output was increased in three years more rapidly than in the previous fifteen years, and the load factor was greatly improved; and, further, they found the system was being used intelligently. Consumers who previously used electric lighting in windows only, had basements wired, and used them during the day, thus improving their own load factor and also that of the supply authority. Incidentally the advantage of this system was that it would have made it possible to get over the loss referred to above by offering the consumer a reduced rental per lamp of maximum demand, and increasing the charge made on the alternative flat rate.

Mr. J. F. C. Snell said he took a more optimistic view of the advent of the metallic filament lamp than the authors. Some time ago he made some photometric tests of incandescent gas burners, and found that 11 c.p. hours per cubic feet were obtained with gas at 2s. 6d. per thousand. That meant that the cost was 0·003d. per c.p. hour. With a one watt per candle-power metallic filament lamp, that meant it was equivalent to electricity at 3½d. per unit, a figure at which a great many stations were supplying current for lighting, and a figure which he thought most undertakings would reach. He could not help feeling that the use of auto-transformers and the fixing of lamps in series was a temporary expedient, and that the inventive genius of the lamp manufacturer would produce a lamp which would work singly on the 240-volt circuit. In the Paper the authors referred to the capital invested in gas and electricity undertakings. Reading these figures, he thought they took a very pessimistic view of the electrical industry. For instance, the capital outlay on electricity undertakings was £7 10s., and on gas £4 10s., to obtain a gross revenue of £1 per annum; whilst the ratio of working expenses to receipts was 46·3 per cent. and 75 per cent. respectively. But the authors did not point out that the net profit on the gas undertakings was only an average of 5·44 per cent., whereas in the case of electricity undertakings the average was 6·89 per cent. Of course, it might be said that this was due to the charges for electricity being too high; but he did not think this was really the case. If the gas undertakings were in the position of the majority of electrical undertakings, and had to pay in addition to interest, sinking fund charges, amounting in all to 6½ per cent., they could not do it because they would require £8.000.000 to pay 6½ per cent. on the capital sum, whereas the profit was only £6.800.000. In the case of electricity, on the other hand, they required £2.250.000, and they had £3.275.000 with which to do it; so that the electricity undertakings appeared to be in a very much better position in that respect than gas undertakings. Continuing, Mr. Snell said that he was one of the heathens who differed from Mr. Andrews and the authors, and believed in the flat rate; although it was not scientifically the correct way, it was commercially the best way of charging lighting consumers. He had had some years' experience in the provinces in a town where gas was extremely cheap, and he knew the very great difficulty he had, in the first case, with the maximum demand indicator. Like many other engineers, he followed that craze, and he also adopted other methods, but finally he adopted a simple flat-rate method, and he could not help thinking that as the supply became more general they would be in a better position to charge a uniform flat rate initially, with varying discounts according to the user.

Mr. Robert Hammond was thoroughly with those who believed that the new lamps were a magnificent thing for the industry. They had been saying for the past twenty or more years that they could entirely abolish gas if, by various methods of economy, electricity could be produced cheaply enough. They had made a fair fight against gas for all these years, and at last they found themselves in possession of the metallic filament lamp, and of being able to supply in England electricity at practically a cheaper price than that at which gas was being supplied. Of course, they were all well acquainted with the fact that in many foreign cities gas had been entirely abolished. When he first went to Madrid to lay down the electricity works there, gas was 12s. per thousand, and even with carbon filament lamps they were able to make such a show that the gasworks were shut up. They had talked of shutting up the gasworks in England for a great many years, and the invention of the metallic filament lamp made the tenure of the gas manager a very short one. He was not so sanguine as Mr. Sparks that they were going to raise the standard of lighting. He thought that in most electrically-lighted houses there was too much light. As long as the Gas Light & Coke Co. was paying its big dividends he was very happy, because he saw what an enormous field there was for electricity. When Mr. Cripps last year was before the Parliamentary Committee, he stated that his clients, the Gas Light & Coke Co., were actually drawing one million pounds per annum from their penny-in-the-slot meters; he (Mr. Hammond) immediately stated in his evidence what a striking proof this was of the enormous advantages that were coming to the electric lighting companies when they took in hand the supply to small consumers. The falling off of output was, of course, going to happen in many cases through the introduction of metallic filament lamps, but it would only be temporary. He had provided an extra 1,500 kw. set at Hackney fifteen months ago; the plans were laid down for it in order that it might be working in December to cope with the enormous increased

* The word "absurdity" in the Paper was altered to "difficulty" in the author's revised proof.—Ed. *E. E.*

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load. As a matter of fact, that load had not come on; they were only about 100 kw. ahead instead of 600 or 700 kw., as had been anticipated. London had not suffered very much so far, however. In 1901 the number of units turned out in London was 69,000,000, an increase of 34 per cent. over the previous year. In 1902 the amount was 86,000,000, an increase of 23 per cent.; in 1903, the number was 110,000,000, an increase of 27 per cent.; 1904, 129,000,000, an increase of 17 per cent.; 1905, 154,000,000, an increase of 19 per cent.; for 1906 there was an increase of 13 per cent.; and for last year to March 31st the increase was 12 per cent.; so that London was not doing badly. He felt quite confident that by the time metallic filament lamps were well at work immense good would come from them. He was entirely with the authors in ridiculing the idea of charging heating and lighting at different rates. He quite understood a factory having its power at a different rate in consequence, of course, of the immense load factor, but he could not understand a double meter system in private houses. He thought a great deal of good would come through the wiping away of that idea, and putting the whole of domestic demand on one price. He was confident that the principle of the author's proposed system of charging was sound.

In some remarks subsequently communicated, Mr. Hammond says that he entirely dissents from those who hold the opinion that the class of consumer who uses the light the longest number of hours can be best obtained by a flat rate. He continues: My strong opinion is that Messrs. Handcock & Dykes are working on the right lines, and that their proposed contract demand system is one which would abolish many of the unpleasantnesses connected with the Wright maximum demand system. I see, however, some objection to a system which might entail a constant source of anxiety upon the consumer, and I welcome Mr. Long's bright idea that each consumer should be charged a rental based upon the assessment value of his house, and, in addition, a small running charge. I trust that the outcome of this debate will be a determined attempt on the part of the leaders of the industry to get the Board of Trade to insert into their next Electricity Bill a provision enabling the electricity supply undertakings throughout the kingdom to make a fixed charge, whether by means of a "rate per kilowatt of maximum demand," or by a proportion of the assessment of the premises. With regard to the "fixed rate per kilowatt of maximum demand," this has figured in all the recent Power Acts and Bills, and is included in the three Bills of this Session.

Mr. Leon Gaster said that if it could be arranged that a maximum demand consumer would not be charged more than a flat rate consumer, he thought the maximum demand system was going to be a great help to the central station. He thoroughly agreed that the metallic filament lamp was going to bring about a great advance in the electrical industry, but hitherto the consumer had not been educated to a judicious use of his lamps. Contractors and lamp makers did not care twopence about the consumer. He suggested the engagement of educated canvassers, men who not only looked nice, but who knew what they were talking about. The gas companies' reply to the electrical people on the question of profits was, that the electrical profits were paper ones; gas people had a safe.

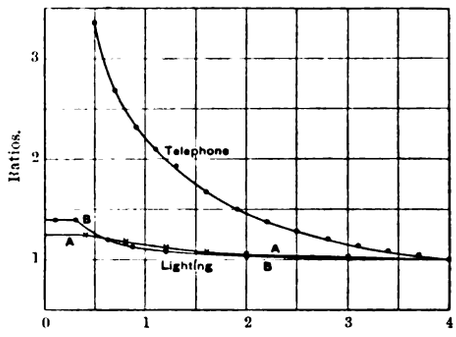
Mr. K. A. Scott Moncrieff (Chief Engineer to the Electric Supply Corporation) said that the cost of services had been much reduced of late, and there was still further scope for reduction. Another point in this connection was that, as the number of services were increased, the cost of the distributing mains per kw. connected was reduced, and this was a very important matter. He thought it would be found that where the supply was cheap the cost of mains was low. There were large batches of houses with rents of £30 and £35 per annum where there was a great scope for business of a paying nature. It was a matter of regret to him that the authors had not given some description of the apparatus which they proposed for dealing with the contract demand. The matter had been brought to his notice some months ago, when he saw an advertisement of an American apparatus of this nature, but after thinking over it very carefully he decided he would not be the pioneer in introducing it. The authors' proposal resolved itself into practically a heavy meter rent and a low charge for electricity. It would be possible to devise a meter which, when it ran at the maximum rated output, would either read at double speed or switch on another train of wheels charging 8d. per unit. It appeared that the change over to metallic filament lamps would be gradual; it would probably take five years for the thing to settle down, and in that time a good deal might happen. When reading the Paper he happened to have before him an ordinary load curve, and it occurred to him to apply the reduction to the load curve. The result was that he cut off the peak, and he got the best curve he had ever seen from the generating point of view, but he had also cut off all the profits. The day load on the curve was motors. He did not think they realised the vast progress that had been made in motor loads, particularly in the north country. In looking through some figures recently he hit upon Darlington, where 38 per cent. of the output was on the tramways, 38 per cent. for lighting, and the remaining 24 per cent. was motor load. In the five years in which he suggested that the metallic filament lamp would establish itself, the motor load was not going to stand still. In addition to that, lighting by metallic filament lamps would reach further, and would obtain a much better diversity than at present. They should hope to light a man from the time he got up in the morning until he went to bed at night. Very few of the supply people did that now. A man might have electric light for an hour or two in his office, and then he went home to gas, or it might be *vice versâ*. In this way there was a great field for extending the use of electric light, making it so cheap that people would waste it and bring down the obnoxious peak in the curve, and they might even hope to get a very much better load factor. Lighting would then be an incident in the diversity of the load; it would not be the predominant partner, and they would reach a point when devices for giving a different rate for lighting and power would be unnecessary, and they could offer a rate for domestic lighting low enough to get domestic heating also.

Mr. E. T. Ruthven Murray (Chief Engineer, North Metropolitan Electric Power Supply Co.) said he would have liked to have heard particulars of tests on small transformers, which he regarded as an entirely temporary expedient. He had heard an alarmist rumour that the power factor was not more than 50 per cent.; but he had found, from some tests of his own, that this was not so. Although at low loads the power factor might be as low as 0·7, it got up to nearly unity at full load. The authors referred to small consumers, and suggested that these had not been tackled satisfactorily by the supply undertakings. One place supplied by a company under the control of the North Metropolitan Power Co. had more lamps connected per inhabitant than any other place he knew of. No less than 25 per cent. of the consumers were rental-wired or "free" wired, and the revenue upon the capital outlay was 12½ per cent. He thought that if it was possible to get this percentage return, including everything, upon free-wired and rental-wired consumers, it was quite a satisfactory business to go into. The absolutely free-wired installation was a most excellent thing in small towns. There was a very large consumption per 8-c.p. lamp installed, for, of course, the lamps were only put in where they were used for long hours; the annual consumption per 8-c.p. lamp in some of these installations was as high as 20 units. In his opinion the reason why the maximum demand system had given so much trouble in many districts was because the wiring contractors had not taken the trouble to understand it. The authors in the Paper mentioned that Section 19 of the Electric Lighting Act of 1882 provides that every person shall be entitled to a supply of electricity on the same terms on which any other company or person is entitled under similar circumstances to a corresponding supply, and stated that they did not understand why a consumer should pay one price for lighting and another for power. Perhaps the authors were not aware that in a large number of Provisional Orders now, the fourth schedule prescribed one rate for lighting, perhaps 7d and 2d., and for power and all other purposes another rate, probably 2½d. Mr. Andrews had already referred to the system in which a fixed charge of 10s. per lamp was made. It was an interesting fact that if the maximum demand indicators were calibrated in thirtieths of a kilowatt, at the declared pressure, that was equivalent to an 8-c.p. lamp taking 33⅓ watts. With a system in which the fixed charge was high, and the charge for energy was low, there was an enormous advertising value. In an undertaking with over 2,000 consumers, with which he was connected, he fixed the charge at 1s. 9d. per 8-c.p. lamp per quarter, and 1d. per unit. The advertising value was so enormous that even the *Daily Mail* was "had" by it, and published a paragraph saying that the Willesden Council was supplying electricity at 1d. per unit; they forgot all about the 1s. 9d. per quarter. That 1s. 9d. represented £10 10s. per kw. per annum. With regard to the contract demand system, he agreed with one of the previous speakers that they would have a burdensome life if they had to fix the contract demand for every consumer. The easiest way of dealing with the limit indicator would be to have a contact which the consumer himself could adjust, to decide what the maximum demand was going to be; it could then be arranged for a bell to ring to give him warning when this was exceeded. He thought this would meet the difficulty. He absolutely failed to understand the authors' opinion that their system of charging would enable heating and such like to come into general use, for he could not see where the advantage came in for the consumer. If a consumer put a radiator or kettle on, it was going to increase his maximum, whether he was on the contract demand system or on the ordinary maximum demand system. His idea was to put an attachment by which the consumer could indicate his maximum demand and which could not be pushed back—and let that be the instrument on which the demand was fixed.

Mr. F. Gill (Chief Engineer, National Telephone Co.) exhibited the curve on page 660, in which he had taken three cases: Wimbledon and Birmingham for electric lighting, and the third curve represented the charge for telephone calls. Ordinates marked "ratios" are the ratios between the price charged and the number of units or telephone calls respectively, taking the rate at 4,000 calls or units as one in each case. *B* represented Birmingham; it started at 5d., and came down to 3·61 per unit when 4,000 units were consumed. The Wimbledon case began at 4¾d., and came down to 3·65d. According to the authors, if there were a large reduction in the consumption the increase

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of price per unit was so little that the undertaking might lose considerably. In connection with telephones, they had a sliding scale, with more slide, so to speak. The telephone scale, of course, only did to some extent what the maximum demand



system did, but he thought it did it in a simpler way. It took into consideration the standing charges, and then the lower subsequent cost of giving the service after it had been established. Incidentally, he mentioned that when he was looking into this question he had a little difficulty in finding anybody's rates. One electric lighting engineer in London said everybody had something different, and it all depended on the look of the consumer.

Mr. R. B. Matthews said that the introduction of the metallic filament lamp would only have a temporary deleterious effect upon the profits of electric lighting stations, and in the end was bound to do a great deal of good. He advocated a scheme of "persistent educational publicity," which would take a year to get into proper working order, and from which benefits would be derived in the second year. The cost of services was coming down rapidly at the present moment. In one district in London last year the average cost of the services was just £4. There was a slot meter on the market at 30s., and for ordinary house services there was an ordinary meter at £2. Consumers could not understand the Wright maximum demand system, and those who had attempted to understand it did not use as much current as they might otherwise.

Mr. W. M. Mordey said he wished to make a small suggestion in the direction of simplicity of words, and it was that they should call these metallic filament lamps "wire" lamps. They really had no business with the word "filament" in connection with lamps; it was a term introduced by the patent agents and lawyers over a patent case when they had to determine what was a filament and what was a stick. It was imported by the physiologists and botanists, and he thought it was far better to simplify the name of the lamp and call it what it was—a wire lamp—a good old single-syllable Anglo-Saxon word. He was with those who thought that this wire lamp was going to be a very great thing indeed for the electrical industry. There might be a little dip in the curve, but the curve must go up very much more rapidly when people realised what they had really got. He would like to emphasise Mr. Arthur Wright's advice which he gave at the last meeting, viz., to imitate the broad lines of the gas companies, and do away with self-imposed restrictions. That advice on the part of Mr. Wright was the best he had ever given, and, coming from Mr. Wright, very great weight must be attached to it. It might be that Mr. Wright was seeing that the maximum-demand system was not theoretically right at all. There were a good many misunderstandings with regard to it, and the fact that it was not applied for power purposes was an indication that it was not believed in. With regard to the point raised by Mr. Long as to short-circuiting the demand indicator when a man gave a party, he quite agreed with Mr. Long that when one man gave a party his guests shut up their houses to a sufficient extent to keep the demand on the station unaffected. In 1901 there were three demand stations to one flat-rate station. He now found that the exact reverse was the position, viz., one demand station to three flat-rate stations. But there was an intermediate class which gave both systems optionally, and the proportions were three optional, three flat, and one demand, showing that there had been a great change of opinion on this subject. The load factor was not any better; in fact, it was worse in the demand stations; the units sold per lamp were not improved; and the price of the unit was not improved either. The system did not do any of the things it was supposed to, but it swallowed up in capital charges enough to cover a good profit for two or three years. It might be interesting if he gave some results which he had got out illustrating what had happened since 1901, when Mr. Wright read his Paper on the maximum-demand system. The output had gone up fourfold, and the average price had gone down threefold, *i.e.*, to one-third. This, he thought, was a very satisfactory result for six years' work. From the electric lighting stations of this country the output was something enormous—674,000,000 units—and this did not include any of the power stations, such as the big Newcastle Company, and no entirely railway or tramway stations. It meant that these stations alone were using 1½ to 2 million tons of coal per annum on a very moderate assumption. Whilst he admired the authors' Paper and their suggestions, he believed it would be better to simplify all installation work, to reduce the cost of getting into the houses, and simplify the methods of charging as much as possible to a flat rate or two or three flat rates for different conditions. They should not have things that even electrical engineers could not understand. If installation engineers could not understand the maximum-demand system, it meant there was something wrong, for however theoretically perfect it might be, it was obvious that practically it was imperfect.

The President (Col. Crompton), summing up a few of the points raised in the discussion, said it was very interesting to notice how completely each speaker had taken part in the discussion from his own point of view only. Some had to deal with a class of district where the ground was already very completely covered; it was impossible in such a case to believe that if the consumers had to spend a great deal of extra money on the lamps they would not make a saving on the amount they had to pay to the supply company. Others, like Mr. Sparks, had districts which were not at all filled up, and where there were an enormous number of consumers yet to be coupled up. These stations would be affected to the good by the advent of the "wire lamp"—he was indebted to Mr. Mordey for the word. Supply stations had got to a very asymptotic point on their curves as regards cost, and nothing could help very much except greatly increased outputs and better load factors. Those who thought that great efforts had not been made to increase the load factors were entirely wrong. Engineers had been giving the matter much attention during the past few years. Enormous efforts had been made; publicity departments had been organised and had been quietly at work, and he knew that in cases coming within his own knowledge practically everything had been done that was possible to get the lighting load. Everything had been done to supplement this by heating and power loads, and with most disappointing results. The heating came on at the same time as the lighting, and made the load factor worse. The power load also had been very disappointing, *i.e.*, the load factor from power itself had been much less than had been expected. They must not forget the fact that they always had to pay practically 10 per cent. practically throughout England to the local authorities in the form of rates, and this was much more likely to increase than decrease. Again, they knew the cost of fuel was more likely to go up than down, and, generally speaking, these increases were quite likely to counterbalance all that they as engineers could do—the very little that they could do—by improving their machinery and improving their organisations. Therefore, they had really to consider this one great question of the equitable nature of the charge to the consumer, and he thought they were indebted to the authors for having brought the matter before the Institution. The Norwich system was a most important one. It was based upon a system which they had been used to all their lives for their water, and it was practically what they would all have to do eventually for electric light. It might not be at once, or for ten years, but he was convinced that ultimately they would be rated when the great electric supply concerns passed into the hands of the local authorities upon the rateable value of their houses *plus* a small charge for the electricity used. If that was to be so at a later period, why should they not work upon it now? It was an eminently equitable method, for it was quite certain that the causes which led up to this method of charging for water were based on the supposition that it was not right that large premises should skimp their water supply for sanitary and hygienic reasons, and he thought it would not be very far distant when electric supply would be considered of equal importance to water supply; and, that being so, why should not it be run on the same simple basis? Anyone could understand it: 5 per cent., or whatever the amount was, on the rateable value of the premises, and a penny a unit, or whatever the charge might be. This would get over the immense injustice of the huge premises—such as the large Government buildings in Kensington—which electric supply companies had to supply, for the lighting of which during a few hours each year every other small user in the district was practically contributing.

Written contributions to the discussion have been sent in by Mr. J. Horace Bowden, Mr. J. E. Tapper, Mr. C. E. Skelton, and Mr. W. R. Cooper.

Mr. J. Horace Bowden (Borough Electrical Engineer and Manager, Poplar) writes that he is placed in a possibly unique position, having control of an undertaking possessing a power load which preponderates over the lighting load. During the current year he estimates that the maximum demand for power on the Poplar undertaking will be 1,700 kw. and the output 4¼ million units, equal to a load factor of 28·54 per cent.; private lighting 1,000 kw. and the output one million units, equal to a load factor of 11·41 per cent.; and public lighting 200 kw. with an output of ⅔ million units, equal to a load factor of 42·81 per cent.; making a total maximum demand of 2,900 kw.

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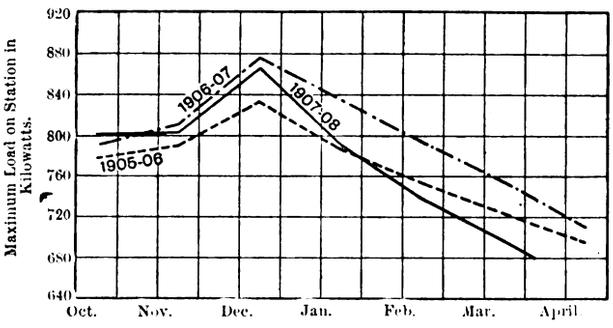
with an output of 6 million units, equal to a net load factor of 23·62 per cent. He anticipates that the average price received will be, approximately :—Power, 1·05d.; private lighting, 5·43d.; and public lighting, 1·5d.; or a net average price of 1·52d. The diversity factor for power upon this estimate is 3·75; for private lighting, 2·5; and for public lighting, nil; or a net diversity factor of 3·06, with a total of 9,075 kw. connected. The standing charge will be, approximately :—Interest and repayments, £15,000; other charges, £7,000; total, £22,000; and he wishes to show a net profit of something in the nature of £4,000, making a total standing charge upon the consumers of, say, £26,000, whilst the running charge will probably be about 0·45d. per unit. According to the principle laid down by the authors, he continues, each consumer should be charged equal to the extent of the maximum demand he may possibly make upon the station, *i.e.*, the capacity of his total connections, although in their examples they do not adhere to that principle. By this system the charge at Poplar should be £2 18s. 6d. per kw. connected, and 0·45d. per unit to produce the same total revenue; and this would reduce private lighting by 1·22d. per unit to 2·21d.; public lighting would be reduced by 0·86d. per unit to 0·64d.; but the price to power consumers would be raised on the average by 0·45d. to 1·5d. In this statement 71 per cent. of the business is for power purposes, upon which the metallic filament lamp has no effect, and Mr. Bowden contends that it is, to say the least, impracticable. As it is impossible to compute the actual value of each individual connection to a system unless the demand is constant throughout the year, he says, it is necessary to resort to classification and allocate to each class its full share of the standing charges as ascertained by the maximum demand upon the station. Public lighting and 100 per cent. load-factor power consumers have no diversity factor, and therefore the standing charge applicable to this class of supply is easily ascertained, a cheap supply being obtained by virtue of the load factor only. Lighting for office, shops, and other business premises of that class should also be governed by load factor and prices fixed according to business hours. The charge to power-users giving an intermittent load must be governed by diversity as well as load factor; the efficacy of this is exemplified in the records of the Poplar undertaking, which has the greatest demand of this class in the Metropolitan area. Mr. Bowden then expresses the opinion that it is the method of charging for domestic purposes to which the most serious consideration must be given, as here is a field capable of enormous development in which cultivation has barely begun. Metallic filament lamps will do much, but cheaper and more perfect cooking and heating appliances will do more; and until we can hope to have the latter, Mr. Bowden thinks that this class of supply must be entirely separated from all others and be charged upon its merits. His opinion is that the time is not far distant when it will be feasible to separate the standing charges in such a manner as to allocate the cost of each individual service and fix an annual service charge to each consumer. The latter would include wiring in some cases, fittings, meter, and connection to mains, to which would be added a charge per kw. for the maximum consumable divided by the diversity factor for the domestic class of load, making in all one fixed annual sum, unless the connections be augmented or reduced. The energy would be charged for as metered at the running cost, which, in a municipal undertaking, would be subject to revision each year similarly to the general rate.

Mr. J. E. Tapper (Resident Engineer, Beckenham Urban District Council Electricity Works) states that in his district one house in six is already supplied, against an average all over the country of only one in ten, and the prospect of picking up a sufficient number of new consumers to cover the immediate loss is very remote. Under-estimating the position, if anything, it is quite possible for the 1,200 consumers at the station referred to to effect a reduction in their total consumption of 25 per cent. To give the same revenue, therefore, as at present, 33⅓ per cent. in consumers must be added to the mains at a capital cost of £3,500 for services only, or an additional annual charge of £200, *plus* extra cost of maintenance of services and collection. During the years occupied in securing the additional consumers it is possible that the undertaking may have to run at a loss unless either meter rents or the prices charged per unit are raised. Mr. Tapper also refers to the power factor of the transformers used for metallic filament lamps, which, apparently, contrary to Mr. Ruthven-Murray, he estimates at 50 per cent. To prevent the carrying capacity of the mains and plant being reduced in this proportion, he advises his consumers to put in transformers which on normal working load are nearly fully loaded.

Mr. C. E. Skelton writes that he does not envy the task of him who seeks to convince the British public that one unit of current is worth more, say, between 5 p.m. and 7 p.m. than at any other hour of the day; he suggests that it would be nearly as wise for a restaurant proprietor to ask for increased prices at the time of his peak of load.

Mr. W. R. Cooper thought there would not be any great falling off in revenue except on alternating-current networks, and this would be more than counterbalanced in many cases after a time by the new fields rendered available by metallic filament lamps. Any restrictions on consumers would be most unwise, and the raising of prices as a solution of the difficulty should be adopted only as a last resource, as it might interfere seriously with the use of electricity for purposes other than lighting. Mr. Cooper advocated modification of our methods of supplying small consumers to imitate those in use on the Continent. There should, he says, be no great difficulty in running a service cheaply along a whole block of buildings, say, under the first floor windows. Such methods, combined with the cheap Continental system of wiring with unprotected wires, would do much to improve the situation. But this would not come about without some combination between contractors and station engineers.

Mr. A. H. Dykes, replying on behalf of both authors, showed the diagram below, which relates to a large alternating-current station. The curve for 1907–8 had started well above the curve of the year before, but in October of last year it had a bad attack of metallic filament lamps, and the curve fell below the curve of the year before. It went on falling, until in January of this year it got below the output of two years before, and it was still going down. This was not a case of the consumers falling off, for the rate of increase in this respect had been well maintained, as shown in the footline to the curve. He knew of single consumers in London who had reduced their bills by as much as £2,000 a year. Mr. Hirst had been a maker of lamps for years; when the conditions altered, he found himself in the possession of a lamp which would give three times the light for the same amount of current. At the same time the station engineer found the conditions changed, and his current was able to give three times the amount of light that it did formerly. Mr. Hirst's advice to the station engineer was to continue to sell current at the same price, and cheerfully to endure the loss for a longer or shorter period, in the hope that eventually he would recoup himself. It was to be expected, therefore, said Mr. Dykes, that Mr. Hirst would sell his new lamps at the same price as the old, and trust to the



Lamps Connected :

1905–6	...	...	... 102,000
1906–7	...	...	... 108,000
1907–8	...	...	... 113,000

increased sales to repay him. Mr. Wright had stated that if the output of the Marylebone station were doubled the cost would immediately come down from 4½d. to 2½d. Then, Mr. Dykes contended, if the criticisms on the Paper were valid, Mr. Wright should have reduced his price from 4½d. to 2½d. a year or two ago, and the increase in new consumers would have more than recouped the loss. Mr. Bowden, in his communicated remarks, had made two mistakes. He had added all his expected profit on to the rental charge, and, secondly, he had charged the consumers on the capacity of plant or lights installed instead of on their contract demand. The effect of this, of course, would be the same as the original Hopkinson method—to reduce the lights installed. Nevertheless, the authors agree that the effect of their system on his figures would be to increase somewhat the charge for power and reduce it for private lighting, and they think that this would be equitable. Meeting the criticism made by some speakers that the system proposed by the authors takes no account of the diversity of the motor demand, they suggest that this is easily met by charging power consumers a lower rental per kw. of contract demand and public lighting a somewhat higher one than lighting consumers, the exact difference depending on the ratio betwen their diversity factors and the proportion which each bears to the total demand on the station. In conclusion, the authors suggest that the Institution should call together a committee of those most interested in the matter of obtaining the consent of the Board of Trade to raising the statutory limit of price chargeable; that this Committee should consider whether joint action is advisable, and, if so, should formulate proposals.

Cambridge University.—The inauguration of the Chancellor-Elect, the Rt. Hon. Lord Rayleigh, F.R.S., will take place to-morrow at 4 Carlton Gardens, Pall Mall, London, at noon.

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION

We have received a copy of the preliminary programme for the thirteenth Annual Convention of the Incorporated Municipal Electrical Association, which will be held in Nottingham from June 30th to July 3rd.

On the first day, Tuesday, June 30th, the Association will be welcomed by the Mayor of Nottingham, after which the President—Mr. H. Talbot, the City Electrical Engineer—will deliver his address. This will be followed by the reading and discussion of Papers, and subsequently the Chairman and Members of the Electricity Committee will entertain the Association at luncheon. In the afternoon various works will be visited. Wednesday, July 1st, will be devoted to a whole day's excursion to Dovedale. The Annual General Meeting will be held on the morning of July 2nd, and in the afternoon the electricity and other works will be visited. The members' annual dinner will take place in the evening. The Conference will come to a close on Friday, July 3rd, the morning of which will be devoted to reading and discussion of Papers.

The following are some of the subjects which will be discussed during the Conference:—The Experiences of a Convener in Establishing an Electrical Undertaking; the Equipment of a Testing Department; A.C. Accumulator Sub-stations; the Designing of Electrical Generating Stations; Overhead Equipment.

It may be mentioned that this is not the first time that the Association has visited Nottingham, for during the Derby Convention of 1904, under the presidency of Mr. T. P. Wilmshurst, the Borough Electrical Engineer at Derby, a visit was paid to Nottingham, several Papers being read and discussed in the morning and the annual dinner held there in the evening.

POLYPHASE MOTORS FOR INDUSTRIAL PURPOSES

Glasgow Discussion

The Paper on the application of polyphase induction motors for industrial purposes, by Mr. G. Stevenson, an abstract of which was given on page 629 of our last issue, was read and discussed at Glasgow on Tuesday, April 14th. It will be remembered that the author was strongly in favour of squirrel-cage motors used in combination with friction clutches, as opposed to slip-ring motors.

Mr. Campbell McMillan said that the author had taken two classes of motor for the engineer engaged in the application of induction motors to choose from—those with short-circuit or squirrel-cage rotors and those with slip-ring or wound rotors—but he thought he might add a third class—those with internal resistance. They did not require any slip-rings, and in many cases they were very much simpler and were recommended up to a certain size—he thought about 50 horse-power. It was interesting to note that in the comparison of prices they would vary very much according to the copper market, because the chief gain in the squirrel-cage rotor was the relatively small amount of copper in the design. In connection with the very neat method of starting patented by Mr. Meyer, simplicity of operation was obtained at the expense of limiting the freedom of the designer, and anyone who stood up against the possibilities of fitting windings into motors according to desired characteristics would relinquish with the greatest reluctance the freedom to change over from the delta to the star connection as the requirements demanded. At the beginning of the Paper it was stated that, even if starting devices were included, the squirrel-cage motor came out still cheaper in sizes up to and including 50 horse-power, because the starting gear for that type was much simpler and less expensive than that required for the motor with wound rotor. But he thought that the occasions on which the throw-over switch could be adopted were rather limited. In connection with clutches, he remarked that if there was any defect in the machinery, the time required to obtain the full speed might mean a great amount of heat generated in the coil, and provision must be made for the dissipation of that heat. He thought that had been the chief trouble in most clutches—not that they failed to grip, but that they did not dissipate the heat in a proper manner.

Mr. John S. Nicolson (Glasgow University) noted that the author, in speaking of the squirrel-cage machine, said that the absence of moving contacts made it absolutely sparkless, and therefore specially suited for operation in mines or mills where dangers from explosive gases existed, but later said that machines up to 20 horse-power might be used with an air-break switch, and above that size it was good practice to use an oil-break switch. He should imagine that where squirrel-cage machines were being started with an overthrow switch there would be a little sparking. The author's remarks on the probable saving of power from the use of roller bearings, as opposed to the ordinary cylindrical bearings, corroborated one or two experiments which he had made with 10 horse-power induction motor, where he found that the power required for starting when he took out the ordinary bearings and put in roller bearings was diminished fully 10 per cent., so that in ordinary cases with a long line of shafting the saving of power would be a great deal higher than 25 per cent.

Mr. W. B. Hird (Mavor & Coulson) said that the author laid great stress on the superiority of the squirrel-cage motor over the slip-ring motor for most purposes. The advantages of the squirrel-cage motor were very evident from the manufacturer's point of view, as it was a machine that would give less trouble and be a cheaper machine to make, and from the consumer's point of view also, on account of the smaller attention which one would have to give the machine. The greater freedom from breakdowns was also a point in its favour. He had had no experience of friction clutches for high powers, but from what he had heard he thought he was lucky in not having had experience. There was no doubt that friction clutches were looked upon with great disfavour. A few weeks ago (see Electrical Engineering, March 12th, page 407) Mr. Henry A. Mavor had described an induction motor which he had devised and which he had called a spinner motor, in which the member carrying the stator winding was free to move as well as the motor, which was provided with an ordinary squirrel-cage winding. The whole thing was self-contained in the motor itself, and the extra cost was not more than would cover the cost of any friction clutch on the market. If the load was too big, it was merely necessary to allow the stator to be free, and it would accelerate. It was under perfect control during the whole time, and as the stator came to rest the rotor took up the speed.

Mr. W. J. Belsey (British Thomson-Houston Co.) said that he would like to emphasise the importance of judging an induction motor by what the author called the apparent efficiency, and not so much by the power factor or the efficiency separately. In the first place, the power factor was an extremely difficult thing to measure with any degree of accuracy, whereas the apparent efficiency could be determined pretty accurately.

Mr. J. Hally Craig (British Westinghouse Co.) thought that the author had been a little too severe on the slip-ring motor. Undoubtedly the squirrel-cage rotor had many advantages that appealed to the user and to the purchaser or customer speaking from a commercial standpoint, but the slip-ring rotor had also many solid qualities, if properly constructed. The internal resistance method was not much used in this country, but in America it was largely used.

Mr. Walter H. Tittensor (J. H. Holmes & Co.) said that people were beginning to realise that shafting required money to run, but not many mill-owners would believe that they were wasting 50 or 60 per cent. of their power. There were many cases where small manufacturers could not afford to go in for separate motors, so they put in one motor for the shafting, but if they really wanted to get the best results they should go in for separate motors. With regard to clutches, he was glad to say that he had not had much experience of them in a large size, but he knew a number of people who had, and when he had asked them for their experience they had replied that they would rather not give it. The experience of most people was that friction clutches gripped too suddenly.

Mr. Stevenson, in reply, said that he was altogether against the method of inserting resistance permanently in the rotor. In one device mentioned by Mr. Meyer the rotor was wound with two windings, one being with coils of iron wire and the other with copper. That method was tried and practised, but it was proved that the iron wires got rusted up with use in this climate, and the method was abandoned. In reply to Mr. Nicolson, in the case of fiery mines an air-break switch would not be used, but an oil-break would be used. With respect to the special arrangement of Mr. Mavor, Mr. Hird had said that the extra cost of the spinner motor was not greater than a friction clutch would be, but he thought that if they took into consideration the special bearings, he did not think that that would apply. He thanked Mr. Belsey for his remarks as to efficiency, as that was really a very important point, because manufacturers were often asked to guarantee the power factor and efficiency separately.

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ELECTRICALLY-DRIVEN WHARF CONVEYORS

An article in the *Electrical World* (New York), describing some of the purposes to which electric power is put in New Orleans, contains details of two different forms of conveyors in use at the docks. One of these is a conveyor installation for handling bananas and similar cargoes at the United Fruit Co.'s Illinois Central Docks. At these docks four Harris-Edel-

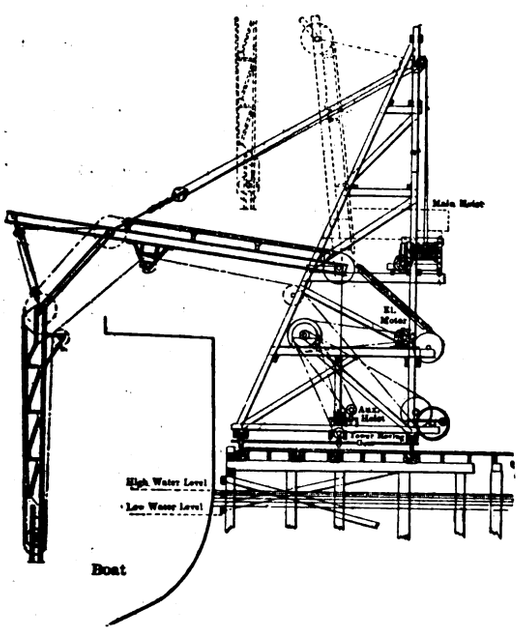


Fig. 1.—Special Electrically-driven Conveyor for Cargoes of Fruit.

ston conveyors have been erected by Messrs. Woodward, Wight & Co. As is shown in Fig. 1, each conveyor consists of an A-frame of steel with derrick and booms, mounted on a movable platform with trucks, in order that the conveyor can be shifted to suit the positions of the hatchways of vessels berthed alongside the wharf. On an endless canvas belt, 5 ft. 4 in. long, are spaced 70 pockets; the spread of the pockets being 36 in. The conveyor belt is lowered into the vessel's hatchway by a marine leg which serves as a frame for the former, the whole leg being attached to the main boom of the hoist by a steel hanger and to an auxiliary boom by a block and fall. The belt is loaded by hand at the different deck levels, and carries its product across the wharf to a platform belt on the shore end of the equipment, delivering the fruit on the platform automatically. Cloth buffers provided at the platform prevent injury to the fruit. From the platform on the docks the fruit is assorted and distributed to the cars of fast fruit trains which are made up on spur tracks terminating near the conveyor.

Each conveyor is operated by a 15 h.p. induction motor, and this motor lifts the main boom, operates the auxiliary hoist, runs the carrier belt, and moves the tower up and down the track, which has a 20-ft. gauge. The tower weighs about 35 tons, but it can be placed in a position and begin unloading the cargo within ten minutes after an open hatchway ship comes alongside the wharf. One man operates each tower, and one tower is used at each hatch. The towers are all adjustable to ships having carrying capacities of 10,000 to 65,000 bunches of bananas, and to a variation in the height of the Mississippi River of 21 ft. 6 in. The main boom consists of a 12-in. I-beam, and the hanger and marine leg frames are of 10-in. channel iron. The conveyor speed is 118 ft. per minute. The different hoists and movements are thrown into service by clutches on the main driving shaft in the tower. The main driving shaft is operated by a 6-in. belt connected with the motor pulley, and the hoist connections are operated through chains and bevel gearing. In actual service each tower is housed to protect its machinery and the fruit handled from the weather. The slack of the conveyor belt is taken up by an idler running in a slot at the lower end of the marine leg.

Each conveyor can handle from 2,500 to 2,800 bunches of bananas per hour, according to the size of the fruit, or about 10,000 bunches per hour from a four-hatch ship. The process of discharging by this means effects a saving of about 50 per cent. in the quantity of labour required, and as the bunches of fruit are handled only twice from the ship's hold to the cars, the saving in damage to the fruit is very great. By the old method of unloading, about 600 men would be required to discharge a large cargo in 24 hours, whereas with the conveyor the same work can now be done in seven or eight hours, and with 300 men. In the old system platforms had to be erected in the holds, on which men stood and passed the fruit from one level to another, sometimes a dozen handlings being required between the ship and the car. This resulted in a loss of 150 bunches through injury by rough handling in a cargo of 30,000 bunches. By the use of the conveyor the damage does not exceed eight to ten bunches, and the saving in time of unloading means about a day's earlier delivery at the interior fruit markets; also, it often means a saving in the value of the ship's charter of from $100 to $200 per diem.

It would be impossible to handle the New Orleans banana traffic without these electrically-operated conveyors. An example of recent rapid unloading is furnished in the case of the steamship *Chirripo*, a four-hatch boat, from which 51,500 bunches were unloaded in 7 hrs. 15 min.; 400 men being employed. Nearly double this force and 24 hours would have been required by hand. The energy cost for operating the four machines two months was only $88, and one and one-quarter

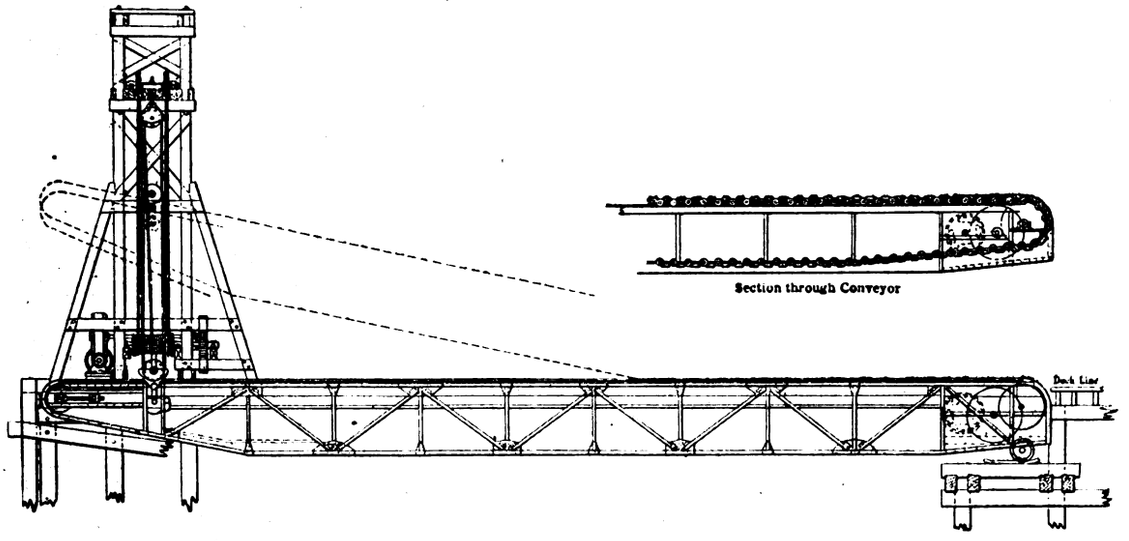


Fig. 2.—Freight Conveyor.

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million bunches were unloaded. The labourers receive 30 cents per hour. Cargoes of sugar have also been unloaded by the conveyor with a saving of 25 per cent. Inward freight, packages, and barrels not exceeding 450 lb. in weight are also unloaded in this way.

At the Southern Pacific docks in New Orleans some 15 floor conveyors or ramps have been installed to eliminate the hard work of pushing truck loads up inclined planks between the ships and the storehouses. Each conveyor is operated by a 15-h.p. motor. A 10-h.p. 220-volt, direct-current motor is provided to raise and lower the end of the ramp to meet the conditions at the ship. The ramp consists of a travelling platform or escalator about 4 ft. wide and 70 ft. long, which runs about 225 ft. per minute between the edge of the wharf and the central aisle of the distribution shed. Each truck load is pushed by the employee upon the ramp, and the two are carried to the inner part of the wharf, whence distribution is easy. Five of the conveyors were built by the Link Belt Engineering Co., of Philadelphia, and ten by the H. W. Caldwell & Son Co., of Chicago.

The width of the conveyor walk for a single slip is 14 ft. Besides being raised and lowered, the outer end can be maintained by a pin lock in any position. The shore end is supported on rollers. Each side of the walk is provided with a chafing strip of 6-in. by 6-in. yellow pine, each strip being secured 6 in. from the edge of the walk. The conveyors proper consist of double strand chain made of bar steel with 3-in. slats of hard maple fastened to each link and forming a continuous apron; the whole being supported by flanged rollers turning on cold steel shafts. The flanges of the rollers are 5 in. deep. The bed frames or supports for the shore end of the conveyor are constructed on creosoted pine piling. Power is applied by the 15-h.p. motor at the shore end of the conveyor. The motor is of the water-tight type. It is contained in the truss, and is connected by compound gearing with the conveyor shaft. It is started from a controller located adjacent to the conveyor. The outer end of the conveyor is suspended from two two-fold purchases consisting of strong iron blocks and of ¾-in. wire cable wound on a flange drum connected with the 10-h.p. motor. Worm gearing is interposed between the motor and the drum, which sustains the load at any point without brakes or ratchets. Each conveyor is furnished with a safety bar to prevent its dropping in case a cable parts. The ends of the conveyors are fitted with steel aprons.

Heat-Gauges for Hardening Tool Steel.—A description of a magnetic heat-gauge manufactured by Messrs. Taylor, Taylor & Hobson, Ltd., of Leicester, is given in a recent issue of *The Iron and Coal Trades Review*. Every variety of carbon steel (but not high-speed or alloy steel), when heated, becomes non-magnetic precisely at the temperature at which it should be hardened. The gauge, which makes use of this fact, consists of a permanent magnet of horse-shoe shape, with its two poles made of metal, which remains magnetic at temperatures higher than the hardening temperatures of carbon steel. Any small steel object held by these poles and heated by a blow-pipe drops off into the quenching liquid at exactly the right temperature.

The Trollhätten Falls Power Station in Sweden.—This large station, which is now being built, will probably be completed by the end of next year. Both the falls and the station are the property of the State, and a large proportion of the output (about 20,000 h.p.) will be for the State Railways. According to the *Elektrotechnische Zeitschrift*, the station will contain eight three-phase units of 10,000 h.p. each, and three 220-volt exciters of 500-h.p. each. The alternators will generate at 10,000 volt, 25 cycles per second, and will run at a speed of 187 revolutions per minute. An accumulator battery will form a reserve to the exciter sets, and each large unit will also have a direct-coupled exciter. Distribution in the neighbouring district will be effected at the generating pressure of 10,000 volts, but a pressure of 50,000 volts will be used for the long-distance transmission. The 50,000-volt lines will be carried on steel poles spaced 220 yards apart. The most important consumer will be the town of Gothenburg (see also Electrical Engineering, Vol. II., p. 326), which will pay a yearly sum of £2 15s. per kilowatt of maximum demand, and a further sum of 0·066 pence per kilowatt-hour consumed. For every kilowatt over a maximum of 7,000 kw. a yearly sum of £3 2s. 6d. will be paid, up to a maximum of 14,000 kw. The town has guaranteed to take at least 3,000 kw. from the year 1910 onwards. The contract extends over a period of 20 years. Other smaller falls on the same stream (Göta Alf) have been purchased by the State, the total available power amounting to at least 200,000 h.p.

BRITISH WESTINGHOUSE CO.'S REPORT

THE directors' report and balance sheet for the year ended December 31st, 1907, has been issued. There is also submitted a balance sheet as at December 31st, 1906, compiled before giving effect to the capital reduction. In the latter balance sheet are included the transactions of the period from July 31st, 1906 (the end of the previous financial year), to December 31st, 1906. The reasons for altering the date of the termination of the financial year from July 31st to December 31st in each year have been previously explained by the directors. The debit balance on profit and loss account for the period ended December 31st, 1906, was provided for in the reduction of capital, together with other items of loss and depreciation incurred in the past, so far as ascertained up to the time of presenting the petition to the Court.

The results for the twelve months ended December 31st, 1907, showed a marked improvement over previous years. The trading profits amount to £92,383 5s. 5d., from which fall to be deducted:—Interest on 4 per cent. debenture stock, £49,654 2s. 4d.; interest on temporary loans, £14,379 4s.; sundry depreciations (not ascertained at time of reduction of capital), £17,008 14s.; leaving a balance to be carried forward of £11,341 5s. 1d. Having regard to the recent writing down of the various assets, it has not been deemed necessary to make further provision in this year's accounts for depreciation in respect of the works and plant. In their circular of January 4th, 1908, the directors referred to the proposed financial plans. In accordance therewith £250,000 (out of £300,000 authorised) of 6 per cent. prior lien debentures have recently been issued at 98 per cent., and have been fully subscribed. The balance of £50,000 will be held in reserve to be used as and when required for the general purposes of the company. The important arrangement with the American companies has been carried out, whereby indebtedness amounting to £186,374 has been liquidated by the transfer to the American companies of shares in the Traction and Power Securities Company, Ltd., at their par value. Out of the proceeds of the prior lien issue, the loans from bankers will be paid off, and a substantial sum added to the working capital of the company. The institution of economies throughout the administration is continuing to have the careful consideration of the directors. During 1907 there was a substantial increase in the volume of the company's business. At the present moment demand is slack, but the company's improved commercial position, both at home and abroad, will enable it to take advantage of any revival in trade. In accordance with the Articles of Association, the retiring member of the board is Mr. J. Annan Bryce, M.P., who, being eligible, offers himself for re-election. The meeting will be held at Hamilton House, London, E.C., on Monday next.

Swiss Telegraphs and Telephones.—An American Consular report gives some details as to the management of the Swiss Government telephone and telegraph systems. Distances in Switzerland being short, the service prompt, and the rates low, the telegraph and telephones are liberally patronised. Long-distance connections are made with all the local or urban telephone lines, enabling patrons to communicate with all cities and towns in the country. There are also international connections with all the countries bordering on Swiss territory. A feature of the Swiss telephone service is that in addition to owning and operating all the lines, the Government manufactures all the instruments used, and controls the business absolutely. The total length of telephone lines in Switzerland is 10,548 miles. The annual rental charge for offices, business houses, and residences is $12·45 per year. An additional charge of one cent is made for each call in the town. For inter-urban or long-distance calls the rate is 2 to 14 cents for three minutes, according to distance, 14 cents being the maximum rate for any distance in the country. The number of telephone subscribers in 1906 was 53,711. During the year there were 32,071,177 local, 7,251,193 inter-urban, and 299,209 international calls over the Government telephones. The revenue from all classes of calls for 1906 was $829,732; income from rent on 53,711 telephones, $668,702, making a total of $1,498,434. The total length of telegraph lines is 66,683 miles. The total number of telegrams transmitted in 1906 was 4,918,679, of which 2,339,956 were international and 1,698,858 local. The total revenue from telegrams for the year was $1,596,664. There is a Government tax of 30 centimes, equal to a fraction under 6 cents American money, on each telegram sent. In addition to this charge there is a universal rate of one-half cent a word throughout the country, distance not being taken into consideration. A telegram of ten words costs only 11 cents. The international rate is 30 cents per word to New York, 2 cents to France, Germany, Italy, and Austria, 5 cents to Spain, 6 cents to England, and 9 cents to Russia. In addition to the foregoing there is a Government tax of 10 cents on each international telegram or cable. The total income from telephone and telegraph service for 1906 was $3,095,098; expense, $2,231,217; profit to the Government, $863,881.

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REPORT OF MARCONI'S WIRELESS TELEGRAPH COMPANY

In submitting their report made up to September 30th, 1907, which will be presented at the annual ordinary meeting to-day, the directors express regret for the delay in its publication. The postponement is stated to have been due, first, to the complex and delicate situation in which the company found itself when His Majesty's Government indicated an intention to ratify the conclusions of the Berlin Conference, and when other governments were considering how far they should go in assenting to the principle of intercommunication. Secondly, the directors felt that they ought, if possible, to come before the shareholders with a definite announcement as to the achievement of the anticipated transatlantic service, the establishment of which had been repeatedly postponed owing largely to the delay in obtaining delivery of the necessary material. The transatlantic service having been established last October, the Board considered it advisable practically to demonstrate its stability and possibilities by testing it in actual operation. The results after six months' continuous working are considered to be satisfactory and encouraging, and are claimed to justify the confidence with which the directors have throughout regarded the feasibility of direct wireless communication with America.

In commenting on the balance sheet, the report points out that these and many other developments have been attained with a capital issue of about 384,190 shares, with the profits which have been allocated to capital account and by financial engagements amounting in all to £94,263 15s. 6d. at September 30th last. Attention is called to the credit side of the balance sheet, on which appear the share interests in the subsidiary enterprises of the nominal value of £2,394,106 10s., which are, together with the patents, set out in the balance sheet at only £242,966 9s. 10d. These holdings represent more than 50 per cent. of the whole issued capital of these companies, and items include practically the whole of the £200,000 share capital of the Marconi International Marine Communication Co., Ltd. By the completion of the arrangements now being made dealing with the transatlantic service, an early accession of income to several of these subsidiary companies is expected.

The report continues:—When the patents were originally acquired in 1897, communications could only be sent a distance of two miles, but as the result of the work on development since that date, communications are now able to be sent 2,500 miles. In all, the company own over 550 patents. The more recent patents cover important improvements relating to new transmitters and receivers which secure increased speed, and improved syntonisation. On the patents are based the licences which are held by His Majesty's Government, Lloyd's, and our associated companies. The British Admiralty are paying £5,000 per annum, for a term of years, for the right of using the Marconi system.

The long distance station at Clifden in Connemara, communicating with the long-distance station at Glace Bay in Nova Scotia, was in October, 1907, so far completed as to admit of its being opened for a limited press service, and in February, 1908, the stations were opened to the public for the transmission of messages between London and Montreal at an inclusive rate of 7½d. per word. A considerable amount of business has already been transacted by means of these stations, and this business is daily increasing. One newspaper in New York stated that it had during five months received despatches, totalling 68,404 words, "promptly and efficiently transmitted by the Marconi system." These stations will be able to cope with a much larger volume of messages when the necessary enlargement and duplication of machinery has been carried out. It is intended to bring up to the same level of efficiency as the Irish-Canadian stations, the two long-distance stations at Poldhu in England and Cape Cod in the United States. The company has an agreement with the British Post Office, whereby the latter engages to grant the same facilities for the collection and delivery of messages by the Marconi transatlantic system as those afforded to the cable companies. A similar agreement has been entered into between the Dominion Government and the Canadian Marconi Company. Up to the present this service has been conducted at speeds varying up to 20 words a minute, but with a comparatively inexpensive modification of certain parts of the existing apparatus, it is expected to attain a speed of 30 words a minute. On the basis of the improved Irish-Canadian service, and of the contemplated English-American service, working the four stations at 12 hours a day at an average net wireless rate of 4d. per word, and at a speed of 20 words a minute, a net revenue (after deducting working expenses) approaching £150,000 per annum is capable of being earned by these four stations. In addition to the total earnings of the long-distance stations at Poldhu and Clifden, the greater proportion of the profits derived from the corresponding stations at Cape Cod and Glace Bay will also pass to this company in the form of dividends, this company holding the majority of the stock in the American and Canadian companies.

The maritime service is progressing most satisfactorily, the North Atlantic being covered by a network of wireless intercommunication. The number of steamers using the Marconi international organisation of ship and shore stations has increased from 80 ships in 1905 to 92 ships in 1906, and 118 ships in 1907 (excluding warships).

The number of words transmitted and received were 643,534 in 1905, 1,354,549 in 1906, and 1,868,540 in 1907. The net receipts by the Marconi International Marine Communication Co. and its associated companies from this source for the same period were £13,066 in 1905, £27,501 in 1906, and £37,936 in 1907. The Poldhu station has been supplying a daily press service to such of the Atlantic liners as are fitted with the long-distance apparatus. The receipts of the Poldhu station during the last two years amounted to over £9,000.

The report deals with the question of intercommunication as follows:—On the establishment of the above organisation the expenditure was necessarily large, and it has been productive of most promising results, but the very success of our efforts in this direction led to foreign intervention. On the proposal of the German Government, the Powers were convened to two successive conferences, the last and most important of which was held at Berlin in the autumn of 1906, in order to frame an International Convention to regulate the use of wireless communication at sea. The effect of this convention was a proposal made by Germany, and accepted by the majority of the delegates, to make intercommunication between all systems compulsory. Thus the manufacturers of any wireless instrument would be entitled to demand the same access to our wireless exchange as those who used Marconi's system only, even if the said instrument was an infringement of our patents, and this without incurring any of the initial expense we have had to incur in establishing our stations and organising our exchange. A Select Committee of the House of Commons was subsequently appointed to inquire into the matter, and by a majority of one they reported in favour of the ratification of the Convention. In this connection we reproduce the following statement by the Select Committee of the House of Commons that deliberated on this question:—"Whilst the Committee consider that the Marconi Company have exaggerated the case against ratification, under the apprehension that they will suffer commercial injury by the operation of the Convention, the Committee would be very reluctant to make any recommendation which would impede or be injurious to the fair working of their business. They recognise the valuable work which has been done by the Marconi Company as the pioneers of practical wireless telegraphy, and this work is fully appreciated by the nation. From the evidence placed before them, the Committee see no reason to apprehend that the obligations of the Convention, if faithfully carried out by all concerned, will prove injurious to the Marconi Company. If, on the other hand, it is found by practical experience that the Marconi Company are injuriously affected, the Committee recommend that they should be treated with a generous consideration quite irrespective of and without prejudice to their legal position." Under these circumstances the directors have been carefully considering the course the company should now adopt. They remain convinced that the working of wireless telegraphy at sea, that is to say, between moving points, can only be efficient if controlled by one central organisation, and in their opinion the rules adopted by your Company and the commercial organisation which it has established afford the best means for ensuring this efficiency and practicability. But the majority of the Governments do not share this opinion, and this being the case your directors are compelled to take the view that it would be wise for this company's business interests to consider how it may best be found practicable to modify the policy hitherto pursued by the Board, and believe that with mutual goodwill and regard to respective interests, arrangements may be arrived at not only satisfactory to the Governments concerned, but also remunerative to the Marconi Companies, who have invested so large an amount of capital in the establishment of this present wireless organisation.

The company owns a fully-equipped factory adequate to cope with the expanding demand for instruments and installations. Over 500 wireless stations have already been equipped by the company, and the number is constantly being added to. Considerable orders are received each year from the British Admiralty and foreign governments for wireless telegraph apparatus and accessories. The Marconi system is also in use for naval and military purposes in Italy, Russia, Belgium, Chili, Brazil, China, and Siam. The factory is freehold, and is valued as a going concern with its equipment and stock at over £95,000.

With regard to the Marconi Wireless Telegraph Company of America, the long-distance station at Cape Cod, as is the case at Poldhu, has been supplying a daily news service to ships fitted with long-distance receiving apparatus, and the four shore stations at Seagate, Sagaponack, Siasconsett, and South Wellfleet, on the American seaboard, have contributed their quota to the wireless exchange. The action in respect of Mr. Marconi's

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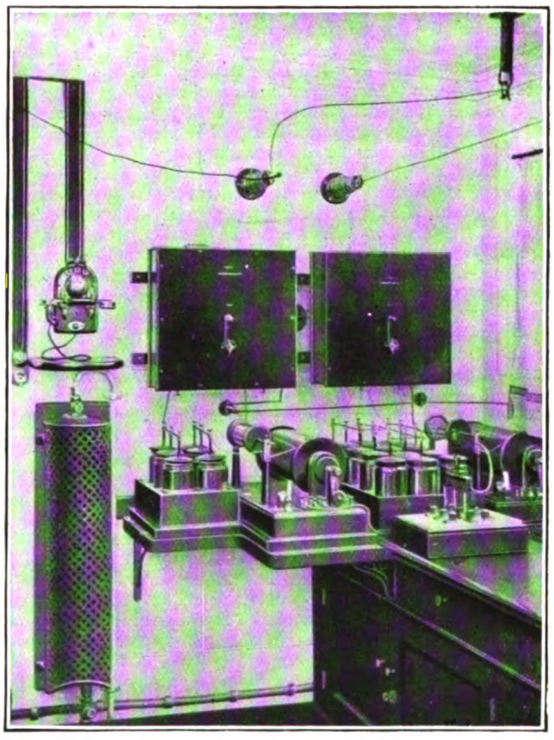
magnetic detector patent has been decided in favour of the company. The Marconi Wireless Telegraph Company, Ltd., of Canada, has erected the transatlantic station at Glace Bay, which corresponds with the station at Clifden, and for communication with ships further stations have been completed at Cape Bear, Prince Edward Island, Quebec, Grosse Isle, and North Sydney, and there are now altogether 20 Marconi stations on the Canadian shores and the St. Lawrence River. Contracts have been made with the Government of Newfoundland for wireless stations, and five stations are working on the Labrador Coast. One of these contracts secures to the company exclusive rights for wireless telegraphy in Newfoundland. During the period under review a company has been formed at Buenos Ayres and is now commencing to instal wireless telegraph stations with a view to extending the operations of the wireless exchange to South America. It is the intention of the Argentine Company to erect a long-distance station to communicate with the long-distance station now being erected by the Italian Government, under the supervision of Mr. Marconi, at Coltano, in Italy.

In France the company's interests are represented by the Compagnie Française Maritime et Coloniale de Télégraphie sans Fil, which is earning profits and paying a dividend. In Italy there are 22 Marconi stations which are available for communication with ships fitted with their instruments, and 14 vessels of the Italian Mercantile Marine have already been installed with Marconi instruments.

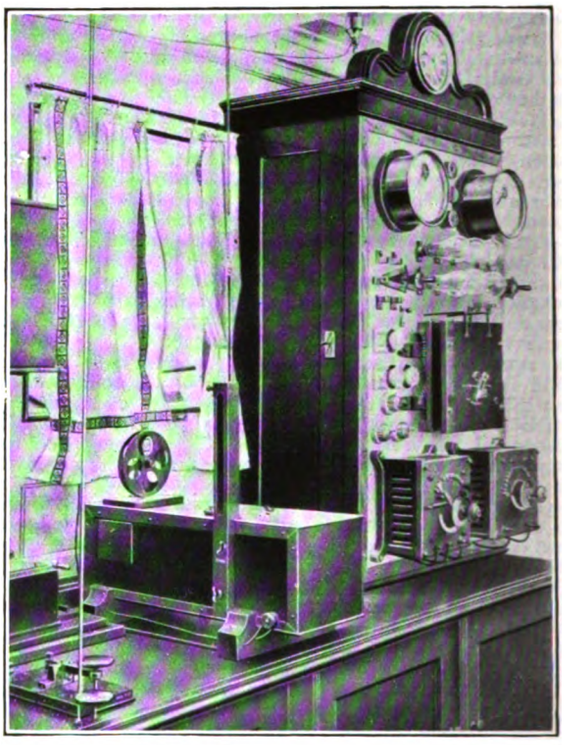
During the period under review Marconi apparatus has been installed at Lloyd's stations at the Butt of Lewis and the Flannan Islands. The Marconi system of wireless telegraphy is in use throughout the British Navy and at British naval stations in the United Kingdom and abroad. Under the terms of its agreement with the Company, the Admiralty continues to utilise the Company's high-power stations for communication with the ships of the fleet, whether in home waters, in the Atlantic, or in the Mediterranean, within a radius of 2,000 miles. Six of the Trinity House Lightships, viz., the "Sunk," "Gull," "South Goodwin," "Tongue," "Cross Sand," and "East Goodwin," are now fitted with the Marconi apparatus. This business is capable of considerable development.

The directors have been considering for some time past the adjustment of the Company's capital account, and they have decided to ask the shareholders to approve the following resolution to be proposed at an extraordinary general meeting to be held immediately after the annual meeting :—

"That the capital of the Company be increased to £750,000, by the creation of 250,000 preference shares of £1 each, conferring the right to a fixed cumulative preferential dividend (in priority to all other shares) at the rate of 7 per cent. per annum on the capital for the time being paid up on such preference shares, and also, subject to the payment of a non-cumulative dividend of 10 per cent. per annum on the ordinary share capital of the Company for the time being paid up, the right to participate *pari passu* in proportion to the capital paid up with the ordinary shares in any profits not required for the payment of such preferential dividend, and of a non-cumulative dividend of 10 per cent. per annum on the ordinary shares which it shall from time to time be determined to distribute, and the right in a winding up to rank in priority to all other shares for the repayment of capital and *pari passu* with all other shares in any excess after repayment of capital paid up thereon." The proceeds of the new issue will serve to pay off the Company's engagements to bankers and others. There would then remain, in the opinion of the directors, an amount sufficient to carry on and extend the business of the Company, to complete the long-distance stations, to provide these with the necessary land line facilities, and to enable the Company to deal with the orders already received and likely to be obtained. The shareholding of the Company in the subsidiary companies, which should become exceedingly valuable as the long-distance business progresses, should provide further resources for the extension of the Company's business. In March last the directors made an agreement with Mr. H. Cuthbert Hall that he should relinquish the position of managing director and his suggested present and future claims for commission in consideration of a payment in cash and of the allotment to him of 10,000 fully paid-up shares in the Company. Mr. H. Cuthbert Hall has since retired from the board.



Marconi Transmitting Apparatus as Used on Atlantic Liners.



Marconi Receiving Apparatus as Used on Atlantic Liners.

Accompanying the report is the following statement showing the development of the Marconi patents :—Shortly after the incorporation of the Company in 1897, two stations were erected at Alum Bay, Isle of Wight, and at Bournemouth, the distance between these two stations being 14½ miles. About the same time a small steamer was chartered and readable signals on board were obtained up to a distance of 18 miles from the station in the Isle of Wight. In July, 1898, the Kingstown Regatta was reported from the high seas by wireless telegraphy for the *Dublin Daily Express*. In December, 1898, the South Foreland Lighthouse and the East Goodwin Lightship were fitted with the Marconi apparatus for the purpose of demonstrating to Trinity House its value for lighthouse and lightship communication. On March 27th, 1899, France and England were, for the first time, connected by wireless telegraphy by means of installations at the South Foreland Lighthouse, near Dover, and the Chalet d'Artois at Wimereux, near Boulogne, and in September of the same year, during the meetings of the British Association at Dover and of the Association Française pour l'Avancement de Science at Boulogne, communication was maintained by means of Marconi apparatus between the Dover Town Hall and the station at Wimereux. In October of the same year the International Yacht Races between the *Shamrock* and the *Columbia* were reported by wireless telegraphy off Sandy Hook. In November, 1899, a number of Marconi installations were, at the request of the War Office, dispatched to South

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Africa for use during the Boer War. In March, 1900, the Marconi system was adopted by the Norddeutscher Lloyd Steamship Company, and apparatus was installed on the Imperial Mail Steamer *Kaiser Wilhelm der Grosse*, on the Borkum Riff Lightship, and at the Borkum Lighthouse. The example of the Norddeutscher Lloyd was speedily followed by other shipping companies, among whom were the Belgian Mail Steam Packets, the Beaver and the Cunard lines. In July, 1900, the British Admiralty ordered 32 sets of apparatus, 28 for use on warships and four for Admiralty stations. A further agreement was made with the Admiralty in 1901, and this was again extended in 1903. The Marconi system is at the present time universally used throughout the British fleet and at Admiralty stations at home and abroad. Five stations were erected in the Hawaiian Islands and were opened for public service in 1901, and in the same year the Government of the Congo Free State ordered two stations to be erected, one at Banana in the Congo Free State, and the other at Ambrizette in the Portuguese colony of Angola. On June 1st, 1901, an agreement was made with the *New York Herald* Company for the installation of Marconi apparatus at Siasconsett Lighthouse and on the Nantucket Shoals Lightship, for the interchange of news between ships at sea and the *New York Herald* office. On September 26th, 1901, an important agreement was made with Lloyd's Corporation. The International Yacht Races were again in 1901 reported by the Marconi system.

The construction of the Poldhu high-power station was commenced in October, 1900, and on December 12th, 1901, Mr. Marconi succeeded in receiving at St. John's, Newfoundland, signals from the Poldhu station—distant 2,000 miles over sea. On February 22nd, 1902, Mr. Marconi left Southampton for New York on the s.s. *Philadelphia*, and during the voyage received on the Morse apparatus legible messages at a distance of 1,551½ miles, and distinct signals up to 2,099 miles from the Poldhu station. On March 17th, 1902, Mr. Marconi entered into an agreement with the Government of the Dominion of Canada, providing for the erection and working of wireless telegraph stations in Canada. In April, 1902, the Belgian Government arranged for the installation of Marconi apparatus on all of the Ostend-Dover mail packets, and at one land station. On December 21st, 1902, the first transatlantic messages were dispatched from the Canadian high-power station to Poldhu. In the following month messages were also transmitted to Poldhu from the transatlantic station at Cape Cod, United States of America. Arrangements were made in March, 1903, for the transmission by the Marconi system of American news for the London *Times*, and the first of these messages appeared on the 30th of that month. This service was eventually discontinued owing to the necessity for the provision of more powerful apparatus at the long-distance stations. In February, 1904, Marconi wireless telegraph stations were opened at Broomfield, Chelmsford, and at Amsterdam, for the transmission between the two countries of press messages and Stock Exchange quotations. On May 16th, 1904, an agreement was made with the Sicilian railways for the installation of Marconi apparatus at three of the railway company's stations. On June 4th, 1904, a daily service of wireless news messages all the way across the Atlantic was inaugurated on the Cunard R.M.S. *Campania*, and a daily newspaper is now regularly published on the principal Atlantic liners. On August 3rd, 1904, the wireless telegraph stations at Bari, in Italy, and Antivari, in Montenegro, were opened for public service. In 1905 the Chilian Government requested the Company to carry out a series of demonstrations with a view to the adoption of the Marconi system by the Chilian Navy. These resulted in an order being placed with the Company for a number of installations. On January 4th, 1905, messages for ships at sea were accepted at Post Offices throughout the United Kingdom. On May 30th, 1905, an agreement was made with Trinity House and the Board of Trade relating to the installation and working of Marconi apparatus on lightships and at lighthouses. Six lightships have already been fitted. In October, 1905, the construction of the new transatlantic station at Clifden was commenced. In May, 1906, a contract was made with the Post Office for the supply and erection of two stations in Scotland—at Tobermory and Loch Boisdale. On October 17th, 1907, the Marconi transatlantic system was opened for a limited press service. On February 3rd, 1908, the transatlantic service was opened to the general public for the transmission of messages between London and Montreal.

A list is also given of about 140 ships to which Marconi apparatus has been fitted, and the full text of Mr. G. Marconi's lectures given before the Liverpool Chamber of Commerce on February 24th, and at the Royal Institution on March 13th (see Electrical Engineering, March 19th, p. 430). The accompanying illustrations representing the standard equipment of Atlantic liners are taken from the former of these.

Threatened Telegraph Strike in America.—The *Electrical World* reports that the Commercial Telegraphers' Union intend to order a strike against the Western Union Company unless that company restores wages by June 1st. It is said that the Postal Telegraph Company will not be affected, as it did not pursue the course of the Western Union in reducing wages after the strike of last year.

ELECTRIC LOCOMOTIVES FOR THE DETROIT RIVER TUNNEL

A SHORT description is given in the *Electrical Review* (New York) of one of the six electric locomotives now being built for the Detroit River Tunnel Co. by the General Electric Co., and the American Locomotive Co. These locomotives will be used to haul both passenger and freight trains through the tunnel now being constructed under the Detroit River from Detroit to Windsor, Ontario.

They are moderately slow-speed machines, and weigh 100 tons on the drivers. The frame is of the articulated type, and can best be described as consisting of two four-wheel trucks hinged together. The trucks are of a very solid construction, with cast-steel side frames of truss pattern, carried on semi-elliptical journal-box springs. The diameter of the driving wheels is 48 in. The draw-bars are carried directly on the outer end frames of each truck, the two trucks being hinged together by substantial hinges and pins. By adopting this method of construction the pull of the locomotive is taken directly through the truck frames and the centre pins are relieved of all hauling strains. The superstructure consists of a cab, 15 ft. 6 in. in length, containing the controllers, valves, &c., in the centre of the vehicle, and the usual low sloping ends containing the contactors, rheostats, and air reservoir.

The electrical equipment of each locomotive consists of four GE-209 motors, and the Sprague—General Electric multiple-unit train control. Each motor will develop approximately 300 h.p., and at its hour rating will develop a tractive effort of 9,000 lb., at a speed of 12 miles per hour, while the complete locomotive is capable of hauling a 900-ton train up a 2 per cent. grade at the required schedule speed. The motors are of the commutating-pole type, and are among the largest units of this type yet constructed for railway work. The current will be supplied to the motors from an inverted third rail at a potential of 600 volts. On account of the heavy torque developed, which amounts to 4,050 lb. at a one-foot radius, a pinion is mounted on each end of the motor shaft. The motors will be cooled by forced ventilation, a blower having a capacity of 2,000 cubic feet per minute being installed in the main cab for this purpose. The compressor for the air brakes has a piston displacement of 100 cubic feet per minute.

The P. & O. Batti Wallah's Society.—A local section of this society of past P. & O. electricians has been formed at Birmingham, and a very successful smoking concert was held on Thursday, April 16th, under the chairmanship of Mr. J. P. Kemp. Full particulars as to the local section of the society may be obtained from Mr. G. Sheppard, Local Hon. Sec., 50 Alcerester Road, Moseley, Birmingham.

Institution of Electrical Engineers.—The following is the result of the ballot for new members at the meeting on Thursday:—*Member:* C. D. Burnet. *Associate Members:* F. S. Collings, I. Dalmer, J. H. Fossett, Captain R. C. Hammond, R.E., A. R. Low, L. Oulton, and W. E. Shuttleworth. *Associates:* G. B. Barham, E. T. Larner, and V. I. Stephens. *Students:* A. R. Alderson, C. G. Dickinson, J. H. Eddison, B. F. Hill, R. D. Norman, and J. Stephen.

Birmingham Electrical Division of the Territorial Force.—Negotiations are in progress for the acquisition of a site near the centre of the city for the erection of a permanent drill hall for the use of the three telegraph companies (see Electrical Engineering, April 2nd, page 524). Up to the present, 100 men, out of the total of 498 authorised, have been attested. Each of the eight detachments of the Cable Company will have a wagon and material for laying and working a 10-mile line, and each detachment of the Air-line Company will have material for erecting 10 miles of air-line.

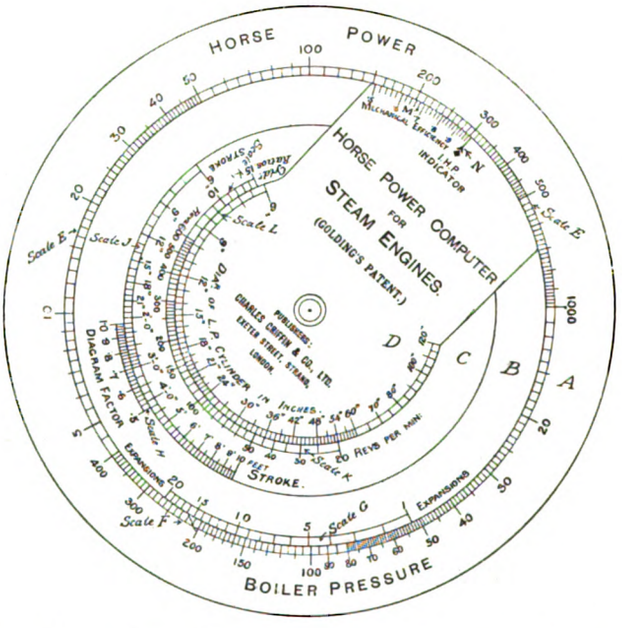
Glasgow Local Section of the Institution of Electrical Engineers.—At the ordinary meeting of the Glasgow Local Section of the Institution of Electrical Engineers held on April 14th, the following nominations for the officers and committee of the section were announced:—*Chairman:* Mr. W. W. Lackie (Chief Electrical Engineer, Glasgow Corporation). *Vice-Chairman:* Mr. S. Mavor (Messrs. Mavor & Coulson). *Chairman of Students' Section:* Dr. Magnus Maclean (Professor of Electrical Engineering, Glasgow and West of Scotland Technical College). *Honorary Local Secretary:* Mr. J. E. Sayers (Messrs. Sayers & Caldwell, consulting engineers). *Members of Committee:* Mr. Charles Day (General Manager, the Mirlees-Watson Co.), Mr. F. Newington (Chief Electrical Engineer, Edinburgh Corporation), Mr. J. K. Stothert (Messrs. Babcock & Wilcox, Ltd.), Mr. W. M'Whirter, Mr. J. S. Nicholson (Lecturer on Engineering Glasgow University), Mr. Joseph Taylor, Mr. Robert Robertson (Messrs. Strain & Robertson, consulting engineers), Mr. E. George Tidd (Messrs. Morris Warden & Co.), and Mr. J. Robertson.

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NEW SLIDE RULE FOR STEAM ENGINE CALCULATIONS

THE accompanying illustration represents an ingenious form of circular multiple slide rule for steam-engine calculations, which has been designed and patented by Mr. Henry A. Golding, and which will shortly be put on the market by Messrs. Charles Griffin & Co. The object of the instrument is to perform with rapidity various calculations connected with steam-engines, such as working out the power of an engine of given dimensions, or *vice versa*, to find the size and speed of an engine to develop a given power.

The instrument consists of four concentric discs, suitably engraved, and graduated with logarithmic scales to represent various quantities, such as boiler pressure, speed, size, and power. The outside disc A is provided with two scales E and F, the former representing horse-power and the latter boiler pressure in lbs. per square inch. The second disc B contains two scales G and H. The outer scale G represents the number of expansions employed, and the inner scale H is graduated for various values of the "diagram factor." The graduations of the scale G are proportional to $\frac{1+\log_e r}{r}$ where r represents the ratio of the number of expansions employed. For multicylinder compound engines the number of expansions is, of course, taken



from the cut-off in the high-pressure cylinder to the end of the stroke in the final cylinder. Similarly the value of the diagram factor H, used for compound engines, will be the combined diagram factor of all the cylinders, that is, the ratio of the total mean effective pressures in all the cylinders referred to the low-pressure cylinder, to the theoretical mean effective pressure obtained by expanding steam hyperbolically from the boiler pressure r times. The next disc, C, also contains two scales, J and K, the former of which on the outer edge represents the stroke and the inner scale the speed. This scale, with its extension K, can be also used as a scale of ratio of cylinder areas. The upper disc D also has two scales L and M, the former graduated upon the outer circumference to represent cylinder diameters (for compound engines, the L.P. cylinder), and an extension carrying the scale M to read off the scale E representing mechanical efficiency. Owing to the power of an engine being proportional to the square of the cylinder diameter, the base of the logarithm scale L is double the length of the base of the other scales.

The uses to which the instrument can be put are very numerous, but it is only necessary to consider one case in detail to show the general action. Suppose it is desired to find the I.H.P. of an engine, having given the size, speed, steam pressure, &c. The number of expansions on the scale G is first set against the boiler pressure on the scale F. The theoretical mean effective pressure is then read on the scale F opposite J on scale G. A suitable figure for the back pressure must be subtracted (about 3 lb. for condensing engines and 16 lb. per square inch for non-condensing engines). The given stroke on scale J is then set against a suitable value of the diagram factor, according to the type of engine employed. The diameter of the cylinder (a L.P. cylinder in a compound engine) on scale L is then set against the given speed on scale K, when the pointer N will show the I.H.P. on the scale E. The corresponding B.H.P. can then be seen against the figure for the mechanical efficiency. These operations, with a little practice, can be easily performed in a very small fraction of the time which would be taken for a succession of corresponding operations on an ordinary slide rule. Other operations which can easily be done by varying the order of the operations include finding the theoretical mean effective pressure for a given boiler pressure and number of expansions, finding the actual mean effective pressure for a given value of the diagram factor, finding the boiler pressure required for a given power, size of engine, and speed; given power, pressure, and size of engine, to find the speed required; given power, diameter, speed, and pressure to find stroke required; given power, pressure, stroke, and speed, to find the diameter of L.P. cylinder required.

A number of other minor calculations can also be made, and the apparatus should be of considerable use to engine designers in adjusting the variable quantities to suit given conditions, and an advantage over the ordinary slide rule is found in the fact that there can be no doubt as to the position of the decimal point. The actual value of the ratios of expansion, and also the diagram factor to be taken, vary somewhat with different boiler pressures and types of engines. They will generally be approximately known for the conditions in question, but Mr. Golding has prepared tables of values of these variables for most ordinary cases, which will accompany the instructions sent out with the instrument.

Electrification of German State Railways.—The Prussian State Railway authorities have decided to adopt electric traction on the main lines from Leipzig to Magdeburg and from Leipzig to Halle. The former has a length of 80 miles, the latter a length of 23 miles. The service will consist of short trains at frequent intervals.

Combination of Steel Tube Makers.—It is announced that Scotch steel tube makers have decided to amalgamate and to form themselves into one limited liability company. The leading firms in the combine are Messrs. Stewarts & Lloyds, Ltd., Messrs. David Richmond & Co., Ltd., and Wilson & Union Tube Co., Ltd., but it is expected that practically all the Scotch steel tube makers will join the new undertaking.

Manufacturing Sites.—There has been lately an increasing tendency for the decentralisation of manufacturing industries, and the establishment of works and factories in country rather than urban districts. This movement has been very marked in the districts served by the Great Western Railway, and attention has been called to the facilities that are to be found in the neighbourhood of Reading, Didcot, Banbury, Kidderminster, Oxford, and the South Staffordshire and South Wales districts, and more especially near London between Southall and Slough, where there are already some 40 new factories in full swing. In addition to the concerns which have migrated from towns in England, it is probable that the provisions of the New Patent Act will result in numerous foreign factories being transplanted to this country. In the districts mentioned, the incoming manufacturer not only obtains advantages of cheap land and labour, water, and light, but has also a choice of rail or water transport facilities for the import of raw material, ample railway services for distribution of the manufactured goods at reasonable rates of carriage, proximity to ports, freedom from harassing restrictions respecting buildings and labour, &c., and, what is of great importance, low rates and assessments. The annual saving is in most cases more than sufficient to warrant the capital expenditure in removal, and erection of new buildings.

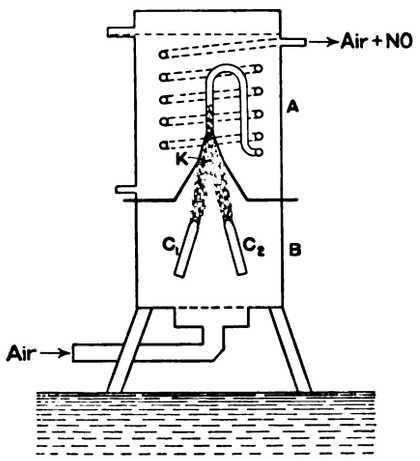
A Portable Electric Railway Sub-station.—In the course of an article on the system of the United Railways Co., of St. Louis, in the *Electric Railway Review*, a description is given of a portable sub-station used by this company for additional feeding of sections of the line where there is temporary heavy traffic. This sub-station contains one 600-kw., 600-volt, three-phase rotary, three single-phase transformers, together with the necessary auxiliary apparatus. The voltmeters and ammeters are so mounted that they can be easily disconnected and packed in a box of waste, which is kept in the car for this purpose. This was done because it was found that in jolting the car over special work the instruments were very liable to get out of order. This station consists of two cars, the car containing the rotary being equipped with four 50-h.p. motors, and the transformer car being hauled by this motor-car as a trailer. This portable sub-station has been extensively used for special traffic, and was also found of great use on one occasion when a portion of the continuous-current plant in the generating station broke down.

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ELECTROCHEMISTRY AND ELECTROMETALLURGY

A MEETING of the Faraday Society was held on Tuesday last week, when three Papers were presented. T. E. Weston and H. R. Ellis read a Paper upon "The Interaction of Aluminium Powder and Carbon." Experiments were carried out in order to ascertain the conditions under which aluminium would unite with powdered wood carbon, sugar carbon, and graphite. It was found that with each form of carbon, when mixed with finely-divided aluminium, reaction could be caused to take place by firing the mixture with a fuse of barium peroxide and magnesium powder. In all cases a mixture of Al_2O_3, AlN, and Al_4C_3 were produced. The carbide had the same formula as that obtained by Moissan in the electric furnace, and upon being decomposed with water yielded methane.

The second Paper was by Professor A. K. Huntington and Dr. C. H. Desch, upon "The Planimetric Analysis of Alloys and the Structure of Phosphor-Copper." In the microscopic examination of metallic alloys, a smooth surface is treated chemically in such a manner as to differentiate between the structural constituents. Either a difference in level is produced, which becomes visible on illumination, or the reagent may form surface films of oxide or sulphide, so that different colours are produced. Copper-aluminium alloys, which were found by analysis to



View of the Gorbov-Mitkievitch Furnace.

contain 9·26, 10·97, and 13·7 per cent. of aluminium respectively, were estimated by the above method to contain respectively 9·4, 10·2, and 13·7 per cent. Such an analysis can be carried out in little more than half an hour.

The third Paper was by Professor N. Piltschikoff upon "Technical Electrochemistry in Russia." There are three works which prepare bleaching powder and caustic soda, viz., Lubunoff, Solvay & Cie., Zabkowickie Electrochemical Cie., and the Russian "Elektron" Company. There are also several copper-refining factories—the Siemens Co. at Kalakaut, which, however, is at present shut down, and a factory at Moscow, which produces annually 500 tons of electrolytic copper, 1 ton of silver, and about 80 lb. of gold. Tin, nickel, and chromium are likewise prepared. In St. Petersburg there is a similar factory, which has been erected to produce copper from its ores. The method of Laschinsky is used. It has been observed that salts of iron, even in small quantity, are oxidised at the anode with formation of ferric sulphate,

$$2FeSO_4 + H_2SO_4 + O = Fe_2(SO_4)_3 + H_2O.$$

This reduces the current efficiency and lowers the quality of the deposit. Therefore, to avoid this oxidation, the plates which form the anode are coated with lead. The oxygen is thus used to form lead peroxide, and the iron is no longer oxidised. The copper is deposited smoothly up to 1·15 grm. per ampere hour. The study of the electrochemical combustion of air by the process of Gorbov and Mitkievitch is about to be carried out upon a technical scale. The furnace shown in the figure consists of a chamber, *B*, the upper part of which is formed by the funnel, *K*, which is connected to a worm, in which the combustion products can be cooled. The arc is struck between carbon or metal electrodes, C_1 and C_2, and fills the whole of the funnel. The arc is driven into the worm by a current of air. The air, therefore, has to pass through this arc before it is able to pass through the worm; here, however, it is immediately cooled, and thus the oxides of nitrogen, after they have been formed, are not again decomposed by the heat of the arc. Either continuous or alternating currents may be used; with three-phase currents three electrodes are required. The terminal voltage employed is from 1,000 to 3,000 volts, and across the arc it is from 600-1,500 volts. Professor Klobonkoff has perfected a method for tanning hides by the electric current, which prevents fermentation of the bath taking place. In St. Petersburg plant has been erected for the purification of water by means of ozone.

In the *Centralblatt für Accumulatoren und Galvanotechnik* of April 20th, the *English Patent* 8,284 of M. C. Thiellet and M. J. Denard for improving accumulator plates is described. It consists of mixing the lead oxide paste with a gelatinous mixture of silicic acid and then adding potassium chromate to it. When this is exposed to bright light, an insoluble compound of the bichromate and the gelatine is formed. The method of preparing it is to make a pulp of asbestos with sulphuric acid of 1·10 sq. gr. This pulp is then added to stronger acid and water glass (sodium silicate) added. The gelatine solution is then mixed, and finally the bichromate . This solution is then mixed with the active material, dried for an hour in the dark, when it forms a stiff paste, and then exposed to the sun. After exposure to the sun it is insoluble in water and in acids, but, being porous, is well suited for holding the lead peroxide.

In the *Zeitschrift für Elektrochemie* of April 10th, G. Baboroysky and B. Kuzma describe the preparation of silver peroxide. They find that the peroxide is not easily obtained if an anode of silver is employed in a solution of silver nitrate, but that it can be obtained with comparative ease by employing a platinum anode and carefully regulating the current density, so that it represents 0·07 ampere per square centimetre. They consider that silver pernitrate, $AgNO_4$, is first produced by the anodic oxidation of the NO_3 ions. This pernitrate then decomposes, two molecules of it yielding $2NO_3$ and silver peroxide thus :—

$$2AgNO_4 = Ag_2O_2 + 2NO_3.$$

ELECTRICAL SCIENCE

British and American

Properties of Selenium.—It is well known that a selenium "cell" varies in its electrical resistance when exposed to temperature change, to pressure change, to radium rays, to hydrogen peroxide, and to other influences, as well as when exposed to ordinary light. The question arises whether these resistance changes are due to the same ultimate property of selenium. In the *Physical Review* for April, this point is discussed by F. C. Brown and J. Stebbins. They have made an extensive series of new experiments on these phenomena, and some of their results and conclusions are of interest. Their experiments on the change of resistance produced by liquid pressure show that the change is about 0·05 per cent. per atmosphere, and that this value is a function of the E.M.F. used in measuring the resistance. Increase of pressure has a harmful effect on the sensitiveness of any selenium cell to light, at every pressure between one atmosphere and one hundred and sixty atmospheres. Temperature rises were found to have a similar effect on the light-sensitiveness. In either case the light-sensitiveness was a function of the initial resistance of the selenium cell. Within the limits of error of the experiments the rate of change of sensitiveness with resistance, whether the resistance changes through pressure or through temperature alterations, was the same for all the experimental curves obtained. Finally, the effect of radium and of hydrogen peroxide in decreasing the resistance of selenium was as much as 35 and 99 per cent. respectively, and the light-sensitiveness followed rules very similar to those mentioned above for the effects of pressure and temperature. The selenium cells used in the experiments were of three kinds, namely, those made by Ruhmer, by Giltay, and by the authors themselves, following Bidwell's directions. When exposed to light the conductivity of the first increased twenty times, of the second, seventy times, and of the third about nine times.

Continental

An Electric Hygroscope.—A distinctly novel device for the detection of minute traces of moisture is described by J. Pionchon, in the *Comptes Rendus* for April 13th. It is based upon the well-known property of a clean glass surface of attracting moisture in proportion to the moisture of the atmosphere in contact with it. A glass tube 10 cm. long, closed at one end, is silvered inside and out to within 1 cm. of the open end. The bottom is then cut off, leaving a fresh cut which separates the two silvered surfaces. This cut is the sensitive portion of the instrument. The cut is, however, not left in the rough state, nor fused, but is polished with fine emery. Wires are connected with the inner and outer coatings, and are inserted in a circuit containing a galvanometer and a battery of 100 volts.

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The deflection of the galvanometer is then found to vary greatly with the moisture of the atmosphere. The mere approach of a moist body affects it. The hand held at a distance of 1 cm. produces various effects in accordance with the part which happens to be near the sensitive surface. The back of the hand produces a deflection of, say, 3 or 4 cm. The point of a finger throws the spot right off the scale. The amount of moisture liberated by the heat of the hand from a paper tube is easily detected. A valuable property of the new hygroscope is the constancy of the zero, which is rapidly recovered.

Ionisation of Colloids.—Some light on the puzzling phenomena of the electric transportation of colloids is shed by the researches of A. Mayer and E. Salles, described in the *Comptes Rendus* for April 13th. As a typical colloid they used the trisulphide of arsenic, As_2S_3. It is usually supposed that the particles of the colloid solution are uniform in size, and have all the same electrical charge, if any. This would imply a uniform rate of transportation. Such a uniform rate is, however, not observed. In fact, the repulsion of one electrode is greater than the attraction of the other, so that if a small column of the colloid solution is enclosed in a long column of liquid, the front end of the repelled column advances less rapidly than the rear portion. The authors make it very probable that the whole motion is not due to any charge of the colloid particles themselves, but that these are dragged along by the motion of ordinary electrolytic ions evolved from them. There is no motion at all unless the E.M.F. suffices to produce traces of electrolysis. The speed grows more rapidly than the E.M.F. The addition of an electrolyte like KCl increases all the speeds. Besides, the preceding colloid may be observed to thicken, while the following colloid thins out. The electrolytic view is corroborated by observations with the ultramicroscope.

Longitude by Wireless.—In connection with the proposals recently brought before the French Academy by Bouquet de la Grye, E. Guyon quotes, in the *Comptes Rendus* for April 13th, a resolution adopted by the Bureau des Longitudes on January 22nd. The resolution, after referring to the gratifying success of the Morocco naval service and the hour signals from Camperdown (Halifax), draws special attention to the usefulness of the Paris-Brest hour service inaugurated by C. Tissot with the aid of the Eiffel Tower installation. The resolution further details the steps which would be necessary for the establishment of an international service for the determination of longitude at sea. A determination of longitude requires an observation of an astronomical phenomenon involving right ascension, such as the southing of the sun or a star, and a simultaneous reading of time. The difference in time between the chronometer reading and the time at which the same astronomical event takes place under the standard meridian is the longitude expressed in time. A wireless service of time would eliminate all errors involved in the rating of chronometers. Such a service can only be efficiently organised by an international committee of electricians and seamen. M. Guyon has been instructed by the Bureau des Longitudes to take the first steps towards the organisation of such a committee.

THE DEVELOPMENT OF THE TURBO-GENERATOR

Mr. G. G. Stoney devoted the first of his afternoon lectures on the development of the modern steam turbine and its application, at the Royal Institution on Tuesday, to the history and present state of the design of steam turbine-driven electrical generating sets, as manufactured by Messrs. C. A. Parsons & Co. At the outset he explained how the advantages of turbine plant over reciprocation engines are more particularly shown in the large sizes, and then proceeded to deal with the development of the steam portion of the set. He described the first Parsons turbine of 10 h.p., running at 18,000 r.p.m., made in 1884, and now in South Kensington Museum, and showed another set of the same design, the fifth to be constructed, which had been in regular service from 1885 to 1896. These machines were of the double parallel flow type. In connection with these very high-speed machines, the use of the Parsons flexible bearing with several loose concentric sleeves separated by films of oil for damping out vibrations was mentioned. Continuing the history, it was shown how the sizes of the machines increased and the speeds became less. The turbines were first run condensing in 1892, and soon afterwards sets were installed in several generating stations, including the Newcastle & District Co., Scarborough, and Cambridge. These machines were of a radial flow design, which was adopted owing to the temporary loss of certain patents, but on the recovery of these patents in 1894 the parallel flow type was reverted to. Several modifications were, however, made on the original designs; the principle of double flow was abandoned, and the balancing pistons introduced. Finer clearances and longer blades were able to be adopted, and a more compact machine with much improved efficiency resulted. A point which was specially mentioned was the advantage of parts where the clearance was small being as thin as possible, as the heat produced by any accidental touching was then a minimum, and serious trouble was avoided. The famous 350-kw. machines which solved the vibration troubles of the Metropolitan Electric Supply Co. at Manchester-square, were spoken of, and also the 2,000-kw. turbo-alternator erected at Elberfeld in 1900. With this progress the steam consumptions were greatly reduced, and with the 3,500-kw. sets at Carville a figure as low as 13·2 lb. per kw. hour had been recorded. A drawing of one of the 6,000-kw. turbo-alternators now under construction for Sydney was shown. Attention was particularly drawn to the effect or economy of a high vacuum in the condenser, and the Parsons vacuum augmenter was described.

After showing a collection of lantern slides of typical turbines, Mr. Stoney passed on to the consideration of the development of the electrical portion of the high-speed generating set, and commencing also with 7½-kw. machines of 1884, running at 18,000, he followed out the stages of development of the Parsons designs which we have already dealt with more fully in Electrical Engineering, April 9th, page 543, in connection with Mr. Stoney's recent Paper before the Institution of Electrical Engineers. The early experiments with compensating windings were spoken of, and the Gramme ring design used for a short time on account of patent troubles. It was in 1903 that the present form of compensating winding was used. A number of slides illustrating the various stages of the designs was shown, and, in conclusion, it was stated that steam turbo-alternators of 20,000-kw. capacity had already been designed in connection with the schemes for the power supply of London.

THE STRANG PETROL-ELECTRIC RAILWAY CAR

A good deal of attention is being paid in America to the development of petrol-electric cars for use on railway branches where the traffic is not sufficiently dense to warrant the use of steam trains or electric cars on short headway. One of the latest designs of car of this nature, which differs considerably from some other cars in use (see Electrical Engineering), is described in the *Electric Railway Review* (Chicago). The main feature of the "Strang" system is the employment of a battery somewhat after the manner of the "auto-mixte" system to assist the generator at times of heavy load. The generator and engine have a capacity sufficient for normal requirements, but when starting or when ascending a grade the storage battery takes care of the "peak" of the load. The storage battery is charged while the car is coasting down grades, coming to a stop or standing still; the gasoline engine running until it is automatically throttled as the batteries attain the full capacity.

The car measures 66 ft. over all, is 9 ft. 6 in. wide, and 14 ft. high. The interior of the body is divided into an engine-room, 13 ft. long, and two compartments, smoking and non-smoking. An observation platform is provided at the rear, which will seat five passengers. The total seating capacity is 75. The weight complete is 114,000 lb. The engine is of the vertical four-cycle type, having six cylinders, 10½ by 9 in., with a continuous rating of 150 h.p. at 425 revolutions per minute. The generator is of 85-kw. capacity at 250 volts. It is a direct-connected shunt-wound interpole machine. There are two interpole motors of 100 h.p. each, series-wound for 250 volts. The battery comprises 112 Planté type cells, having a capacity of 300 ampere-hours; General Electric type M control is fitted with connections for supplying current to a second car, and Westinghouse automatic air brakes. The cooling and heating system consists of an electricaally-driven centrifugal pump, which circulates the jacket cooling water through either the radiators on the roof or through the heating pipes in the passenger compartment.

In starting the engine power is fed from the storage battery to the generator, which, acting as a motor, drives the engine up to speed. The car carries sufficient petrol to run it 200 miles, and consumes about six-tenths of a gallon per mile.

The passenger compartments are heated by pipes connected with the water system. This car will maintain a speed of 55 miles an hour. It can be made the motor-car of a train, being capable of hauling three trailers carrying 75 passengers each. In the event of mishap the double system of power allows its batteries to carry it, for 15 miles if necessary, to a station. The car was built by the J. G. Brill Co. for the Strang Gas-Electric Car Co. of New York.

Accident on Barmen-Elberfeld Suspended Railway.—An accident in which five persons were slightly injured occurred on April 11th. An empty train ran into another train standing in a station, and damaged the cars considerably, but both trains remained hanging safely on the rail, although according to the *Elektrotechnische Zeitschrift* the stationary car was lifted and derailed. That the cars would fall in the event of a collision has been one of the objections to the introduction of such a mono-railway in Berlin (see Electrical Engineering, March 12th, page 405).

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published April 16th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

7,642. H. H. LAKE (*Parker Clark Electric Co.*). Carbon filaments and others having a negative temperature-coefficient tend to carry the greater proportion of the current through the central portion of the conductor, as the surface is more rapidly cooled and is consequently of a higher resistance. In order to work the surface of the filament at a high temperature, the filament may be constructed with a core of high resistance carbon, covered with a layer of combined non-crystalline silicon and carbon, and a final coating of dense, pure silicon. A plain cellulose or a graphitised filament is heated in the presence of a volatile silicon chloride, and a suitable gas for taking up the hydrochloric acid produced. To obtain the final pure surface deposit of silicon, a little CO_2 is introduced. A high operating temperature with a high efficiency is obtained with such a filament. Four claims, no figures.

8,153. BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). In order to drive a load at speeds varying over wide ranges, two motors are sometimes employed, one connected to the load through low speed gearing and the other connected to drive the load at high speed. To vary the speed of the motors, they are supplied from a motor-generator driven from the supply mains, and the generator voltage is varied. When changing from the low-speed to the high-speed motor, the voltage of the generator must be lowered from its maximum to its minimum value. This cannot be done quick enough, and according to the present invention, after the low-speed motor has reached its maximum speed, the generator (which is generating its maximum voltage) is connected in series with the high-speed motor to the supply mains. Current flows in opposition to the generator voltage, and drives the high-speed motor. The generator voltage is then gradually reduced, thus increasing the voltage and speed of the motor. By providing the generator with a series winding, which will oppose the main field when the generator and motor are in series, the voltage of the motor will be automatically increased with increasing load. By adding the generator voltage to the supply mains the speed of the motor may be further increased. Four claims, one figure

10,071. BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). A method of supporting the filaments of incandescent lamps, and especially suitable for tungsten filaments. The filaments are attached in the usual way to radial arms at the foot of the lamp, and the ends of the loops are supported by hooks at the ends of radial arms of copper or tantalum, the other ends of which are attached by means of glass beads to steel spiral springs, which in turn are supported in a vertical position on a glass pedestal rising from the foot of the lamp. Neither copper nor tantalum tends to combine with the tungsten filament, but if copper is chosen a relatively large diameter wire must be used, as otherwise the copper would melt at the point of contact. The flexibility of the support permits progressive contraction of the filaments, but maintains the proper tension on the filament. The filaments are also protected from jars during transportation. Three claims, one figure.

17,781. A. D. JONES. The enclosed flame arc-lamp, which was described in ELECTRICAL ENGINEERING, February 27th, 1908, page 299. Particulars of the composition in the grooves of the positive carbon were given in this Patent Record for March 5th, 1908, page 365. This specification further states that if a sodium steadying salt is added, an improvement is effected by the addition of a little potassium silicate; if a potassium steadying salt is used, sodium silicate may be added. One of these silicates diluted with water may be used as the binding material to hold the chemicals in the grooves of the positive carbon. The arc with a current of 5 amperes at 70 volts is about one inch long and quite thin. Five claims, three figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1906 Patent

26,560A. BURNS. Electrically-operated locks.

1907 Patents

539. RUHMER. Production of high-frequency arcs.
3,215. RUHMER. Apparatus for Hertzian telephony.
5,194. POSTANS. Electrical ignition apparatus.
7,687. WEBB. Radio-telegraphy and radio-telephony.
7,941. BEVIS & ANGOLD. Electric arc lamps.
7,941A. BEVIS & ANGOLD. Electric arc lamps.
7,959. HOWSON. Electric automatic fire alarms.
8,183. MERSHON. Alternating-current machines.
8,364. GES. FÜR DRAHTLOSE TELEGRAPHIE. Receivers for wireless telegraphy.
8,563. DEUTSCHE GASGLÜHLICHT AKT.-GES. (AUER GES.). Manufacture of metallic filaments for incandescence lamps.
8,641. BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Joints between lamp filaments and leading-in wires.
8,903. DAVIS. Electric lamp-holder.
9,868. ELECTRIC & ORDNANCE ACCESSORIES CO. & HALL. Circuit breakers.
11,381. SIEMENS BROS. & CO. & GRIMSTON. Electrical messenger call installations.
11,850. BOTTING & BOTTING. Electric sign switches.
12,402. GRIFFIN. Mechanism for magneto machines.
12,420. LANCASHIRE DYNAMO & MOTOR CO. & STANSFIELD. Dynamo-electric machinery.
12,907. NEWITT. Electrical counting gear.
12,960. MARCONI'S WIRELESS TELEGRAPH CO. & FRANKLIN. Receiving apparatus.
14,150. MOORE & POWLES. Electrical signalling.
14,287. BRITISH THOMSON-HOUSTON CO. & HOPPS. Self-propelled vehicles.
16,364. MAYO & HOULEHAN. Multiple fuse blocks.
16,385. APPLEYARD & QUIGGIN. Electric light fittings.
16,489. SIEMENS & HALSKE, AKT.-GES. Manufacture of a plastic mass from tungsten compounds.
16,513. WISE (*Mailloux*). Apparatus for cooling electric machinery.
17,655. HEYS (*Scott Electrical Co.*). Arc lamps.
17,686. STONE. Space telegraphy.
18,045. FELTEN & GUILLEAUME-LAHMEYERWERKE AKT.-GES. Inverted repulsion motors.
21,087. COOMBS. Diaphragms for telephonic apparatus.
21,408. THOMPSON (*Ges. fur Drahtlose Telegraphie*). Detector for wireless telegraphy.
22,259. ETCHELLS. Controlling locks for electric lifts.
22,349. ETCHELLS. Electric switches.
23,709. UNDERWOOD & SMITH. Dynamo-electric machines.
23,756. DIEHL & BECKER. Electric fans.
24,212. JOHNSON (*Felten & Guilleaume-Lahmeyerwerke Akt.-Ges.*). Electrical targets.
24,702. RENNERT. Electrical fire-alarm systems.
25,187. BRAUN. Bathing tubs for electrical treatment.
26,530. GES. FÜR DRAHTLOSE TELEGRAPHIE. System of radio-telephony.

1908 Patents

559. DRÄGER & DRAGER. Lamps for miners' helmets.
879. HUBBELL. Holders for electric lamps.
2,676. LOEBL & BRITISH EVER READY ELECTRICAL CO. Holders for electric lamps.
7,041. RUHMER. Production of electric impulses of high frequency.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patents

19,477. GAIFFE. Rotary mercury interrupters.
28,649. METALLURGISKA PATENTAKTIEBOLAGET. Magnetic separation of ore.

1908 Patents

7,289. SIEMENS-SCHUCKERTWERKE GES. Regulation of alternating-current commutator machines
7,480. SIEMENS & HALSKE AKT.-GES. Method of testing electrolytic valve cells.
7,493. FESSENDEN. Telephonic transmitters or relays.
7,494. FESSENDEN. Wireless telegraphy.
7,507. OERTLY & DUDLEY. Electrically-heated tools.
7,621. ATELIERS THOMSON-HOUSTON. Alternating-current repulsion motors.

Expiring Patent

The following patent expires during the current week, after a life of fourteen years:—

8,607, of May 1st, 1894. (Amended 1899.) W. P. THOMPSON (*A. E. Keith*). A mechanism for use in automatic telephone exchanges, and consisting of a series of wires for electrically interconnecting the several exchanges. A shaft, on which is carried a series of switch arms disposed radially at different angles, and which is capable of rotation and longitudinal movement, is actuated by suitable mechanism to bring the switch arms in contact with any one of the series of wires. Five claims, three figures.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ltd.	10	7	7%	10¾—11¾	
Do. 4½% Cum. Pref.	10	4½	4½%	10—11	
Do. 6% Cum. Second Pref.	10	6	6%	10¼—11	
Do. 4½% Debenture, Red.	Stock	4½	4½%	102—105	
Bromley (Kent) E.L.& Power Co., Ltd.	5	5½	5½%	4½—5 xd	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	96—99	
Brompton & Kensington E. S. Co., Ltd.	5	10	10%	7¼—8¼	
Do. 7% Cum. Pref.	5	7	7%	6¾—7¾	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	98—101	
Ch. Cross. W. E. & City E. S. Co.	5	5	5%	3⅝—4½	
Do. 4½% Cum. Pref.	5	4½	2½%	4½—4¾	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	4—4½	
Chelsea Electric Supply Co., Ltd.	5	4½	4½%	3—3½	−⅛
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9¾—10½	
Do. 6% Cum. Pref.	10	6	6%	11¾—12¾	
Do. 5% Deb. Red	Stock	5	5%	123—125	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	101—104	
City of Durham E. P. Dis. Co.	5	4	2%	3—3⅜	
Do. 5% Pref.	5	5	5%	4¼—4½	
County of London Elect. Sup. Co. Ltd.	10	5	5%	7⅜—8¼	
Do. 6% Cum. Pref	10	6	6%	10¾—11½	
Do. 4½% Deb. Red	Stock	4½	4½%	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	98—101	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	¼—1¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	52—57	−5
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4⅜—5⅛	+⅛
Do. 5% Cum. Pref.	5	5	5%	4¼—5⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8¾%	6¼—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	92—95	
Kensington & Knightsbridge E.L.Co.	5	10	10%	7⅜—8¾	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N't'ng Hill E.L. Cos. Db. Rd.	Stock	4	4%	97—101	
London Electric Supply Corporation	3	4	2½%	1—1½	
Do. 6% Pref.	5	6	6%	4½—5	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6½%	4⅜—5¼	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E.Corp.for P.Dist.1stMt.D.	100 & 500	4½	4½%	96—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	9¼—10¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	8%	5⅜—6¼	
Do. £2 Pm.	5	8	8%	5⅜—6¼	
Do. 5% Pref. (fully paid)	5	5	5%	5¼—5⅜	
Do. 10/- Pm.	5	5	5%	5¼—5⅜	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7%	5¾—6⅜	
Do. 4% Deb. Red.	Stock	4	4%	93—95	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7¼—8¼	
Do. 7% Non-Cum. Pref.	5	7	7%	6¼—7	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—1⅛	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4%	2⅜—2⅞ xd	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅜—⅝	
Do. 7% Cum. Pref.	1	7	7%	1¼—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5%	1⅜—2¼	
Do. 5% Cum. Pref.	5	5	5%	1⅜—2¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¼—8	
Do. 4½% Cum. Pref.	5	4½	4½%	4¼—5¼	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	89—92	
Central London	Stock	4	3%	75—78	
Do. 4% Preferred.	Stock	4	4%	84—86	+1
Do. Deferred.	Stock	4	2%	54—57	
Do. 4% Debentures.	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pr. Deb.	Stock	4	4%	81—84	
City and South London Cons.	Stock	2¼	4¼%	39—41	
Do. 4% Perp. Deb.	Stock	4	4%	101—104	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1896	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11s6d.	¾—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4%	6—7	
Do. 4% Perp. Deb.	Stock	4	4%	87—90	
Mersey Cons.	Stock	nil	—	2—4	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	½%	42½—43½	−1
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	76—79	
Do. 3½% Convertible Pref.	Stock	3½	3½%	73—76	
Metropolitan District	Stock	nil	—	11¼—12¼	−½
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Deb.	Stock	4	4%	no price	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pr. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co of London 5% Profit Sha. Sec. Notes	Various	5	5%	36—40	−3
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅜—⅝	
Do. 5% Cum. Pref.	1	5	5%	¼—⅜	
Do. 4½% Deb. Red.	Stock	4½	4½%	89—94	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	4—4½	
Do. 5% Perp. Deb.	Stock	5	5%	90—95	−1
Do. 4½% 2nd Deb.	Stock	4½	4½%	71—75	−1
City of Birmingham Trs. Co., Cm. Pf.	5	5	2/6*	4½—5	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	97—100 xd	

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%	%		
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	94—97	−1
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	⅜—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	1⅝—1⅞	
London United Trs., Ld., Cm. Pf.	10	5	5%	6½—7⅜	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—85	
Manx Electric R. Co., 5½% Cm. Pf.	5	5½	5½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	85—90	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—1/8	
Do. 5% Cum. Pref.	1	5	5%	¼—⅜	−1/16
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	94—97	−1
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—½	−1/16
New General Tr. Co., 6% Cm. Pf.	5	nil	—	¼—1	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9¾d*	¼—⅜	
Do. 5% Cum. Pref.	1	5	5%	¼—⅜	
Do. 4½% Deb. Red	Stock	4½	4½%	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4¾—5¼	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6%	¾—1	−⅛
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1⅛	
Do. 6% Cum. Pref.	5	nil	—	3—3⅛	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅜	15/-*	55—58 xd	
Do. 6% Pref. Crd.	Stock	6	30/-*	98½—100½xd	
Do. Def. Ord.	Stock	1⅜	1%	13⅜—13⅝	−⅛
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3¼—3½	
Do. 10% Cum. Pref.	5	10	10%	8¾—9¼	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4½	4/-*	13⅜—14 xd	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99½—101½	+½
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	99—101	
Do. do. (Mauritius Sub.)	25	4	4%	100—102	
Eastern Ext. Australasia & China	10	7	7/6	13—13½	+⅛
Do. 4% Mort. Deb. Perp.	Stock	4	4%	99—102	
Eastern Telegraph Co.	Stock	5½	7%	131—136	+1
Do. 3½% Pref.	Stock	3½	3½%	84—87	
Do. 4% Mort. Deb.	Stock	4	4%	101—104	
G. N. Tel. Co. (Copenhagen)	10	20	20%	31½—33½	
Indo-European Telegraph Co. Ltd.	25	13	65/-	55—5⅝	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅜—½	
National Telephone Co., Ltd., Pref.	Stock	6	6%	107—109	
Do. Deferred	Stock	5½	6%	108½—110½	+½
Do. 6% Cum. 1st Pref.	10	6	6%	10½—12½	+½
Do. 6% Cum. 2nd Pref.	10	6	6%	10½—12½	+½
Do. 5% 3rd Pref.	5	5	5%	5⅜—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	98—100	
Do. 4% Deb. Red.	Stock	4	4%	101½—103½	
West African Telegraph Co. Ltd.	10	4	4%	10—10¼	
Western Telegraph Co., Ltd.	10	7	7%	13½—13¾	
Do. 4% Deb.	Stock	4	4%	99—102	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	6%	½—⅝	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅜—3⅝	
Do. 6% Pref.	1	6	7½d	1⅞—1⅝	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	6½—6⅝	
Do. 6% Cum. Pref.	5	6	6%	5⅝—6½	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	95—100	+1
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅜—⅝	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—½	
Do. 6% Pref.	2	nil	—	⅞—1⅛	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	74—79	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	59—64	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10¼—11½	
Do. 5% Cum. Pref.	5	5	5%	5¼—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106½—108½	
Consolidated Electrical Co., Ltd.	1	3	3½%	7/8—1	
Crompton & Co., Ltd.	3	5	5%	1⅜—1⅝	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1¾—1⅞	
Do. 6% Cum. Pref.	1	6	6%	1—1¼	
Do. 4½% Deb. Red.	Stock	4½	4½%	100—103	
Edison & Swan United "A." £3 paid	5	4½	2/6	3—3⅛	
Do. do (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	¾—⅞	
Do. 7% Cum. Pref.	2	7	—	1¼—1⅜	
Do. 4½% 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8½	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10½—11½	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—5⅜	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	30½—32½	
Do. 4% Deb. Bds. Red.	100	4	4%	100—103	
White (J. G.) & Co., 6% Cum. Pref.	10	7	7%	8—9	
Willans & Robinson. Ord. Shres	1	nil	5%	1—1¼ xd	
Do. 6% Cum. Pref.	5	nil	6%	3⅜—3¾ xd	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

ABERDARE: *Electric Lighting.*—The Town Clerk has been instructed to engage a consulting engineeer to report to the Council upon an electric lighting scheme.

ARGENTINE: *Electric Supply.*—The *Review of the River Plate* states that the electric light station in Necochea was inaugurated on the 8th inst. A local company is being formed in Daireaux, Province of Buenos Aires, for the electric lighting of that town.

AUSTRALIA: *Sydney Power-house Management.*—The second report of Mr. G. A. Julius, the expert chosen to inquire into certain matters in connection with the operation of the Sydney City Council's electric lighting scheme, has been made public. This report, says the *Australian Mining Standard*, deals with the question of aldermanic influence; and the conclusions arrived at are summarised as follows:—That the plant in the power-house in August, 1906, was in a moderately good condition, but in view of the rapidly increasing output the city electrical engineer was entirely justified in recommending the appointment of a power-house superintendent to direct and supervise the maintenance and running of the plant; and that during the latter part of 1907 the plant was allowed to fall into very bad condition. The report absolves the Council from blame for interference, and refers to laxity of experience and administration on the part of certain officers. Following on the discussion of the report by the City Council, the Lord Mayor presented a minute recommending that the services of the power-house superintendent be dispensed with, and that Mr. Woof, now in charge of the overhaul of the plant for Messrs. Dick, Kerr & Co., be appointed at a salary of £400 per annum, to be increased on a sliding scale to £500. The minute was adopted.

BARKING: *The Tramway Losses.*—At the last meeting of the Council, the chairman of the Tramways Committee was asked what measures he contemplated to do away with the enormous losses on the running of the trams. The chairman said there was to be a meeting to go into the whole question.

BEDFORD: *Incorporated Municipal Electrical Association.*—The Corporation has delegated the Chairman of the Electricity Committee and the Borough Electrical Engineer to attend the annual conference of the Incorporated Municipal Electrical Association at Nottingham from June 30th to July 3rd.

BELFAST: *Third Party Insurance.*—The Corporation has refused to join a conference proposed by the Halifax Corporation on the question of a mutual insurance scheme against third party tramway risks, for the reason that up to the present the Belfast Tramways Committee has not insured against these risks.

BEXLEY: *Electric Supply Tariff.*—At the last meeting of the Urban District Council the Electric Lighting and Traction Committee reported that they had had under consideration the desirability of instituting an alternative daylight tariff for supply to motors, and they recommended the following tariff:—Up to 2,000 units, per annum, 3d. per unit; from 2,000 to 2,500, 2¾d. per unit; from 2,500 to 3,000, 2½d. per unit; from 3,000 to 5,500, 2¼d. per unit; above 3,500, 2d. per unit. Minimum charge to be £2 13s. 4d. per annum, and charges to be net. Meter rents to be charged in addition, at the same rates as on the existing daylight tariff, and the new tariff to be governed in all other respects by the regulations applying to the former. The report and recommendation were adopted.

BLACKBURN: *Blackburn, Padiham & Whalley Light Railways.*—It is proposed by the Light Railways Commissioners to hold a public inquiry at the Blackburn Town Hall on Friday, May 8th, into the application of the Blackburn, Padiham, & Whalley Light Railways Co. for an order for revival and extension of time.

BLACKPOOL: *Electricity Profits.*—The profit upon the municipal electricity undertaking for the year ended March 31st amounts to £8,476. The output was 3,404,511 units, an increase of 300,000 over the number for the previous year, and it is to be noted that the largest increase in the consumption was for the private lighting. In spite of the largely increased output, the coal consumption was only 153 tons more than in the previous year. The total income was £36,585, generation and distribution charges amounting to £16,140, and interest and sinking fund to £11,969. The capital expenditure to date amounts to £199,052; reserve fund now amounts to £13,151.

BURY: *Tramway Committee's Chairman.*—Col. Hall, the Chairman of the Tramways Committee, has resigned, partly on account of ill-health and partly owing to calls upon his time in other directions.

The net profits of the Bury tramway system for the year ended March 31st were £4,606 as against £5,225 for the previous year. The Tramway Manager points out that the difference is more than accounted for by the fact that the Easter holiday traffic is not included in the accounts for 1907-8. As the agreement with the Heywood Council with regard to the tramways will shortly expire, the Outside Authorities Sub-Committee have been instructed to meet the Heywood representatives with a view to its renewal.

Electricity Accounts.—The net profit for the year ended March 31st, 1908, are estimated at £3,950 against £2,947 for the previous year.

Incorporated Municipal Electrical Association.—The Chairman of the Electricity Committee and the Electrical Engineer have been requested to attend the annual conference of the Incorporated Municipal Electrical Association at Nottingham from June 30th to July 3rd next.

CARDIFF: *Tramway Employees.*—The local branch of the Amalgamated Association of Tramway and Vehicle Workers has asked the Tramways Committee to agree to the formation of a Conciliation Board to deal with all matters relating to the tramway employees which cannot be amicably settled by the tramway manager. Mr. Arthur Ellis, the tramway manager, stated at the meeting of the Tramways Committee last week that hitherto there had been no trouble or misunderstanding with representatives of the tramway men's Union, who now discussed all matters with him. If the suggestion of a Conciliation Board were adopted, he foresaw that the men's Union might not acknowledge his authority if he, for instance, dismissed a man for neglect or misconduct, and they would be constantly appealing to the Board. After a little discussion it was decided to ask the Association to explain more fully what their request was.

COWDENBEATH: *Public Lighting.*—The Fife Electric Power Co. has made two offers in connection with the public lighting in this district. In the first, the company offer to erect 20 1,500 c.p. arc lamps, to supply the necessary cables and connections, and to maintain them, for an inclusive sum of £12 per lamp per annum. For incandescent lighting they propose to supply the lamps and pillars, and maintain them for the sum of 38s 9d. per lamp per annum on a 10 years' contract. These offers have been submitted to a committee for consideration.

CROMER: *Electric Lighting Committee.*—An Electric Lighting Committee has been appointed to take charge of the department. Hitherto this work has been carried out by the Highways Committee.

DARWEN: *Tramways and Electricity Profits.*—There has been a profit on the Darwen electricity and tramway undertakings for the year ended March 31st of only £600, alleged to be due to the rise in the price of coal, and other circumstances. The profit of the Electricity Works alone amounted to £100.

DUBLIN: *International Exhibition.*—In Dublin last week a sale was held of the electrical plant and fittings which were used at the recent international exhibition. The plant included switchboard and instruments, rubber-covered and lead-covered cables, electroliers, brackets, and fittings.

EDINBURGH: *Incorporated Municipal Electrical Association.*—The Electric Lighting Committee recommend the appointment of the Convener, Mr. A. Murray, and Bailies Stevenson and Neill, together with the Electrical Engineer, to attend the annual Conference of the Incorporated Municipal Electrical Association at Nottingham from June 30th to July 3rd.

Electric Lighting Estimates.—The estimated expenditure upon the electricity undertaking for the year ending May 15th, 1909, is £70,230, compared with £65,040, the amount of the expenditure during the current year. Interest and sinking fund are estimated to require £56,070 against £50,065, giving a total estimated expenditure of £126,300, compared with £121,105. The estimated revenue is £136,200 against £132,585, leaving a surplus of £9,900, compared with the estimated surplus of £11,408 at the end of May 15th next. The capital expenditure is put at £33,090, mainly in regard to alterations and additions at the Macdonald Road station.

International Exhibition.—The National Telephone Co. has provided a 50-line switchboard in connection with the International Exhibition. A number of call offices have been erected in the grounds, in addition to two in the Industrial Hall and one in the Machinery Hall. Arrangements have been made for users to be able to communicate with each other in the exhibition or with any part of the city, and trunk connections can be had through the main exchange in Edinburgh.

Underground Telegraphs.—The Postmaster-General has intimated to the Town Council that he will consent to the use of the telephone ducts in certain streets for the purpose of the underground telegraph wires, although there are serious drawbacks to this course, in view of extensions.

ERITH: *Tramways Intercommunication.*—The Urban District Council, having received from the London County Council a plan showing the proposed temporary terminus of the London County Council tramway at Abbey Wood, is to ask the County Council their reasons for suggesting to make the present terminus at a distance of about 80 ft. from the county boundary, and to point out that it is most desirable for the convenience of through passengers that the tramways of the London County Council and the Erith Council should actually be joined up at the county boundary, as provided by the London County Council (Tramways and Improvements) Act, 1904. The Woolwich

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Borough Council has also protested against the County Council's proposal with regard to the terminus.

FALKIRK: *Proposed New Tramways.*—A letter has been received by the Council from the Secretary of the Falkirk & District Tramways Co. in regard to the recent request made by a deputation of ratepayers to extend the tramways to Laurieston. The company state that it is impossible for them to construct the extension unless the local authorities are prepared to grant facilities. The tramway undertaking has not been a financial success, owing to the heavy wayleaves and operating charges for bridges, and the directors are unwilling to incur further capital expenditure except upon terms which promise reasonable profit. In return for extending the tramways, the company make certain propositions, including the withdrawal of the wayleaves in respect of the tramways in the borough, and that they be also relieved from local rates in respect of the extension. The Council has unanimously decided that the terms proposed cannot be entertained.

FRANCE: *Electric Cranes.*—The facilities of the port at St. Nazaire are to be increased by the construction on the quay of the Penhouet dock of an electric crane with a lifting power of 180 tons. This crane will be able to lift 180 tons to a height of 145 ft. above the quay level, and take it a distance of 34 yards outside the quay. The arm of the crane will be fitted with another rolling crane of 15 tons lifting power.

HASLINGDEN: *Workhouse Lighting.*—The General Purposes Committee of the Haslingden Guardians decided last week-end to furnish each member with the report of Messrs. Peers, Copeland & Cardin, as to a scheme for the lighting of the workhouse and new infirmary by electricity. At the meeting on April 23rd, the following amended terms for the supply of electricity for the lighting of the workhouse buildings were submitted by the Rawtenstall Corporation. For 15,000 units, 4½d. per unit; for 20,000 units and over, 4¼d. per unit; for 25,000 units and over, 4d. per unit. The Corporation agreed to lay and maintain the necessary cables, and were prepared to enter into an agreement for five years in the first place, subject to termination at any time by six months' notice on either side. It was resolved that further consideration of the matter be deferred until a deputation had met the Corporation's representatives.

LANCASTER: *Tramway Fares.*—A recommendation by the Tramways Committee in favour of halfpenny fares on certain routes, and a penny universal fare on other routes, was negatived at the last meeting of the Town Council in favour of a reversion to halfpenny stages without overlapping.

LEEDS: *Tramway Accounts.*—The accounts for the year to March 31st show a gross profit of £163,051, an increase of £6,470 over the figures of the previous year. Working expenses amounted to £177,317, and out of the balance has to be deducted income tax and interest on capital, leaving a sum of £123,538, from which the following amounts are deducted :—Sinking fund, £37,452; permanent way renewals, £21,252; and amounts written off Provisional Orders, £385; leaving £64,246 to be transferred to the city fund in aid of rates compared with £69,262 in 1907.

LONDON: *St. Pancras: Highgate Hill Tramways.*—In reference to a request by the London Council Council that, in the event of the County Council taking over the Highgate Hill Tramways, St. Pancras Borough Council should undertake to maintain portions of the road in the Borough outside the tramways area, the General Purposes Committee express the opinion that the request should not be acceded to.

Woolwich.—The Law and Parliamentary Committee recommend that counsel be reserved in the House of Lords in opposition to the London and District Electric Supply Bill and the London Electric Supply Bill.

MUSSELBURGH: *Public Lighting.*—The Town Council held a special meeting last week to discuss, with the representatives of the Musselburgh Electric Light & Traction Co., the question of the defective public lighting of the town. The representatives of the company complained that the fault lay with the lamps, which were the property of the Council, and it was not within the province of the company to take these out and put in others. After some discussion, the Council requested the company to submit proposals for the betterment of the existing state of things, and the company's representatives were reminded of the Council's threat to revert to gas lighting.

PLYMOUTH: *Incorporated Municipal Electrical Association.*—Mr. E. G. Okell, the Borough Electrical Engineer, will attend the annual conference of the Incorporated Municipal Electrical Association at Nottingham in June.

Third Party Insurance.—A communication has been received from the Halifax Corporation Tramways Committee inviting the Council to appoint delegates to attend a Conference on third-party insurance with a view to formulating a mutual scheme. It was decided that the members of the Tramways Committee should be notified of the date of the proposed Conference, and that if any of them, or the Town Clerk, should be in London at the time, they might attend as representatives of the Corporation.

RADCLIFFE: *Depreciation.*—It is recommended that the Council should base the charges for depreciation upon the electrical plant in future on the following rates, less the amount of contributions to sinking fund, viz.: Buildings, 2½ per cent.; machinery, 5 per cent.; switchgear, accumulators, meters, motors, and mains, 7½ per cent.

ROTHERHAM: *Electricity Accounts.*—The receipts from the electricity undertaking during the year ended March 31st, 1908, amounted to £13,108, an excess over the previous year of £1,999. The total number of units sold was 1,698,174, representing a gross receipt of 1·652d. per unit. Generation, distribution expenses, rates, and management charges amounted to 0·88d. per unit, compared with 0·87d. for the previous year. After meeting capital charges there is a surplus of £3,302, from which is deducted £1,960 for depreciation and renewals, leaving the sum of £1,342 net profit.

Tramways Accounts.—The gross receipts from the tramways department amounted to £31,653, representing 11·55d. per car mile. There is an increase of £4,737 over the receipts for the previous year. The expenses are considerably higher than those of the previous year, owing to renewals. The traffic expenses amounted to £8,124, and after debiting the whole of the working expenses and repairs there is a balance of £10,330, from which has to be deducted capital charges. The net surplus, subject to provision for renewals fund, is £5,618. The Tramway Manager calculates that the proper sum to be set aside for renewals is £4,898, but inasmuch as in his opinion the sums set aside for the previous years is inadequate, he recommends that the whole of the surplus be retained for this purpose.

SALFORD: *Damages for Tramcar Accident.*—At the Manchester Assizes on Monday a widow named Elizabeth Ball was awarded £200 damages in respect of the death of her husband, who was killed by a Salford Corporation tramcar on November 9th last.

TORQUAY: *Dolter System.*—Mr. Pringle has inspected the Torbay route on behalf of the Board of Trade, and expressed his satisfaction with it.

WALTHAMSTOW: *Charge for Tramway Energy.*—The Council, at its meeting on April 24th, decided, on the recommendation of the Rate Committee, that a charge of 1⅝d. per unit be made to the light railways undertaking for the current consumed for the year ended March 31st last.

TENDERS INVITED AND PROSPECTIVE BUSINESS

AUSTRALIA.—The Board of Trade correspondent at Melbourne (Mr. M. Hirsch) has forwarded particulars of a call for tenders for the supply to the Deputy Postmaster-General at Melbourne of 2,800 jacks in strips of 20; 1 mile of 64-wire switchboard cable; 50 three-conductor cords, 7 ft. long; 96 three-part plugs; and 66 listening and ringing keys. Tenders will be received by the Deputy Postmaster-General, Melbourne, up to 3 p.m. on June 9th.

The Board of Trade are notified by the London representative of the Australian Commonwealth (Capt. R. Muirhead Collins, C.M.G.) that tenders will be received at the office of the Deputy Postmaster-General, Perth, until noon on Monday, September 7th, for the supply of the following telephone material, viz.: 650 wall sets, 150 table sets, 800 protectors, 90 extension switch and bell sets, complete, 30 switchboards for four lines, 20 switchboards for six lines, 5 switchboards for twelve lines, 5 switchboards for twenty-four lines, 20 wall sets for party lines, and 10 table sets for party lines. Tenderers must state the country in which the articles tendered for have been made or produced, and, in the case of manufactured articles, where the material has been made or produced. Tenders must include customs duty, if any. A deposit, equal to 5 per cent. of the amount of the offer, will be required to qualify any tender. Specifications, conditions, and forms of tenders may be obtained at the Commonwealth of Australia Offices in London, 72 Victoria Street, S.W.

Tenders for the following are invited by the Deputy-Postmaster-General, Sydney :—Supply and delivery of eight tons of hard-drawn copper wire (400 lb. per mile), 1½ cwt. of copper tape binding (200 lb. per mile), 1,300 best white large porcelain insulators, and 2,000 tallow-wood crossarms, 5 ft. 2 in., by June 10th, and the supply, delivery, and erection of a branching metallic multiple magneto switchboard by August 12th. Specifications, conditions, and forms of tender may be obtained at the Commonwealth Offices in London, 72 Victoria Street, S.W., where also preliminary deposits on tenders may be paid.

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BEDFORD.—Electrical sundries are to be purchased to the value of about £130.

BIRMINGHAM.—A Local Government Board inquiry was held on Tuesday into the application by the Corporation for sanction to borrow £251,285 for extensions to the electricity undertaking. The proposed loan will be split up amongst the power station and sub-station as follows:—Summer Lane station, £183,635; Water Lane station, £17,300; Dale End, £15,000; sub-stations, £14,850. £20,000 is proposed to be utilised for motors, and £4,000 for meters. Under the scheme of extensions, the Dale End station will be abandoned for generating purposes, and converted into a sub-station. At the Summer Lane generating station it is proposed to add a 1,500-kw. direct-current and a 1,500 alternating-current set each year, in order to deal with the gradual development of the load, and in this way it was explained to the Local Government Board inspector that the whole of the money would not be expended at once. Of the total of ten new boilers, however, six will be installed during the current year. A reserve coal bunker, bringing the total storage from 2,000 to 3,000 tons, is also to be erected. It was stated that the generating expenses at Dale End were 2·1d. per unit, against 0·284d. per unit at Summer Lane.

BRIGHOUSE.—A Local Government Board inquiry will shortly be held into an application by the Corporation for sanction to borrow £3,600 in connection with extensions to the electricity undertaking. An arrangement has been made for supply in bulk from the Yorkshire Electric Power Co.

BURNLEY.—A Local Government Board Inspector will hold an inquiry to-morrow relative to the borrowing of £12,500 for public baths, and £26,460 for the purposes of the electrical undertakings.

CHELTENHAM.—Tenders are invited for an electric lighting installation at the new refuse destructor works. Full particulars from the Borough Surveyor, and tendes by May 2nd.

COLNE.—A Local Government Board inquiry will be held to-morrow at the Town Hall into the application of the Corporation to borrow £4,170 for electric lighting purposes.

DARLINGTON.—Tenders are invited for a Lancashire boiler and superheater. Particulars from the Borough Electrical Engineer (fee £1 1s., returnable), and tenders to the Town Clerk by May 11th.

DUNDEE.—The Tramways Manager has submitted a report upon a circular tramway in the town, of an approximate length of 2½ miles. The estimated cost of constructing a double line on the overhead system is put at £28,500, in addition to an allowance for street widenings. The estimated revenue is put at £2,738, and the cost of working and maintenance at £7,690, thus showing a deficit of £4,592. If a single line were made over a somewhat shorter route the cost is put at £10,900, the revenue at £1,870, and the working expenses at £2,149. The report has been circulated amongst the committee, and will be considered at a subsequent meeting.

EAST HAM.—Tenders are invited for the reconstruction for electric traction on the overhead system of the existing horse tramways between High Street North and Green Street, Romford Road, including the permanent way, paving, and overhead line construction. Full particulars from the Borough Engineer, Mr. A. H. Campbell, or the Tramways Engineer and Manager (fee £2 2s., returnable), and tenders to the Town Clerk by May 5th.

ILFORD.—At a Local Government Board inquiry into the application of the Urban District Council to borrow £27,000 for purposes of electric lighting, it was explained that the application was necessitated by the growth of the undertaking. It was mentioned that there are now 3,045 customers, and 1,445 street lamps, and there are 62 oil lamps in the Beehive and Barkingside districts, which are to be replaced and supplemented by electric lamps. The existing machinery was sufficient for present purposes, but next winter the additional plant would be required.

LONDON: *London County Council.*—Tenders are invited for the wiring and fitting for electric lighting of a tramway car shed at Mare Street, Hackney. Particulars from the Clerk, fee £2 2s., returnable, and tenders by May 12th.

Tenders are also invited for the supply and delivery of about 2,000 tons of steel girder tramway track rails and fastenings required for the electrification of further portions of the Council's tramways. The Council also invite alternative tenders for the supply and delivery of about 5,000 tons of track rails and fastenings. Full particulars from the Engineer to the Council (fee, £2, returnable), and tenders to the Town Clerk by May 19th.

Tenders are invited for the supply and delivery of (*a*) 175 double-deck, roof-covered, electric car-bodies; (*b*) 175 pairs of maximum traction swing bolster trucks; (*c*) 175 complete electrical equipments for operation upon the overhead trolley, surface contact, and underground conduit systems of electric traction. Full particulars from the Clerk to the Council (fee £2 2s. returnable), and tenders by May 9th.

Battersea.—In order to cope with the anticipated load in the Nine Elms district next winter, the Lighting Committee report that it will be essential to make some provision for maintaining the pressure by either providing an additional low-tension cable, estimated to cost £8,833, or a feeder, booster, and accessories, estimated to cost £1,847. The committee, although feeling that greater security against breakdowns would be given by provision of the additional low-tension cable, do not see their way to incur the expenditure involved, being of opinion that for the present purposes the smaller scheme will suffice.

Three electric radiators are to be provided and fixed in the dressing-rooms at the Nine Elms Baths at a cost of £18 9s. Application has been made to the L.C.C. for a loan of £8,558 for expenditure incurred in the laying of mains and services for the electric lighting.

Stoke Newington.—A distributor cable is to be laid along the Bethune Road from Fairholt Road to Grange Court Road at an estimated cost of £61. The Finance Committee, at the request of the Electric Lighting Committee, is to negotiate for taking up a further £1,000 of the £5,000 recently sanctioned by the L.C.C. for the extension of mains.

St. Pancras.—An artesian well is to be sunk at the King's Road generating station at a cost of £2,000.

Woolwich.—The Electricity Committee reported at the meeting of the Borough Council on April 23rd that they had received an application for electricity supply for lighting and power "in a district where there is every possibility of obtaining remunerative demand in the near future, especially for power." Mains are to be extended to meet this demand at an estimated cost of £680. The committee reported another application for electricity supply, which it was anticipated would ultimately prove remunerative, "the district being a very promising one, and the premises being situated within the compulsory area of supply included in the second schedule of the Council's 1905 Order." Mains are to be extended to the premises in question at an estimated cost of £131. Tenders are to be obtained for the supply of a motor alternator to the specification of the Borough Electrical Engineer, power being delegated to the committee to accept one of the tenders, subject to subsequent report to the Council.

MANCHESTER.—The Tramways Committee invite tenders for the supply of hard-drawn copper trolley wire. Specifications, &c., from the General Manager, and tenders to the Chairman of the Electricity Committee, 55 Piccadilly, Manchester, by May 5th.

PORTSMOUTH.—Tenders are invited for the wiring and fitting of the laundry at the Infectious Diseases Hospital. Full particulars from the Borough Electrical Engineer, and tenders by May 6th.

A transporter bridge is to be constructed across the Langstone Harbour in connection with the proposed light electric railway to Hayling Island.

RAWTENSTALL.—Tenders are invited for the supply, delivery, and erection of steel tramway poles, overhead line equipment and accessories. Full particulars from the Consulting Engineers, Messrs. Lacey, Sillar, and Leigh, 2 Queen Anne's Gate, Westminster, and 78 King Street, Manchester (fee £3 3s., returnable), and tenders to the Town Clerk by May 4th.

RUGBY.—The Urban District Council invite tenders for 880 yards of paper-insulated lead-covered and armoured service cable. Particulars from the Clerk, to whom tenders by May 5th.

SOUTH AFRICA.—It is stated that the East London Council will shortly invite tenders for an electrical installation, and that particulars may be obtained from Messrs. Dyer & Dyer, 17 Aldermanbury, E.C.

SWANSEA.—The Swansea Harbour Board is considering the question of whether electric or hydraulic power shall be adopted at the new dock, and a committee has been appointed to submit a report.

SWITZERLAND.—The Federal Council recommends the adoption of the following projects, viz.:—(1) The construction of a funicular electric railway, of 1m. gauge, from the Place Léonard, at Zurich, to Susenberg (Zurichberg), a distance of 1,614 metres; (2) the construction of an electric railway of 1m. gauge, partly cogged, from Brigue to Belalp, a distance of 11,700 metres.

SPAIN.—A public competition will be held at the Junta de Obras (Board of Works) of the port of Tarragona, at 5 p.m. on May 31st, for the purpose of adjudicating the contract for an electric installation for lighting and motive power at that port. Tenders will be received up to the time of the adjudication. Local representation is necessary.

WAKEFIELD.—The West Riding and Yorkshire Rivers Board invite tenders for two exhaust electrical fans, switches, &c., for their laboratory at Wakefield.

WALTHAMSTOW.—The Urban District Council has received from the Local Government Board sanction to the borrowing of £17,189 for the provision of additional plant at the generating station, and £222 for an air compressor and weighbridge.

WEDNESBURY.—The Local Government Board has sanctioned a loan of £8,000 for the purpose of a generating station. Hitherto the Council has taken a supply in bulk from the Midland Electric Corporation for power distribution, but owing to the price being too high to allow of the undertaking being made remunerative, the agreement has been cancelled.

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TENDERS RECEIVED AND ACCEPTED

ADMIRALTY.—Messrs. Vickers, Sons & Maxim, Ltd., on behalf of the Admiralty, have ordered from the British Thomson-Houston Co., Ltd., 21 motor-generator sets, each giving 120 amps. at 55 volts (6·6 kw.) 1,600 r.p.m., with the necessary control panels. These are to operate searchlights on board H.M.S. *Vanguard*, a battleship of the *St. Vincent* class, which Messrs. Vickers, Sons & Maxim are building.

The British Thomson-Houston Co., Ltd., are also supplying nine motor generators (8–120 amp. and 1–80 amp.) for operating searchlights on H.M.S. *Defence*.

DARLINGTON.—The tender of the British Thomson-Houston Co., Ltd., has been accepted by Messrs. Pease & Partners, Darlington, for plant to be installed at Bowden Close Colliery :—One 120 h.p. 480 r.p.m. 440-volt 40-cycles three-phase slip-ring protected-type haulage motor, with tramway-type reversing controller and panel; one 25 h.p. 770 r.p.m. fan motor; one 150 kw. three-phase 2,750/440-volt oil-cooled transformers, with the necessary switchgear.

HUDDERSFIELD.—Messrs. Joshua Whiteley & Co., Ltd., have placed a contract for the complete electrical equipment of their "Albert" textile mill with the British Thomson-Houston Co. The installation consists of 23 three-phase induction motors totalling upwards of 800 h.p., with the necessary steel work for mounting the ceiling-motors, and controlling gear and cables. This is the first textile mill to be electrically driven from the Corporation three-phase mains in the Huddersfield district, which is one of the main centres of textile industry. This contract should be as far-reaching in its influence on the development of textile driving in this district as the Acme mill has been in Manchester.

JOHNSTON (N.B.).—The British Thomson-Houston Co., Ltd., are supplying to Messrs. Finlayson, Bousfield & Co.'s linen-thread mills a 200 kw. 428 r.p.m. 500–550-volt 50-cycle three-phase alternator, with three pedestal bearings, protection caps, rope pulley, base plate, and direct-coupled exciter, together with the necessary switchgear.

LONDON: *Battersea.*—The Lighting Committee recommend the acceptance of the tender of the Lancashire Dynamo & Motor Co., Ltd., to provide feeder booster, switchgear spares, &c., at £1,502 4s., the Council to carry out the work of providing foundations, cable, &c., at an estimated cost of £545.

Hammersmith.—Messrs. Gwynnes, Ltd., have ordered the following plant from the British Thomson-Houston Co., Ltd., viz. :—A testing plant, consisting of a 120 kw. motor-generator set, made up of two 60 kw. C.C. generators, tandem-coupled to one induction motor, one 110 k.v.a. three-phase motor-generator, and a motor exciter of 10 kw.

Metropolitan Asylums Board.—The following tenders have been received for the installation of electric lighting, &c., at the South-Western Hospital and Ambulance Station :—W. J. Fryer & Co. (accepted), £3,434; Electrical Co., Ltd., £3,700; G. E. Taylor & Co., £3,787; H. J. Cash & Co., Ltd., £3,819; W. Barton & Sons, £3,825; H. & C. Davis & Co., Ltd., £3,833; J. S. Anderson, £3,900; Tamplin & Makovski, Ltd., £3,926; Lund Bros. & Co., £3,980; C. Pullan, £4,027 16s.; Tilley Bros., £4,095; Pinching & Walton, £4,157 12s.; G. Weston & Sons, £4,368; A. Hawkins & Sons, £4,475; Perry & Co., £4,486; W. G. Cannon & Sons, Ltd., £4,560 10s.; A. Arthur & Ure, £4,685; H. J. Godfrey, £4,735; Wenham & Waters, Ltd., £4,741; T. Potter & Sons, Ltd., £4,866; A. C. Smith, engineers (Lincoln), Ltd., £4,956 16s.; F. A. Glover & Co., Ltd., £5,700; Laing, Wharton & Cunnington, £5,750; J. H. Taylor & Co., £5,899; Cox-Walkers, Ltd., £5,995. Engineer-in-chief's estimate, £4,000.

St. Pancras.—The Electricity Committee has provisionally accepted the following tenders for the supply of coal at the generating stations: Charrington, Sells, Dale & Co., 600 to 800 tons "Babbington" large hard steam coal at 16s. 3d. per ton; Spenser Whatley, Ltd., 600 to 800 tons "Desford" steam cobbles at 14s. 11d. per ton.

Woolwich.—The Borough Council has received the following tenders for the supply of oil eliminating plant to the Plumstead Electricity Works :—Atkins Filter Engineering & Water Softening Co., £90; Stanhope Water Engineering Co., Ltd., £160, time for delivery, 7 weeks; Harris Patent Feed Water Filter, Ltd., £175, 10 weeks; Babcock & Wilcox, Ltd., £200, 8 weeks; Paterson Engineering Co., Ltd., £200, 2–3 weeks; Wm. Boby, (a) £204, (b) £209, 7 weeks; Davis-Perret, Ltd. (accepted), £299 15s., 4–5 weeks.

The Borough Council has also received nine tenders for the supply of motors, viz., (a) 50–3 amp. size, (b) 50–5 amp. size, (c) 50–10 amp. size, (d) 25–25 amp. size, (e) 25–50 amp. size, (f) electrolytic type of motor, (g) period of guarantee, 5 years. The tender of Messrs. Chamberlain & Hookham has been accepted at the following prices :—(a) £1 16s.; (b) £2; (c) £2 5s.; (d) £2 10s.; (e) £2 14s.; (f) Mercury motor type; (g) 3 years. The total amount of the tender is £452 10s. Tenders by Messrs. Marples, Leach & Co., the Electrical Co., and Siemens Bros., the Electricity Committee point out, were for motors of foreign manufacture, which had not yet received the Board of Trade's approval. The motors to be supplied by Venner & Co. (for Chamberlain & Hookham) were of a new type, and had not, of course, had an extended trial. Large numbers of the same manufacturers' old-type motors were in circuit in the Borough, and gave every satisfaction, but the manufacturers claimed further advantages for their new type. In considering the tenders, the Committee paid due regard to the question of price in relation to the merits of the respective meters, and from previous experience they were convinced that motors of substantial design were the cheapest in the end.

SHEFFIELD.—The Sheffield Coal Co. have recently placed contracts for the following plant for their Birley Collieries, near Sheffield, with the British Thomson-Houston Co., Ltd. :—One 250 kw. 375 r.p.m. 3,000-volt 50-cycle three-phase B.T.-H.-Belliss generating set; three-panel main switchboard; five sets of main and tail haulages (two 30 and three 50 h.p.); two motor-driven pumps (30 and 80 h.p.); one 100 kw. and two 70 kw. transformers, and high-tension and low-tension panels.

Messrs. D. Selby Bigge & Co. have ordered from the British Thomson-Houston Co., Ltd., for Earl Fitzwilliam's Colliery, Elsecar, near Sheffield, a 350 kw. exhaust steam turbo-alternator, with heat accumulator, condenser, and the requisite switchgear.

STALYBRIDGE, HYDE, &c., ELECTRICITY BOARD.—The following tenders have been received for a 2,000 kw. turbo-alternator and condensing plant :—Messrs. C. A. Parsons & Co., Ltd., £7,900; Messrs. Willans & Robinson, Ltd., £8,250 (accepted).

TAMWORTH.—The following plant is being supplied by the British Thomson-Houston Co., Ltd., to Messrs. Morris & Shaw, Ltd., Birch Coppice Colliery, Polesworth, near Tamworth :—Main switchboard, pit-bottom and feeder panels; one 75 h.p. three-phase motor for driving endless haulage gear, the requisite feeder cable.

WARWICKSHIRE.—The British Thomson-Houston Co. is supplying to the Ansley Hall Coal & Iron Co., Atherstone, Warwickshire, a 500 kw. 340 r.p.m. 500-volt compound-wound open-type C.C. generator, to be driven by ropes by a pair of Robey engines running at 85 r.p.m., with the necessary switch panels.

COMPANIES' MEETINGS AND REPORTS

BABCOCK & WILCOX.—At the annual general meeting last Friday the report and accounts given in our last issue were adopted. Mr. John Dewrance, the Chairman of the company, who presided, referring to the large balance available for disposal, viz., £266,264, said that this appeared to be a considerable proportion compared with the company's capital, but a perusal of the balance-sheet showed that, owing to the conservative policy which had always been adopted, the nominal capital was really very small in proportion to the total assets, and therefore the profit was really not a very large one upon the company's trading. He regarded the satisfactory result as being due to the magnificent organisation which the company had throughout the world, which enabled them to make a profit on prices which their competitors could not touch. In a brief reference to the Eight Hours' Bill the Chairman said that this legislative attempt to restrict the output of coal would stimulate an enormous amount of commercial disturbance, probably with strikes in all parts of the country, which could not fail to have a serious effect upon the company, as well as upon others. There had been instances of these dangerous legislative threats being shelved, and he hoped this would be the case with the Eight Hours' Bill.

BRITISH ALUMINIUM.—At the annual general meeting on Friday the report and accounts given in our last issue were adopted. Mr. J. D. Bonner, who presided, stated that the result of the year's working, having regard to the derangement of the metal markets throughout the world, which followed the collapse in copper last June, must be considered very satisfactory. The company had contracts for deliveries extending to 1910, and contracts for further large quantities were being completed on the basis of current prices. Whilst it was clear that they would in future have to be content with a smaller percentage of profit, there was every indication that their sales would greatly increase. Now that their works at Stangfjord, and their temporary works at Kinlochleven, were at work, it was anticipated that their output by the middle of this year would

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be twice what it was last year. They did not expect, however, to have any power available at their Orsières works until after the end of next year.

CATHCART DISTRICT RAILWAY.—At the meeting last week, the chairman stated that in order to counteract the serious competition of the Glasgow Corporation Tramways, the company had introduced zone tickets available for any number of journeys.

CITY OF BIRMINGHAM TRAMWAYS.—At the annual meeting on Thursday, the report and accounts given in our last issue were adopted. Mr. Emile Garcke (chairman), who presided, said that nothing had happened during the past year that was not anticipated, in a very large degree, some years ago. They had lost some of their lines at the end of December, 1906, and the resultant loss of traffic during the past year has been £124,000. The net profits, however, were only £43,359 less than in the preceding year, showing that the expenses of working had been reduced in the same proportion as the receipts. The shrinkage in the receipts had, as a matter of fact, been less than anticipated, as the result of losing the lines, which reverted to the Corporation at the end of 1906, and this notwithstanding the fact that they had been exposed to very severe competition by the Corporation's new electric tramways. The Board had been occupied during the past year in conducting negotiations for the realisation of the remaining assets, and at the present time accumulated redemption funds for the redemption of debentures and an investment fund which, with cash and other assets of a liquid nature, amounted to an aggregate of £552,610. The total paid up capital was £284,000, the debentures were £300,000, and sundry creditors amounted to £32,000, or a total of £616,224, so that their liquid assets stood at a total very nearly approaching the total amount of their paid up capital and obligations. The investments, however, included an investment in the Birmingham and Midland Motor Omnibus Company, standing at £50,000, which he was sorry to say is not likely to produce its full value. Taking it altogether, however, he thought the financial position of the company was satisfactory. The assets still to be realised were the Bristol Road Tramways and the Cable Tramway until the year 1911, which represented 4¼ miles, and 7½ miles of tramways outside the city, some of which belong to the company, and are not purchasable by the local authorities until the year 1936. There was also the working of the lease of the Aston Corporation Tramways, which, however, were not yielding any profit at present to the company. Touching upon the question of whether it would be advisable to carry on the operations of the company in future under the powers of a liquidator, the chairman stated that various negotiations which have still to be carried on with local authorities are of such a nature that it was not advisable to put the company into liquidation at present. Moreover, so long as they were able to earn more than 4 per cent. on their investments, there was no direct economic advantage in liquidating the company merely for the purpose of redeeming the debentures, upon which they paid interest at the rate of 4 per cent. per annum. The average yield on the company's investments during the past year was about 5¼ per cent.

WEST COAST OF AMERICA TELEGRAPH.—The report for the year ended December 31st, 1907, shows gross receipts amounting to £61,854, as against £68,048 in 1906. The working expenses were £34,616, as compared with £34,173 for the previous year. After providing £6,000 for the interest on the 4 per cent. debentures, £800 for the interest on the 4 per cent. income bonds, and £193 for income tax, there remains a balance of £20,245, to which is added the sum of £1,923, brought forward from December 31st, 1906, making a total of £22,168. Of this amount £16,000 has been placed to the general reserve fund, and £2,000 to the maintenance ship's reserve fund, and the directors recommend the payment of a dividend of 2½ per cent., free of income tax, amounting to £2,813, leaving a balance on the revenue account of £1,355 to be carried forward to the next account. The meeting is to-day.

CRAIGPARK ELECTRIC CABLE.—The report for the year ended March 31st shows a profit of £7,128, to which is to be added £604 brought forward from last year. The directors recommend the allocation of £1,000 to depreciation of buildings and machinery. A dividend upon the 6 per cent. preference shares for the half-year to September 30th, 1907, and to the half-year ending March 31st, 1908, has been paid, and a dividend of 6 per cent. upon the ordinary shares for the twelve months ended March 31st, 1908, is now recommended, together with a transfer of £1,000 to reserve account, and £1,232 to be carried forward. The report states that in the cable department of the company the business shows a satisfactory increase in spite of the general depression in trade. Prices of raw materials are more favourable, and the directors look forward with confidence to the coming year.

DUDLEY, STOURBRIDGE & DISTRICT ELECTRIC TRACTION.—At the annual general meeting on Thursday, Mr. A. C. Miles presiding, the report and accounts given in our last issue were adopted. The Chairman pointed out that in spite of the reduction in the number of passengers carried during the year of 130,000, the receipts had been maintained at 11d. per car mile. One reason for the reduction in the amount to be distributed was that the directors had allocated a sum of £2,000 for renewals. The directors deplored the result of the appeal case before the House of Lords in respect of Light Railway No. 5, as in consequence the company was receiving about £16,000 less than if the undertaking had been purchased under the Light Railway Act. It was the intention of the Board to utilise the purchase money of the tramway in question for acquiring the Kinver Light Railway. The centralisation of the workshops for the whole system at Tividale had led to great economies, and further economy was anticipated by the agreement with the Shropshire, Worcester & Stafford Electric Power Co., for a supply of electrical energy.

THE ELECTRIC TRACTION CO. OF HONG KONG.—The report for 1907 shows a profit of £5,950, after paying debenture interest and other charges. With the amount brought forward from the last accounts, the available balance is £6,530. Of this the directors have placed £6,000 to reserve for depreciation and renewals, carrying the balance of £530 forward. The reserve for renewals fund now stands at £12,000. A loss of £4,000 is reported in respect of subsidiary coinage, and the report states that unless some definite step is taken at an early date to mitigate this evil the Board would have to consider the question of raising the fares.

INDO-EUROPEAN TELEGRAPH.—The report for the year ended December 31st, 1907, states that the company's revenue from message account and other sources amounts to £136,579, as compared with £124,610 for 1906, showing an increase of £11,969. The expenses are, on commercial and general account £47,618, and on maintenance account £25,434, making a total of £73,052, as against £73,642 for 1906, showing a decrease of £590. The revenue account therefore shows a balance of £63,526, which is carried to profit and loss account, 1907, and after deduction of income-tax paid is reduced to £60,228. To this is added the balance of profit for 1906 brought forward of £8,974, making a total of £69,203. The sum of £18,144 has been provided to meet the further depreciation to date, which has unfortunately taken place upon the company's investments, and a small loss in connection with the redemption of certain of the same. Deducting this sum and the interim dividend of £10,625 already paid, there remains a balance available for distribution of £40,433. The directors now propose to declare a dividend for the six months ended December 31st, 1907, of 17s. 6d. per share (making with the interim dividend already paid, 6 per cent. for the year) and a bonus of 20s. per share, both free of income-tax, carrying forward £8,558. It is also proposed to make a special distribution to the shareholders of £12,750, equivalent to 15s. per share, out of interest upon certain investments. For this purpose a small sum from the interest accrued during 1907 upon the equalisation of dividends fund investments has been added to the interest (for the year 1907) upon unappropriated investments and upon the deposit of Russian Government Rente, from which sources a similar distribution was made last year. At the meeting on Tuesday the report and accounts were adopted.

JOHNSON & PHILLIPS.—The report for the year ending 1907 shows a net profit, after making provision for bad and doubtful debts, and charging to revenue £4,300 for maintenance and building plant, &c., of £31,530, to which is added a balance of £11,451 brought forward from 1906, making a total available of £42,981. A dividend of 7 per cent. per annum upon the ordinary shares is recommended, transferring £8,000 to reserve, and carrying forward £6,873. At the meeting on Monday, when Mr. R. W. Blackwell, Chairman, presided, the report and accounts were adopted. In his speech the Chairman said that the principal thing he would like to call attention to was that at the present moment the business of the company, being centred in general telegraphic and submarine work, and in the working of india-rubber, and in the manufacture of cables, they had been able to a large extent to escape the great troubles met with by purely electrical engineering manufacturing firms. The new works which had been started early last year had been entirely completed and fully occupied during the past year. In view of the very considerable price which the company had to pay for electric power, the directors were very glad to notice that steps were being taken to obtain Parliamentary powers, which would provide something in the nature of a bulk supply for London. At the present moment they were practically depending upon one supply, and any breakdown in the station would be a very great disadvantage.

KALGOORLIE ELECTRIC POWER & LIGHTING.—The report for 1907 states that the amount of power sold during the year constitutes a record. The increase in the profit, although not in proportion to the increase of electricity sold, was nevertheless considered satisfactory, the gross profits for the twelve months being £26,597. Reconstruction and registration expenses, and the issue of debentures reduces this total to £22,010, out of which debenture interest, preference share dividends, reserve for depreciation and renewals, and dividend tax in Western Australia leave a balance of £5,330 to be carried forward. The directors recommend a dividend of 5 per cent. per annum on the ordinary shares for the six months ending June 30th, 1908. Since the date to which accounts have been made up a dividend has been declared upon the preference shares for the six months ending March 31st, 1908, of 6 per cent. per annum.

KALGOORLIE ELECTRIC TRAMWAYS (WESTERN AUSTRALIA).—The report for the year 1907 shows gross receipts of £48,008, compared with £51,379 for the previous year. The

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net profits are £16,270, compared with £17,546. The falling off is attributed to the reduction in the number of men working in mines, in consequence of the increased use of labour-saving machinery. During the year 650,530 car miles have been run, and 3,052,241 passengers carried, the respective figures for the previous year being 673,544 and 3,220,728. The number of units sold in 1907 was 930,231, compared with 933,109. The revenue per car mile in 1907 was 17·63d., and the expenses 11·17d., against 18·22d. and 11·31d. respectively. The percentage of expense to revenue in 1907 was 63·36 per cent., compared with 62·24 for the previous year. Owing to the depression in the money market the directors have been able to redeem a larger amount of debenture stock than was anticipated. The meeting will be held on May 6th.

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION.—The report and accounts for the year 1907 shows that the total capital expenditure to December 31st, 1907, on account of buildings and plant for electric supply amounted to £50,798, an increase of £5,023, which is chiefly due to the installation of the new 500 kw. generating set and auxiliary plant. The gross receipts, including the amount receivable from the Kidderminster and Stourport Electric Tramway Company for dividend on the shares held by this company, amount to £9,388, which, added to £687 brought forward from last account, makes £10,075. After deducting the expenses (including debenture stock and loan interest), amounting to £5,861, there remains a balance of £4,214. The directors propose that £750 should be placed to depreciation and renewals fund; debenture and loan redemption reserve, about £500; dividend on cumulative preference shares for the year 1907, £1,500; a 2½ per cent. dividend on the ordinary shares, £1,175; leaving £289 to be carried forward. After the above appropriation has been made, the balance of the sums reserved to date out of revenue by this company and the tramway company for the purposes shown in the accounts is £6,395.

Attached to the report is a copy of the balance sheet and profit and loss account of the Kidderminster and Stourport Electric Tramway Company for the year ended December 31st, 1907. The gross receipts amount to £6,335, being a decrease of £18 as compared with 1906, and the expenses to £3,268, an increase of £67. The profit on the year's working is £3,066, which, added to the balance of £39 brought forward, makes a total of £3,105 at the credit of profit and loss account. This amount has been applied as follows :—To reserve and renewals fund, £500; 4½ per cent. on the ordinary shares, £2,574; carrying forward £32. The demand for electrical energy for lighting and power purposes continues to increase satisfactorily, the connections in 8 c.p. lamps, including traction, having increased from 37,667 in 1906 to 47,814 during 1907. The total number of Board of Trade units sold in 1907 was 1,042,204, as compared with 705,841 during the preceding year, while the profit from the electrical supply business shows an increase of £795. The new 500 kw. generating set was first run on load on November 24th last, and, owing to its efficiency being higher than that of the older machines, a further substantial reduction in the casts per unit generated should be obtained during the current year. The company has joined the British Electrical Federation. The following particulars of the tramways are given in the report :—Miles open : 1907—route miles 4·60, single line 4·31, double line 0·29; number of passengers carried, 793,217; average traffic receipts per passenger, 1·84d.; average expenditure per passenger, 0·98d.; proportion of expenses to receipts, 53 per cent.; number of cars in stock, 13. The meeting will be held in London to-day.

LYMINGTON ELECTRIC LIGHT & POWER.—The report for the year 1907 states that the total connections have increased from the equivalent of 15,105 to 16,787 8-c.p. lamps. Including a balance of £154 brought forward, there is a profit of £1,550, from which has been deducted interest on debenture and loans amounting to £574. The directors recommend that £500 be placed to the credit of reserve account, and that a dividend of 5 per cent. per annum be paid on the preference shares, carrying forward £154. At the meeting last week the report and accounts were adopted.

MARCONI'S WIRELESS TELEGRAPH.—The report and accounts for the year ended September 30th, 1907, are given on page 665.

MELDRUM BROS.—The accounts for 1907 show a loss of £6,655. The loss last year amounted to £7,884, thus making a total debit balance of £14,539.

MERTHYR ELECTRIC TRACTION AND LIGHTING.—The report and accounts for the year ended December 31st, 1907, shows a total capital expenditure of £107,288. The directors have had under consideration the question of making provision for the cost of renewals other than those ordinarily charged against the year's revenue, and have accordingly debited the profit and loss account with £1,000, to be placed to a renewals provision account. The gross receipts on the light railways for the year amounted to £11,265, and the gross receipts on account of electrical supply to £5,873, making with £206 sundry receipts, a total of £17,344. After deducting all expenses chargeable to revenue, including £2,056 for debenture interest and placing £1,000 as mentioned above to a renewals provision account, there remains a surplus of £4,347, making with the amount brought forward a total of £4,785. The payment of the dividend on the preference shares for the twelve months ended October 15th, 1907, amounting to £1,500, reduces this sum to £3,283, which the directors recommend should be applied as follows :—Depreciation and reserve account, £1,250; 5 per cent. dividend on the ordinary shares, £1,500; carrying forward £533. £263, the cost of renewing plates in the battery, has been charged against the renewals provision account. The results from the year's working of the electric supply undertaking continue to show satisfactory progress. The gross receipts amounted to £5,872 and the expenditure to £2,103. The receipts for 1907 exceeded the receipts for 1906 by £1,089, while the expenditure was £183 less. The installations (exclusive of the light railways) connected to the mains on December 31st, 1907, represented the equivalent of 18,602 8-c.p. lamps compared with 13,097 for the previous year. The gross receipts from the light railways show an increase of £626 and the expenditure an increase of £336. The Board of Trade has granted a further extension of time for two years from May 16th, 1907, for the construction of the half-mile of line in Cefn. The Merthyr Tydfil Corporation has not yet constructed a new bridge across the river, and until this is carried out the company cannot proceed with the work of laying the lines. The company has joined the British Electrical Federation. The following particulars are given in the report of the light railways :—Miles open : 1907—route miles 2·98, single line 2·02, double line 0·96; number of passengers carried, 1,974,204; average receipts per passenger, 1·41d.; number of cars in stock, 16. At the meeting on Monday the report and accounts were adopted.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAYS.—At the annual general meeting on Wednesday the report and accounts given in our issue for April 16th were adopted. Mr. E. Garcke, the Chairman, who presided, said that the passengers carried during the year were 200,000 more than during the preceding year, an increase of about 4 per cent.

PRIMITIVA GAS & ELECTRICITY.—At the annual general meeting on Tuesday the report and accounts given in our last issue were adopted. The chairman, Mr. H. E. Jones, said that in consequence of the arrangement between the Buenos Aires municipality and one of the large electric traction and lighting companies in the city, by which at the end of fifty years the whole of that company's undertaking would revert to the Corporation, a similar proposal had been made to them, but there were certain clauses in the proposed agreement which they did not feel able to accept, and they had declined to be bound by the terms proposed.

SWANSEA IMPROVEMENTS AND TRAMWAYS.—The report for the half-year ended December 31st, 1907, deals first with the tramways undertaking. The directors have had under consideration the question of provision for expenditure on renewals and reconstructions as distinguished from ordinary repairs and maintenance, and they have decided in addition to the depreciation and reserve fund to build up out of each year's revenue a fund to be available for defraying or equalising the cost of extraordinary renewals of the permanent way and plant and equipment. They have accordingly set aside out of the year's profits the sum of £2,500 for this purpose. The gross receipts amount to £27,817, being an increase of £2,741 upon the corresponding period of the previous year. After deducting all expenses chargeable to revenue, including debenture and other interest and the amount payable to the Swansea Corporation in respect of the tramways and light railways leased from the Corporation, and after charging profit and loss account with the sum of £2,500 for provision for renewals as stated above, there remains a surplus of £5,288. The addition of the sum of £3,443 brought forward from last account brings the available balance up to £8,731, out of which the directors recommend the allocation to reserve and depreciation fund of £2,000, and the payment of dividends of 6 per cent. and 5 per cent. per annum upon the preference shares, and 3 per cent. on the ordinary shares, leaving a balance to be carried forward of £1,532. The results for the half-year show material improvement as compared with the corresponding period of 1906. The increased receipts are mainly due to the operation of the revised scale of fares which was put into force on July 1st. The expenses show an increase of £801, which is due to the payment of higher rates of wages to employees, to the increased cost of fuel, and to increased expenditure on repairs and maintenance. The expenditure on capital account during the half-year amounted to £879, including £240, the instalment due in respect of the purchase of cars. During the half-year the liability of the company to sundry creditors has been reduced by £4,183, of which amount £3,500 was carrying a high rate of interest. The company has joined the British Electrical Federation which has been formed by various electric traction and lighting companies for the purpose of co-operation and joint action in matters of common interest. At the meeting on Tuesday the report and accounts were adopted.

TYNEMOUTH & DISTRICT ELECTRIC TRACTION.—The report for the year ended December 31st, 1907, states that the total revenue for the year amounted to £12,847, and after deducting all expenses chargeable to revenue, including repairs and maintenance, interest on debentures and loans, and a sum of £573 which has been placed to provision for renewals, there remains a balance of £4,235, which, added to the amount of £372 brought forward from last account, leaves an available balance of £4,607.

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The directors have had under consideration the question of making provision for the cost of renewals other than those ordinarily paid out of revenue, and have accordingly debited the profit and loss account as already mentioned, with £573 to be placed to provision for renewals, and recommend that the available balance be dealt with as follows :—To depreciation and reserve account, £500; to capital redemption fund, £500; dividend of 5 per cent. per annum on the cumulative preference shares to December 31st, 1907, £1,525; and dividend of 4 per cent. per annum on the ordinary shares to December 31st, 1907, £1,856; carrying forward £226. The capital expenditure during the year amounted to £88, making the entire capital outlay of the company to December 31st, 1907, £93,501. Having regard to the bad weather experienced continually throughout the year and the depression in the shipbuilding industry on the North-East coast, the directors consider that the result of the year's working is satisfactory. The undertaking has been maintained in good working order and repair. The work of re-roofing ten of the cars with teak and the renewal of staircases and seats has just been completed. A small proportion of the work was carried out before December 31st last, and the cost charged to revenue. Having regard to recent contracts entered into by the Tynemouth Corporation for the supply of current to other lesser consumers on more favourable terms and to other considerations, the company have made representations to the Corporation with a view to a reduction in the price charged to the company. The company has joined the British Electrical Federation. The following statistics are given :—Miles open : route miles 4·21, single line 0·59, double line 3·62; number of passengers carried, 2,060,808; average traffic receipts per passenger, 1·45d.; average expenditure per passenger, 0·86d.; proportion of expenses to receipts, 58 per cent.; number of cars in stock, including water car, 22. The meeting is to-morrow.

WOLVERHAMPTON & DISTRICT ELECTRIC TRAMWAYS.—At the annual general meeting on Thursday the report and accounts given in our last issue were adopted. Mr. S. R. Blundstone, who presided, said that the reason for the profit available being apparently £1,000 less than for the previous year, was that the Directors had allocated the sum of £1,000 for renewals before arriving at the profit. He thought it was satisfactory that the number of passengers had increased by 28,000, in view of the fact that trade was very bad in the district.

THE BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO.—The annual report for the year ending December 31st, 1907, is given on page 664.

PARLIAMENTARY INTELLIGENCE

PROGRESS OF ELECTRICAL BILLS.—In the House of Commons on Monday the Motherwell Burgh Extension and Wishaw Borough Electricity Bills were read a third time.

APPOINTMENTS AND PERSONAL NOTES

The Glasgow Tramways Committee recommend the following increases in salaries in the Tramways Department :—Mr. James Dalrymple, General Manager, from £1,000 to £1,100 per annum; Mr. L. Mackinnon, traffic superintendent, from £575 to £600 per annum; Mr. J. Ferguson, chief engineer, £575 to £600 per annum; Mr. J. N. Wilson, from £325 to £350 per annum; Mr. E. T. Goslen, electrical engineer, from £475 to £550 per annum.

Mr. Patrick Hamilton, formerly Manager of the Electrical Department of Messrs. Kelvin and James White, has joined the board of directors of Messrs. Everett Edgcumbe & Co., Ltd. Mr. Hamilton, who will take an active part in the supervision and design of Messrs. Everett, Edgcumbe & Co.'s various products, and in the management of the business generally, will be located chiefly at the company's Westminster offices, 87 Victoria Street, London, S.W.

MISCELLANEOUS CITY NOTES

LONDON ELECTROBUS.—We give in this issue the prospectus of the London Electrobus Co., from an advance copy of which we gave some extracts last week.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.—The proposed scheme for dealing with the profit-sharing notes which fall due in June, published in our issue for April 16th, is now being offered to the holders of the notes in question. The *Times* correspondent in New York, telegraphing last week, states that the scheme has been well received by American holders, and it is believed that the plan will go through promptly.

KAMINISTIQUIA POWER CO. (MONTREAL).—Subscriptions have been invited during the week at 97 for $1,325,000 first mortgage 30 year 5 per cent. gold bonds. The bonds are secured by trust mortgages in favour of the Royal Trust Co. The share price is equivalent to £99 13s. 3d. per bond of $500 or £102 14s. 10d.

NORTH-WEST LONDON RAILWAY CO.—It is stated that an issue of ordinary stock will be made in about three weeks' time, and that shareholders will be entitled to free season tickets in proportion to the amount of stock allotted to them.

700 H.P. SINGLE-PHASE LOCOMOTIVE FOR THE SEEBACH-WETTINGEN RAILWAY

THIS railway, which was electrically equipped by the Oerlikon Co., in the year 1905, has a total length of track of about 15 miles, and deals chiefly with goods traffic. The first locomotive in use on the railway was of the Ward-Leonard type, and contained, besides the transformer and driving motors, an asynchronous motor generator set. The second locomotive was equipped with two 200-h.p. Oerlikon single-phase series-commutator motors, each geared to two of the four axles.

The third locomotive, which was described recently in *Elektrische Kraftbetriche und Bahnen*, and which commenced operation in October of last year, was built by the Siemens-Schuckertwerke. This locomotive is constructed with two three-axle bogies, and is equipped with four 175 h.p. 15-cycle single-phase series-commutator motors of the type described in ELECTRICAL ENGINEERING, Vol. II., page 367. The motors are geared to the axles with a gear ratio of 3·72, corresponding to a speed of 46 miles per hour at rated load. Artificial ventilation is provided for the motors, which, it is stated, have a capacity of 175 h.p. when not artificially ventilated, and 225 h.p. when ventilated. These motors are totally enclosed, but gauze-covered openings are provided for the entrance and exit of the cooling air. The excitation and compensating windings are wound in semi-closed slots in the stator core, the compensating winding producing the necessary commutating field. The rotor winding consists of former wound coils in open slots. The locomotive is provided with two bow collectors and two finger collectors of the Oerlikon type. The two transformers, each of which has a capacity of 500 kw., transform down from the contact-line pressure of 15,000 volts to the motor pressure of from 150 to 380 volts. The transformers are oil cooled, and are situated in a special compartment in the locomotive. There are nine running positions of the controller. The current for operating the contactors is obtained from a low-voltage tapping on the secondary winding of the main transformer. The total weight of the locomotive equipped with four of the 175-h.p. motors is 68 tons. There is room for two more motors on the remaining two axles, and with such a six-motor equipment the total weight would be 75 tons.

CATALOGUES AND PAMPHLETS RECEIVED

IGNITION ACCUMULATORS.—A new price list of ignition accumulator has been issued by Accumulator Industries, Ltd., of 4 White-street, Moorfields, and Maybury, Woking. These cells are fitted with positive plates of an improved Planté type, and the negative plates consist of a special form of porous lead, contained in an under-cut grid. A special feature is the discharge indicator, which can be fitted to any of the cells, consisting of a tube visible from the front of the cell containing four coloured glass beads, to which the acid has free access. These beads are calculated to float only at a certain specific gravity, which corresponds to the condition of the cell.

POWER SUPPLY.—The Loughborough Corporation Electricity Department have prepared a pamphlet, which they are just issuing, calling attention to the advantages of electrical driving, and giving a number of examples of costs of running to show the saving that may be obtained as compared with other forms of power, and containing a list of the principal power consumers on the Corporation mains. It is intended to send out two follow-up letters after intervals in connection with the pamphlet.

TIME SWITCHES.—A leaflet from Messrs. Venner & Co., of 6 Old Queen Street, S.W., illustrates a special form of the "Venner" time switch for incandescent street lighting, arranged in a compact iron case. The working of this switch was described in ELECTRICAL ENGINEERING, Vol. I., page 730.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted on Tuesday night was £59 to £59 10s. per ton (last week, £59 10s. to £60 per ton).

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—Creditors of the Monobloc Accumulator Syndicate, Ltd., are requested to send in particulars of their claims to the liquidator, Mr. H. Newton-Smith, 37 Walbrook, London, E.C., by May 30th.

The Kevan Electric Co., Ltd., is to be wound up voluntarily. Creditors are requested to send particulars of their claims to the liquidator, Mr. Edmund Heisch, 120 Fenchurch Street, London, E.C., by June 3rd.

Kevan Signs, Ltd., is to be wound up voluntarily. Mr. Edmund Heisch, 120 Fenchurch Street, London, E.C., is liquidator.

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NEW COMPANIES

ELECTRIC BATTERIES AND CARBONS.—This company was registered on April 24th, with a capital of £20,000 in £1 shares, to acquire and turn to account any patents, brevets d'invention, concessions, and the like, conferring an exclusive right to use any invention by F. J. Gerard and L. Fiedler, and to carry on the business of engineers, electricians, manufacturers of electric accumulators, electric or other motors, motor-cars, omnibuses, vans, carriages, vehicles, locomotives, dynamos and apparatus, &c. The subscribers are :—R. G. Orr, E. F. Stranack, L. Fiedler, F. R. Graves, L. V. Oswald, L. H. Raw, V. C. G. Marden. Minimum cash subscription, £100. The number of directors is not to be less than two nor more than five; the first are R. G. Orr, E. F. Stranack, and L. Fiedler. Qualification, £100. Remuneration, 2 guineas each per board meeting attended (chairman, 3 guineas), and 5 per cent. of the net profits after 10 per cent. is paid on the ordinary shares. Registered office, 709 Salisbury House, E.C.

HAVANA TELEPHONE SECURITIES CO.—This company was registered on April 24th, with a capital of £1,000 in £1 shares, to acquire any bonds, debentures, securities, obligations, coupons, notes, scrip, shares, stock, or capital of the Havana Telephone Co. (incorporated in New Jersey, U.S.A.). The subscribers are :—W. Hicks, F. Birch, E. A. Lewis, F. J. White, G. L. Devisse, W. G. Dunstall, F. H. Nicholson. No initial public issue. The number of directors is not to be less than three nor more than nine; the subscribers are to appoint the first. Qualification, £200 debentures or £10 shares. Remuneration as fixed by the company.

F. HILLIER & CO.—This company was registered on April 16th, with a capital of £1,000 in £1 shares, to carry on the business of exhibition stand fitters, electric light installers, furniture and brass and copper letter dealers, decorators, builders, manufacturers of electrical plant, &c., and to adopt an agreement with F. Hillier. The subscribers are :—J. Robertson, H. Child, E. E. Ban, A. North, F. Hillier, L. Fayolle, F. A. Black. No initial public issue. Registered without articles of association. Registered office, 25 Brewer Street, Regent Street, W.

IMESON, FINCH & CO.—This company was registered on April 15th, with a capital of £10,000 in £1 shares, to acquire the business carried on at Stockton-on-Tees as "Imeson Brothers, Finch & Co.," to adopt an agreement with A. Imeson and A. H. Finch, and to carry on the business of electric, mechanical, and general engineers, machinists, smiths, founders, fitters, metal workers, manufacturers of roller controller fingers, roller contacts, automatic ears, trolley heads, lamps, samnite bronze, overhead electrical equipment and insulators, gear-wheels, and pinions for tramways and railways, &c. The subscribers are :—G. P. Lewis, J. H. Phillips, A. Imeson, A. H. Finch, Major H. Hart, N. White, C. H. Norris. Minimum cash subscription, £750. The number of directors is not to be less than two nor more than five; the first are G. P. Lewis, J. H. Phillips, A. Imeson, A. H. Finch, and Major H. Hart. A. Imeson and A. H. Finch are joint managers, with not less than £250 each per annum. Remuneration of directors, £50 each per annum, and 5 per cent. of the net profits available for distribution in any year when 10 per cent. is paid on the ordinary shares, Table "A" mainly applies. Directors' borrowing powers restricted to the amount of the nominal capital. Registered office, 5-6 Great Winchester Street, E.C.

PRIVATE TELEPHONE CO.—This company has been registered with a capital of £1,000 in £1 shares to adopt an agreement between M. Atkinson, M. C. Greenhill, and L. M. Porter to carry on business of electricians and manufacturers of and dealers in electrical apparatus, mechanical and electrical engineers. No initial public issue.

SAFETY LIGHT.—This company was registered on April 22nd, with a capital of £150,000 in £1 shares, to adopt a certain agreement (the parties to which are not named), to acquire and turn to account inventions, processes, patents, brevets d'invention, licenses, concessions, rights and privileges, and to carry on the business of electrical engineers, producers of electric light or power, gas makers, vendors, and suppliers, water supply engineers, founders, toolmakers, &c. The subscribers are :—A. Shanks, D. N. Ritchie, J. A. Tinling, H. M. Carter, A. C. M. Anderson, H. E. Smith, L. B. de Laitte, E. Walden-Vincent. No initial public issue. The number of directors is not to be less than five nor more than nine; the first are A. Shanks, D. N. Ritchie, J. A. Tinling, L. B. de Laitte, E. Walden-Vincent, and one other to be nominated by the de Laitte Gas Machine Co., Ltd. As soon as the Elwell-Smith Petrol Safety Gas Co., Ltd., shall have subscribed for £22 500 of an issue of £40.000 first mortgage debentures, the said D. N. Ritchie, E. Walden-Vincent, and J. A. Tinling shall have the right to nominate one other director. Qualification (except first directors), £250 shares. Remuneration (except managing director), £150 each per annum (chairman, £200), and 5 per cent. of the distributed net profits when 10 per cent. dividend is paid, to be increased to 10 per cent. when more than 10 per cent. dividend is paid.

SYLVERLYTE ELECTRIC LAMP CO.—This company was registered on April 24th, with a capital of £2,750 in £1 shares (1,500 preferred ordinary and 1,250 deferred ordinary), to acquire and turn to account any invention relating to the manufacture of electric and other lamps, and any lenses, reflectors, or other accessories used in connection therewith; in particular, to acquire the benefit of an invention referred to in an agreement with J. S. Burns, and to carry on the business of manufacturers of electric lamps, reflectors, lenses, and other articles, opticians, glass-blowers, &c. The subscribers are :—A. Hill, J. S. Burns, S. F. Rumball, A. H. Skan, F. E. Hodges, N. Richardson, H. A. Wilding. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Qualification, 50 shares. Remuneration according to profits.

WARNER ENGINEERING CO.—This company has been registered with a capital of £2,000 in 20 founders' shares of £5 each, and 1,900 ordinary shares of £1 each, to acquire patent No. 15,059 of 1905 granted to J. S. Warner for improvements in railway and tramway trucks, together with the American, German, French, and other patents with regard to these trucks, and to acquire the business carried on by J. S. Warner as the Warner Engineering Co. No initial public issue. Registered address, 11 Dartmouth Street, Queen Anne's Gate, London, S.W.

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JAMES C. INGLIS.
General Manager.

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ELECTRICAL ENGINEERING

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SUMMARY

THE new 6,000 kw. turbo-alternator which was put to work on Tuesday at the Stuart Street Lighting Station of the Manchester Corporation Electricity Department forms the largest generating set in this country. (Page 685.)

THE London Electric Supply Companies are making another effort to arrange for a co-operative electrical exhibit at the Franco-British Exhibition. With this end in view, the companies on their own initiative have taken space in the machinery gallery, upon which it is proposed to erect a pavilion. This will be divided into a number of sections showing various applications of electricity, including a furnished house, the fitting of which has been arranged by Messrs. Waring. An appeal is being made to the electrical industry to subscribe towards the expenses of wiring, the supply of current, &c., to the exhibit, the companies themselves providing sufficient funds to meet the expense of space and the pavilion which it is proposed to erect. (Page 685.)

LETTERS are published from several correspondents relating to the adoption of the term "wire lamp" instead of the more cumbrous definition "metallic filament lamp." It is pointed out by some that with one exception the filaments are not wire drawn, and the term "metal lamp" is put forward as a substitute. (Page 686.)

ARRANGEMENTS have been made for an electrical supply for the power and lighting needs of the Franco-British Exhibition aggregating about 6,000 kw. About half of this supply is taken in bulk from the special feeders of the Hammersmith Borough Council and the Notting Hill and Kensington Company, and the remainder is generated within the Exhibition. Three independent distributing services are laid down on the single-phase three-wire at 2 × 220 volts, three-phase four-wire at 220 volts and continuous-current three-wire at 2 × 250 volts. The whole electrical installation is of a substantial nature, and is said to have cost £30,000. (Page 687.)

PROFESSOR SILVANUS P. THOMPSON gave the first "Kelvin" lecture before a crowded meeting at the Institution of Electrical Engineers last Thursday. The lecture was devoted to an account of the life and work of Lord Kelvin. (Page 691.)

AT the Institution of Electrical Engineers on Thursday, Mr. H. F. PARSHALL presented a bronze bust of Benjamin Franklin on behalf of the American Institute of Electrical Engineers. He stated that it had been the original intention to present the bust on the occa-

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sion when Lord Kelvin took the chair as President of the Institution of Electrical Engineers, but, alas, that was not to be. (Page 694.)

THE Marseilles Electrical Exhibition was opened on April 14th. (Page 694.)

THE Edison nickel-iron cell is used in the Bergmann electrically-propelled vehicles With the exception of the heaviest type of delivery waggon all the cars are provided with only one motor geared to the back axle through toothed gearing in the case of the lighter vehicles, and through chain gearing in the case of the heavy waggons. The control is effected by splitting the battery into two halves, and putting these halves in parallel or series. The series fields of the two-pole machine are also either in parallel or series. Some particulars of the cells, which are of particularly robust construction, are given. (Page 695.)

WE publish a detailed description of two unusually large cables—a telephone cable containing 800 pairs of wires, and a composite telegraph and telephone cable containing 64 screened telegraph wires and 49 pairs of telephone wires. Both are employed by the British Post Office. (Page 697.)

A NEW type of small transformer for use with low-voltage metallic filament lamps has been put on the market. A novel feature is the turn-down device which may be obtained embodied in the transformer case, which is very compact and can be suspended from the flexible between the switch and the lamp. (Page 698.)

A NEW method of controlling tramway points electrically without the necessity for an attendant has been introduced. (Page 699.)

A SPECIAL form of overhead contact rail and pantograph collector is used in the East River Tunnel, New York. (Page 700.)

ALTHOUGH the electric lighting arrangements at the Edinburgh Exhibition, opened on Friday, represent a capacity of some 575 kw., there is a large amount of gas lighting. An article gives a detailed account of the electrical circuits, and also some particulars of the gas lighting. (Page 701.)

THE Paper by Dr. W. E. SUMPNER and Mr. J. W. RECORD upon new alternating current instruments, read recently before the Institution of Electrical Engineers in London, has been further discussed in Birmingham, when several engineers expressed favourable opinions on the new instruments described. (Page 702.)

MR. T. P. WILMSHURST, Borough Electrical Engineer, Derby, has sent us some extremely interesting observations of the life of 100-volt Osram lamps used for street lighting. The best lamp had a life of 4,114 hours, and the average life of the 23 lamps, on which there is complete information, comes out at 1,570 hours. Some details of comparative costs, showing a great saving as compared with incandescent gas lighting, have been received from Mr. G. WILKINSON, Chief Electrical Engineer, Harrogate Corporation. (Page 703.)

UNDER ELECTROCHEMISTRY AND ELECTROMETALLURGY an article by A. Ahlin upon "Electrolytic Bleach Liquor," in which it is shown that particular precautions are necessary in order to ensure high yields and yields of constant composition. Some authorities prefer the presence of magnesium salts, because it is considered that they prevent reduction at the cathode by producing protective coatings of oxychloride; and when magnesium salts are not present in the raw product it is customary to add them. But Ahlin considers their presence to be a disadvantage. Tin can be smelted in the electric furnace apparently satisfactorily, although we do not know that it has been tried on an industrial scale. (Page 704.)

UNDER ELECTRICAL SCIENCE, in the British and American section, are an account of Lord RAYLEIGH'S installation as Chancellor of the University of Cambridge, a summary of Prof. LARMOR'S Royal Institution lecture on Lord Kelvin, and a note on an improved form of high resistance; in the Papers abstracted in the Continental section, F. NÈGRE deals with a resistance of porcelain insulators at high voltages; B. GLATZEL describes a new method of producing slightly damped oscillations; and PAUL ASTEROTH investigates the hysteresis of magnetic alloys. (Page 704.)

AMONG the specifications published by the Patent Office last Thursday was one by E. RUHMER, relating to a system of wireless telephony, in which a series of groups of undamped waves are sent out by the transmitter instead of, as in the previous system, a continuous train of waves of varying amplitude and frequency. A specification by the BRITISH THOMSON-HOUSTON Co. describes an improved method of welding metallic lamp filaments to leading-in wires; and another by the SIEMENS & HALSKE AKT.-GES. relates to the manufacture of tungsten filaments. An improved method of artificial cooling for railway motors is patented by C. O. MAILLOUX, and a commutator motor of the inverted repulsion type is described in a specification by the FELTEN & GUILLEAUME-LAHMEYERWERKE AKT.-GES. (Page 705.)

THE Belfast Corporation recommend that a through service of cars be maintained over the lines of the Cavehill and Whitewell Tramway Co., the company to receive the receipts at their end of the route and the Corporation the receipts at their end.—A list of certificated electric wiremen is being drawn up by the Birmingham Electricity Department.—Dealing with the question of renewal of tramway track, Mr. F. AYTON, the Electrical Engineer and Tramway Manager at Ipswich, estimates that the whole of the rails will require relaying in 1919, and that the cost will be £42,500. By 1919 only £10,408 of the original loan for track will have been paid off, thus leaving a sum of £32,092. Mr. Ayton's suggestion of levying a rate to meet this, owing to the improbability of the receipts being sufficient to cover the balance, has been vetoed by the Finance Committee.—In consequence of owners of property compelling the Middlesex County Council to acquire the whole when only a portion would be required for the purposes of the tramway undertaking, it has been found necessary to apply for additional borrowing powers to the extent of £100,000. (Pages 707–709.)

LOCAL Government Board inquiries have been held during the week in connection with electric lighting loans at Brighouse (£3,624), Burnley (£26,406), Colne (£4,170), and Taunton (£2,000). A Lancashire boiler and superheater are required by the Darlington Corporation; stores by the Metropolitan Asylums Board; cooling towers, tanks, &c., by the Salford Corporation; and switchgear, &c., by the Bristol Corporation. A scheme of extensions at the Dickinson Street and Stuart Street generating stations of the Manchester Corporation has been drawn up, involving an expenditure of £135,000. Messrs. Marple, Leach & Co. have secured the contract for the complete electrical equipment of the Tyne Ring Spinning Co., near Manchester. Messrs. Ferranti, Ltd., are supplying 55 transformers to the St. Petersburg Corporation, and a 1,000 kw. Siemens alternator, with a turbine by Messrs. Howden & Co., is being supplied to the Wimbledon Urban District Council. (Pages 709–710.)

THE accounts of the Great Northern Telegraph Co. show a decrease of about £13,200 for 1907 over those of 1906. A 20 per cent. dividend is declared, how-

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ever. Commodore Suenson, the Chairman and Managing Director, has resigned on account of ill health, and the company has decided to substitute for the managing director, a Board of Managing. A balance of £18,116 is shown in the accounts of the National Electric Construction Co. for 1907, and after meeting various charges the sum of £9,047 is carried forward. The report of the South Metropolitan Electric Tramways & Lighting Co. for 1907 shows a surplus of £8,477, and after deducting depreciation, preference share dividend, &c., a balance of £437 is carried forward. The annual general meeting of the British Westinghouse Co. was held on Monday, when the chairman stated that the affairs of the company were now in a very much more satisfactory position. A feature of the year's operations were the economies which had been effected in the management, for with a pay roll of 2 per cent. less, an output having an additional value of 10 per cent. had been produced. (Pages 711–712.)

AT Bournemouth on Friday evening last, a tramcar belonging to the Corporation left the rails at a curve after descending a steep hill at a high speed. At the Board of Trade inquiry, opened by Major Pringle on Monday, and continued on Tuesday, evidence was given which showed that, although one magnetic brake shoe was broken before the accident, the other three were in good condition. The rear controller was found in the reverse position after the accident, and in this position it would have been impossible for the magnetic brakes to have acted. There is some doubt as to whether the wheels skidded or not. The inquiry is adjourned in order that the driver, who is slightly injured, may attend. (Page 713.)

THE annual general meeting of the Marconi Wireless Telegraph Co. was held on Thursday. Sir CHARLES EVAN-SMITH, the chairman of the company, who presided, said that the company had now accepted, under certain provisos, the principle of intercommunication, while the Post Office, on their side, acquiesced in and promised their favourable consideration and support to several very important matters. The company believed they would now receive the support of the Post Office, Colonial Office, the Admiralty, and the Foreign Office. With regard to the progress of their undertaking, they were now securing a profitable business all over the world, America, Canada, South America, France, Italy, Russia, Belgium, and China all having come to the company for apparatus and installations. Mr. MARCONI, who seconded the report, said that he had recently carried out some tests with short distance stations with the result that duplex working had been rendered possible. If this were applied to transatlantic stations it should double the rate of telegraphing. He was confident that with slight modifications of the apparatus, a speed of at least 30 words a minute could be obtained in ordinary working. (Page 715.)

AT the Municipal Exhibition, which was opened on Friday last at the Royal Agricultural Hall, Islington, there are very few exhibits of an electrical nature. At the Conference in connection with the Exhibition two papers will be read on Illumination. (Page 716.)

WE are very pleased to be able to announce in this issue that the scheme for a Co-operative Electrical exhibit at the Franco-British Exhibition, which a few weeks ago appeared to have fallen through, has been revived in a somewhat different form, and through the energies of a combination of the London Electric Supply Companies, the British electrical industry will be represented in one of the buildings of the exhibition. It would indeed have been a pity, considering how much has been talked of the wondrous display to be given by those interested in the use of gas and the excellent examples of French electrical engineering that will be seen, if the matter had been allowed to lapse. Some details of what is now proposed will be found in a circular from Mr. F. J. WALKER, Hon. Secretary of the Conference of Chief Officials of the London Electric Supply Companies, which was convened to take up the question. There will be a good deal of electrical interest in the power and lighting arrangements of the exhibition, and modern developments in generating sets will be well represented by a large steam turbo-generator, numerous gas-driven sets, and a Diesel engine, all of which will be actually in use. At this season there is a good deal of activity in the direction of exhibitions, and in this issue we are able to give a certain amount of information regarding the electrical particulars of the Scottish National Exhibition at Edinburgh, and the Marseilles Electrical Exhibition, as well as a long special article on the electrical arrangements at Shepherd's Bush. The much more extensive employment of gas than electric light at the Edinburgh Exhibition should not fail to be observed by the electrical engineer, and should be contrasted with the completeness of the electric lighting at the Franco-British Exhibition. It is true that great use is made at Edinburgh of electric lighting, but gas lighting is very prominent in the grounds and buildings, in spite of the obviously greater convenience and safety of electric lighting. It is unsafe to hazard an explanation for this, for the rules governing the allotment of exhibition contracts differ considerably from those followed in ordinary commercial cases, but the fact cannot be passed by without notice. Even more surprising is the neglect of the claims of the metallic filament lamp by both exhibition authorities. From our accounts of both exhibitions it will be noticed that at the Franco-British and the Edinburgh Exhibitions carbon filament lamps are to be employed principally for decorative lighting, although alternating current is available and pressures of 25 volts might easily have been provided by the use of transformers locally. The extra cost of installing these transformers would, we should think, have been amply covered by the saving in electrical energy, but the cost of the lamps would have been several times as much, and probably difficulty would have been experienced in obtaining delivery of the very large numbers required. It is still possible that when the fitting-up of the lamps for decorative purposes in Edinburgh is carried out, low-pressure metallic filament lamps will be employed; for the outlining of the buildings at Shepherd's Bush, however, the carbon lamp has been chosen. It is probable, however, that when the lighting of the stands is more complete we shall find that a large proportion of those exhibitors who are paying for their supply by meter will take full advantage of the great economy of the new lamps, although such incentive will be wanting in the case of the smaller stand-holders whose charges are based on a fixed amount per 16 or 8 c.p. lamp, as the lower initial cost of the lamp itself will be the predominating consideration.

ATTENTION must be directed to the excellent results of the life records of 100-volt Osram lamps which have been obtained in street lighting at Derby and elsewhere. It is truly remarkable that such results should

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be obtained in these early days of the metallic filament lamp industry, and it speaks well for the future that lamps containing four separate filaments, each nearly as long as the single filament of a 100-volt carbon lamp and of about one twenty-fifth of the section should show such consistent and reliable results. The position of the 200-volt metallic filament lamp is made promising by these tests, for the average life of about 1,570 hours leaves a margin for considerable diminution. At Harrogate, too, excellent results have been obtained, and an even higher average life is indicated; and Mr. G. WILKINSON calls attention to a curious fact, that the life of the lamps seems longer when not enclosed in globes, owing, possibly, to some temperature effect. His figures of costs effectually prove that street lighting by Osram lamps is considerably cheaper than gas.

As we stated in our last issue, we trust that the term "wire lamp" will soon replace "metallic filament lamp" in general use. Some correspondents raise technical objections in letters printed in another column, but we think that it should be generally agreed that it is quite accurate enough for practical purposes to call the "filament" a wire, even when it is not wire-drawn. Before adopting the name definitely in our columns, however, we await some further expressions of opinion on the matter, for its use by a minority only would lead to occasional confusion. The term "metal lamp," which has been suggested as a substitute, seems to have some advantages.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, MAY 7TH.

Royal Society.

4 p.m. Meeting at Burlington House. Among the Papers down for reading are the following:—(1) "Helium and Radioactivity in Rare and Common Materials," by the Hon. R. J. Strutt, F.R.S. (2) "A Tantalum Wave Detector and its Application in Wireless Telegraphy and Telephony," by L. H. Walter, communicated by Prof. J. A. Ewing, F.R.S.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at the Society of Arts, John Street, Adelphi. Paper to be read:—"The Manufacture of Electrical Condensers," by G. F. Mansbridge.

Röntgen Society.

8.15 p.m. Meeting at 20 Hanover Square, London, W. Agenda:—Paper by Dr. Horace Manders on "Continuous Oscillations of Electricity and Their Application." Mr. R. S. Wright will show and explain the new "Vita" interrupter for obtaining an increased output from an induction coil without a corresponding increase of primary current.

FRIDAY, MAY 8TH.

Physical Society.

8 p.m. Meeting at the Royal College of Science, South Kensington. Mr. C. G. Whitehead will read a Paper on "An Examination of the Formulæ for the Grading of Cables."

Association of Engineers-in-Charge.

8 p.m. Annual Meeting at the St. Bride's Foundation Institute, Bride Lane, Fleet Street, E.C.

TUESDAY, MAY 12TH.

Faraday Society.

8 p.m. Meeting at the Institution of Electrical Engineers, 92 Victoria Street, Westminster. Agenda:—(1) "The Industrial Uses of Ozone in Connection with Water Purification," by Dr. F. M. Perkin. (2) "Determination of Boiling Points of Very Small Quantities of Liquids," by L. O'Dowd and Dr. F. M. Perkin. (3) Dr. Veley, F.R.S., will exhibit an apparatus for measuring dielectric constants of non-conducting liquids.

Institution of Electrical Engineers: Glasgow Local Section.

8 p.m. Annual General Meeting. Messrs. Handcock and Dykes' Paper on "Electric Supply Prospects and Charges as Affected by Metallic Filament Lamps and Electric Heating" will also be discussed.

Incorporated Institution of Automobile Engineers.

8 p.m. Meeting at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, when the following Papers will be read:—(1) "The Effect of Motors on Roads," by D. Mackenzie (from the Motor Engineer's point of view) and W. J. Taylor (from the Road Engineer's point of view). (2) "Notes on Wheel Diameters," by Col. R. E. B. Crompton, C.B.

THURSDAY, MAY 14TH.

Iron and Steel Institute.

10.30 a.m. Annual Meeting at the Institution of Civil Engineers, 25 Great George Street, Westminster, London.

7 p.m. Annual Dinner in the Grand Hall of the Hotel Cecil.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at the Society of Arts, John Street, Adelphi, London. Paper to be read:—"Switchgear Control Apparatus and Relays for Alternating-Current Circuits," by Dr. C. C. Garrard.

FRIDAY, MAY 15TH.

Iron and Steel Institute.

10.30 a.m. Annual General Meeting at the Institution of Civil Engineers, 25 Great George Street, Westminster, London.

SATURDAY, MAY 16TH.

Birmingham and District Electric Club.

7 p.m. Meeting at the Colonnade Hotel, New Street, Birmingham. Paper to be read:—"Electrical Porcelain," by H. W. Brady.

Kent Collieries Electrical Plant.—In the Official Referee's Court on Wednesday, Mr. Muir Mackenzie had again before him the action brought by Messrs. Ernest Scott & Mountain, Ltd., against the Kent Collieries, to recover the balance of the contract price for electrical plant supplied, and further sums for wages paid and for repairs. Defendants pleaded that the plant was not in accordance with the contract, and counterclaimed for damages to the amount of £48,000. At the last hearing evidence was given for the plaintiffs by Mr. Hodgkin, assistant managing director of the company, and Mr. Mountain, director (see ELECTRICAL ENGINEERING, April 16th, page 601). Mr. J. J. Prest, a Durham colliery manager and mining engineer, who gave evidence on behalf of the plaintiffs, said that the machines supplied were quite in accordance with the specifications. Mr. Morley, who was left in charge of the work, remarked on the difficulty of working the pumps in the shaft, owing to the amount of suspended matter in the water. Several times the pump was choked up altogether, and in December, when he examined the pump, he found the spindle was reduced in diameter from 3¼ inches to 2⅝ inches, due to the action of the suspended matter. Other evidence was given to show that the generators supplied were of the required output, and that steam plant had not been properly looked after. Mr. Morley thought that the cause of the breakdown of the pump motor was the condensation of moisture after the machine was stopped. It had been running for some time, and was hot. After 3½ hours it was started up again, without any preliminary drying out of the coils. With regard to the delay, witness said that he was obliged to write to his own company for materials which he had expected to be supplied with. Mr. Bousfield opened the defence by saying that from the defendants' point of view the counterclaim was the most serious part of the case. The Kent Colliery Co. had raised some £100,000 in cash in order to take over the Dover Colliery, and continue the work. As a result of the failure of the motors and pumps, a large amount of the capital had been sacrificed. They had used the plant, though it was not capable of doing the work, without overheating, in order to save time. Counsel thought that the plaintiffs should have reckoned on the serious result of condensation in such enclosed motors. The motors, he said, had never had anything like their full load without overheating and breaking down. The plaintiffs had guaranteed a steam consumption of 28 lbs. per kilowatt hour, but the actual consumption had been 47 lbs. Plaintiffs, however, contended that they guaranteed the consumption to be 28 lbs. of steam per kilovolt-ampere, not per kilowatt. Mr. Bousfield, continuing, said that the first pump was not delivered until two months after the date fixed by contract, and he held that the defendants were entitled to compensation for this delay. The work of pump should have occupied only a fortnight, whereas it actually took five months. The defendants claimed damages for this delay also, which, they held, was entirely due to the incapacity of the plant supplied. The hearing was adjourned.

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NEW 6,000 KW. TURBO-ALTERNATOR AT THE MANCHESTER CORPORATION ELECTRICITY WORKS

Inaugural Ceremony

ON Tuesday the Lord Mayor of Manchester (Mr. Edward Holt) performed the ceremony of starting up a new 6,000 kw. turbo-alternator at the Stuart Street works. We are obliged to postpone our detailed description of the set until our next issue, but it is interesting to note that it is not only the largest generator running in this country (or one of the largest, since the latest ones at Carville, Newcastle, have about equal output), but it is also, we believe, the first large turbo-alternator that Messrs. Siemens Bros.' Dynamo Works have supplied in England, and the largest steam turbine that Messrs. Willans & Robinson have yet built for any electricity works. The machine will supply three-phase current at 6,500 volts, between phases and 50 cycles frequency, and runs at a speed of 1,000 revs. per minute.

Although not precisely of the Continental "chimney" type, the alternator is cooled by forced ventilation, supplied by a Sirrocco fan in a small building outside the generating station. This air circulates through the machine, and then passes out again by a separate air duct from the base of the station.

Beneath the turbine is a Richardson-Westgarth "contraflo" surface condenser with electrically-driven pumps. At present the existing boiler plant and the existing cooling towers are employed, but extensions will shortly be made.

The Lord Mayor of Manchester presided at a dinner held in honour of the occasion in the evening. In responding to the toast of the Lord Mayor and Corporation, proposed by Mr. Alexander Siemens, he said that he considered that trading committees of municipalities should make at least 5 per cent. profit in aid of rates, after proper amounts had been set aside for depreciation and reserve fund, in addition to the sinking fund. Councillor Royse proposed "The Trade and Commerce of Manchester," and Mr. Francis Ashworth, President of the Manchester Chamber of Commerce, replied.

Dr. E. Hopkinson, in giving the toast of the Electricity Department, called attention to the progress that had been made since the first station was built in Dickinson Street fifteen years ago, under the advice of his brother, the late Dr. John Hopkinson. The output was half a million units per annum then; for the year 1907–8, it was 63 million units from the present Manchester electricity works. He called attention to the fact that the five-wire distributing system originally laid in the centre of the city is still in use. Councillor Howarth, Chairman of the Electricity Committee, in his reply, dealt first with the Lord Mayor's remarks as to profits. He said that a duty as important as relieving rates was the supply of power at low but remunerative rates to encourage the Manchester industries, and also to lessen the smoke emitted by the manufacturing works. There were, he pointed out, 1,000-h.p. plants near at hand giving out as much smoke as the Stuart Street station with its 30,000 h.p. The output of 63 million units for the year closed on March 31st last, was an increase of 16 million units over the previous year, and, in spite of reduction in price charged to consumers and to the tramway department and an increase in the price of coal, there had been a large surplus over the estimates.

Councillor Kay, Deputy Chairman of the Electricity Committee, proposed "The Visitors," and Mr. Bythell, Managing Director of the Manchester Ship Canal, responded. The last toast was that of "The Contractors," given by Alderman Jennison, Chairman of the Stuart Street Sub-Committee, who expressed his confidence in the firms employed to carry out the contracts, and referred to the fact that the accepted tender had not been the lowest. [The lowest tender was by the Westinghouse Co., and was not accepted, but we believe the difference in price was not great.] Mr. Peache, of Messrs. Willans & Robinson, in his reply, referred to the assistance that had been given him by Mr. Pearce, the City Electrical Engineer, in carrying out the work.

THE FRANCO-BRITISH EXHIBITION

Co-operative Electrical Exhibit

IN connection with the announcement made in our issue for April 16th, page 579, that the endeavour made by Dr. R. T. Glazebrook and Mr. C. S. Northcote to secure support for a co-operative electrical exhibit at the Franco-British Exhibition had failed, we are pleased to see that the idea is not to be entirely abandoned. The London electric supply companies from the commencement have strongly urged the need for such an exhibit, and the following letter, which we have received from Mr. F. J. Walker, secretary of the St. James's and Pall Mall Electric Light Co., and hon. secretary of the Conference of Chief Officials of the London Electric Supply Companies, indicates that they are not disposed to abandon the project. The history of the previous effort was given in our issues for April 2nd and 16th. Mr. Walker's letter, which is being sent around to the trade, is as follows:—

You are doubtless aware that the steps which were taken to organise a collective electrical display at this Exhibition were recently abandoned through lack of sufficient support. The Electric Supply Companies of London are strongly of opinion that, having regard to the magnitude of the Exhibition, the importance of which has not as yet been sufficiently realised, it would be detrimental to the interests of the industry if further efforts are not made to remove the necessity for this decision, and they have therefore resolved to make this appeal to the trade to secure their co-operation in promoting a collective exhibit worthy of the occasion.

With this end in view, and because of the shortness of time at their disposal, my Conference have taken upon themselves the responsibility of securing a suitable space in the Machinery Gallery, and have arranged with Messrs. Waring for the erection thereon of a handsome pavilion. Sufficient funds have been guaranteed by the Supply Companies to cover the cost of the space and pavilion, and the general superintendence of the exhibit will be undertaken free of charge by my Conference; but there remains the expense of wiring, current, and attendance still to be provided for, which may be estimated not to exceed £600. If, as is hoped, not less than thirty firms respond to this invitation, the average inclusive contribution per exhibitor would not be more than £20, and as there is no obligation on exhibitors to provide attendance (though they are, of course, at liberty to do so if they think proper), it will be seen that the cost of participation is extremely moderate. It is proposed that half this contribution should be paid before the opening of the exhibit, and the balance, or such amount of it as may be required, at a later date.

The pavilion will be divided up into six sections as follows:—(1) A suite of furnished rooms, comprising hall, dining-room, drawing-room, bedroom, nursery, and kitchen designed for the display of domestic lighting, heating, cooking, and ventilation. (2) Small machinery worked by motors. (3) Medical apparatus, including baths, high-frequency and X-ray appliances. (4) and (5) General exhibits. (6) Reception room and information bureau, which will be available for a few selected exhibits.

I am directed by the Conference of Officials to appeal to you to contribute to the success of this exhibit by signifying your intention of participating, and informing me what class of goods you propose to show and the approximate amount of space required. I shall be also greatly obliged if you will attend a meeting at this office on Wednesday next, the 6th inst., at 4 p.m., when the subject can be more fully discussed. I would draw your attention to one of the regulations of the exhibition that all goods exhibited must be of British production or manufacture.

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CORRESPONDENCE

"WIRE LAMPS."

To the Editor of Electrical Engineering.

Sir,—On page 647 of your issue of the 30th ult., I note in your letter on "Metallic Filament Lamps" a reference to Mr. Mordey's suggestion that incandescent lamps with filaments composed of metal or metal alloy should be called "Wire Lamps." It seems to me that, although this name is more convenient than the usually accepted "Metallic Filament," it is somewhat of a misnomer. When one talks of a "wire" one has in mind a metal rod which has been drawn through a die. Now, most of the metallic filament lamps have filaments composed of more than one metal, and in some cases are certainly not entirely metallic; for instance, the "Osram" lamps at the present date contain a certain proportion of carbon in their filaments, though I am aware that this is an incident in manufacture and is not really intended. However, the case is as I state; in fact, it seems to me that the only lamp which can be called a "Wire" lamp without terminological inexactitude is the "Tantalum" lamp.

Yours faithfully,
E. C. L.

[In connection with this question, we have endeavoured to ascertain the views of some of the leading makers of these lamps, and give some of the most interesting of the letters which we have received so far below.—Ed. *E.E.*]

To the Editor of Electrical Engineering.

Sir,—We are in receipt of your letter of the 2nd inst., *re* suggestion to use the name "wire lamp" instead of "metallic filament lamp" as applied to this class of lighting. The term is certainly convenient, but we cannot say that it is appropriate. We would suggest as a simplified term the name "metal lamp," which we think would meet the views of everyone concerned.

Yours faithfully,
M. Grainger.
(Sunbeam Lamp Co., Ltd.)
Gateshead, May 4th, 1908.

To the Editor of Electrical Engineering.

Sir,—I am in receipt of your favour of the 2nd inst., and in reply beg to say that, to my mind, Mr. Mordey's suggestion that the term "wire lamp" be used in place of "metallic filament lamp" deserves commendation for the sake of simplicity. I fear, however, that to the "man-in-the-street" it would convey a wrong impression, for he would argue somewhat on these lines:—Why should I pay such a high price for these lamps when the filament is only made of *wire*? Even in the early days of electric incandescent lamps the layman's expression for the carbon filament was "the black wire." Viewed from a purely commercial aspect—which, after all, is a point of view not to be lost sight of by any manufacturer—I have great doubts whether merely the description "wire lamp" would be conducive in making the new current-saving device more popular. The tendency of the manufacturer is to coin a trade name for his product, and he tries to make it known by such. The more retentive that name is, the more frequent will be the inquiries for the article to which it applies. The old saying, "Give a dog a bad name," &c., may be paraphrased, "Give a new article a good name, and it will require no pushing."

Faithfully yours,
H. Oppenheimer.
(International Electric Co.)
55 Redcross Street, E.C., May 5th.

To the Editor of Electrical Engineering.

Sir,—Replying to your esteemed letter of the 1st inst, addressed to Messrs. Philips & Co., we would say we do not fall in with Mr. Mordey's suggestion to use the term "wire lamp" instead of "metallic filament lamp," seeing this is not a clear definition of the lamp in question.

Yours respectfully,
Philips' Metallic-Glowlampworks, Ltd.
Eindhoven (Holland), May 4th.

To the Editor of Electrical Engineering.

Sir,—We are in receipt of your letter of the 1st inst., and note that Mr. Mordey suggested the use of the term, "wire lamp" instead of "metallic filament lamp." We quite agree with you that the latter name is too long; at the same time, we do not consider "wire lamp" a proper term either. We think "metal lamp" would be much more appropriate, for the simple reason that, firstly, it is just as short as "wire lamp," and, secondly, as a number of metallic filament lamps are not made of wire. We have used the term "metallic filament lamp" for a considerable time, and our customers are quite used to it.

Yours faithfully,
J. Stottner.
(The Electrical Co., Ltd.)
Charing Cross Road, May 5th, 1908.

To the Editor of Electrical Engineering.

Sir,—We are in receipt of your letter of May 2nd, with regard to the suggested use of the term "wire lamp" for metallic filament lamps. As far as we are concerned, the matter does not appear to us to be of very great importance, but at present we are not inclined to agree to the term of "wire lamp," as most of the metallic filament lamps on the market are not made of wire. Perhaps some of your correspondents will be able to suggest another term, which would be more in keeping with the actual material used in the filament.

Yours faithfully,
C. Wilson.
(Robertson Electric Lamps, Ltd.)
Hammersmith, May 5th, 1908.

To the Editor of Electrical Engineering.

Sir,—Replying to your letter, I think that the term "wire lamp" is certainly terse, but it does not describe it sufficiently well. The word "wire" certainly suggests something far thicker than the filament of an "Osram" or "tantalum" lamp. The public has already begun to learn the name of metallic filament lamp in conjunction with the names "Osram" and "tantalum"; why complicate matters further by changing the name again?

Yours faithfully,
A. G. Beaver, Manager.
(Sun Electrical Co., Ltd.)
Charing Cross Road, May 5th, 1908.

International Conference on Electrical Units and Standards.—The President of the Board of Trade has appointed a committee, consisting of Mr. G. R. Askwith, K.C., Sir John Gavey, K.C.B., Dr. R. T. Glazebrook, F.R.S., Major P. A. MacMahon, F.R.S., Major W. A. J. O'Meara, R.E., C.M.G., and Mr. A. P. Trotter, to prepare a programme for the consideration of the Delegates to the International Conference on Electrical Units and Standards, to be held in London in the ensuing autumn, and to make arrangements for the reception and assembly of the Delegates attending the Conference. Mr. M. J. Collings, of the Board of Trade, will act as secretary to the committee.

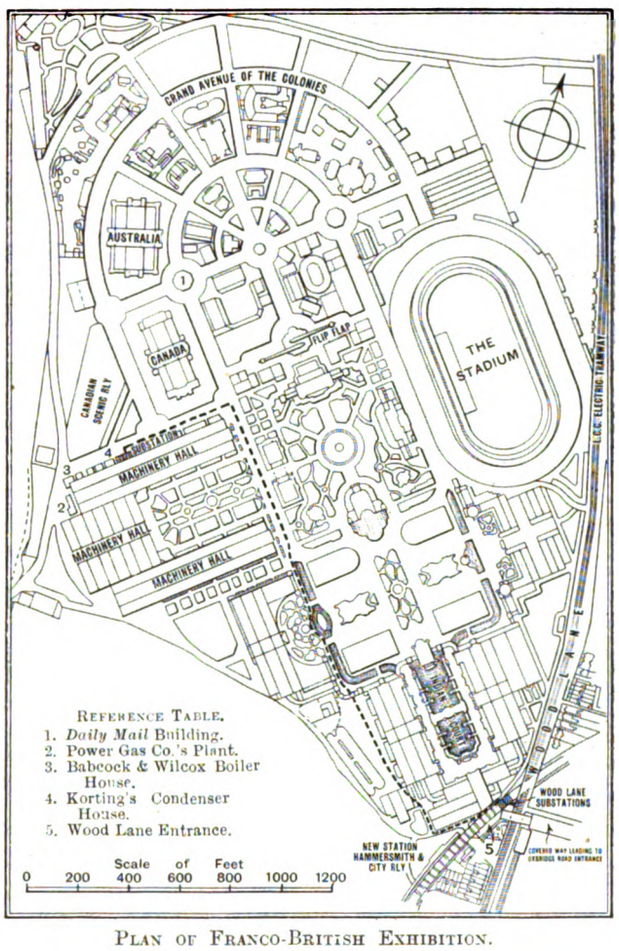
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THE ELECTRICAL ARRANGEMENTS AT THE FRANCO-BRITISH EXHIBITION

THE increasing part which electricity has played in various ways in large exhibitions during the last few years is very noticeable, and it is not to be wondered at that at so large a display as the Franco-British Exhibition, which opens next week in London, the arrangements for the supply of electricity for power and lighting form an undertaking of very considerable magnitude. In considering the special facilities for access to the site near Shepherd's Bush, one cannot help also noticing the prominent part played by electric traction. Special stations have been constructed on two electric railways, and electric tramways, forming part of two different systems, pass the doors. The extension of the Central London Railway, which will be dealt with more fully next week, includes a new station close to the Wood Lane entrance of the exhibition. Close to this, on the other side of the road and practically within the exhibition area, is the new station on the electrified Hammersmith and City Railway, which forms an intermediate station on that line between Shepherd's Bush and Latimer Road. The line is here carried on a viaduct of brick arches, and the station has been made by the addition of more or less temporary wooden platforms with the necessary stairs, &c., on each side of the viaduct. The London United Tramway terminus is opposite the so-called main entrance to the exhibition in Uxbridge Road, which is connected to the exhibition proper by a spacious overhead covered way some 70 ft. wide and 900 yards in length. This passage, which is not shown in the plan, is carried partly over the Central London Railway extension and terminates in a bridge over Wood Lane at the Wood Lane entrance. The other electric tramway connection is that of the new Hammersmith-Harlesden London County Council line, which crosses Uxbridge Road and passes up Wood Lane. This line is now in an advanced stage of construction, and is interesting as being the first L.C.C. line on the overhead trolley system. Electrical interest will, of course, centre around a certain proportion of the exhibits, particularly in the French section, and there is every reason to hope that the British electrical industry will be represented to some extent, owing to the revival of the scheme for a co-operative electrical exhibit, to which we have referred on several occasions. A consideration of the exhibits must be deferred until after the opening of the exhibition, but it is the purpose of this article to deal more particularly with the arrangements for the supply of electricity for lighting and power which, at the time of writing, are in a more advanced state than much of the work of other departments.

Some idea of the magnitude of the undertaking may be gathered from the facts that the area of the exhibition site is 140 acres, not including the passage-way to Uxbridge Road, which accounts for another 4 acres; over 2,000 arc lamps are used in what may be called the public lighting as distinct from the lighting of the stands, and the whole electrical installation is said to have cost about £30,000, of which the cables alone account for about £20,000. The maximum load taken from the bulk supply from external sources, to which reference is made below, is 3,000 kw., and generating plant, aggregating about the same capacity, is provided within the exhibition. It should be emphasised that the electric supply arrangements in no way partake of the nature of a temporary installation, but the whole of the work is of as substantial and permanent a character as the public supply of a town. Although we are told that gas is to make a wonderful show of its capabilities in the hands of a group of exhibitors, it is electric light and electric light alone that the authorities have relied on for the general and decorative lighting of the exhibition itself.

The bulk supply already referred to is taken under a contract with the Hammersmith Borough Council, in whose area of supply the whole of the exhibition lies. Only about one-half of the supply, however, comes from the Council's station in Fulham Palace Road. The remainder is provided by the Notting Hill and Kensington Electric Supply Co. from their station on the opposite side of Wood Lane, this company acting, so to speak, as sub-contractors to the Hammersmith Borough Council. The terms of the agreement



PLAN OF FRANCO-BRITISH EXHIBITION.

with the exhibition authorities provide for a charge of 1d. per unit from sunrise to sunset, and 2d. per unit from sunset to sunrise, with a minimum payment for the period from May 1st to October 31st of £10,000. The Hammersmith Council guarantee a consumption from the Notting Hill and Kensington Co.'s station of one million units, and will pay for this bulk supply at the rate of 0·8d. per unit, reduced to 0·75d. per unit for quantities over a million units.

The supply from the Hammersmith station is single-phase at 2,200 volts 50 cycles, and that from Wood Lane is three-phase at 5,000 volts 45 cycles. Special feeders have been laid in triplicate from each of the two stations, and these enter the exhibition grounds at the sub-stations, shown on the plan, under the railway arches close to the Wood Lane entrance. The single-phase and three-phase sub-stations are quite dis-

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tinct, although of similar design and situated side by side.

The single-phase sub-station contains three 200-kw. single-phase Berry type air-cooled transformers, supplied by the British Electric Transformer Co., of Hayes, which step down to 2 × 220 volts, with tappings for a neutral wire for the three-wire single-phase distribution system, with the necessary switch-gear. These transformers and the switch-gear on the high-tension side are the property of the Hammersmith Borough Council, but the low-tension boards and wiring belong, of course, to the exhibition. The H.T. board has incoming feeder and transformer panels, and is equipped with Messrs. Cowan's oil circuit breakers, fitted with Mr. L. Andrews' patent discriminating release devices. All the H.T. apparatus is in substantial brick chambers, closed by gates of wire-netting, and the 'bus bars run horizontally along the top between slate partitions. The low-tension board is of simple, straightforward arrangement. The 'bus-bars are carried in front of the board and are sectionalised into three divisions, which can be isolated as desired by withdrawing the horizontally placed switch-fuses with which they are normally connected. Above the bars are the feeder switches and fuses, and at the bottom of the panels are the meters. Owing to the method of charging, a special double tariff meter, supplied by Messrs. Siemens Brothers' Dynamo Works, Ltd., is used in each circuit in conjunction with automatic time switches. The low-tension switchboards were supplied by the Universal Electrical Manufacturing Co., of Queen Street, Battersea. The neutral point of the three-wire system from this board is earthed in the sub-station. The three-phase sub-station equipment is precisely similar, except that the transformers, which are also of the Berry type, are three phase. The secondaries are star connected, and the distribution is four-wire with the neutral earthed in the sub-station. The number and capacity of the transformers are the same, and a similar subdivision of the 'bus-bars is employed. At the time of our visit an extra transformer was in use, connected temporarily to a main leading to another sub-station, to which reference will be made hereafter.

From these sub-stations a series of low-tension 220-volt exhibition feeders are run, from which distributors are teed off to points in the various buildings. Among these feeders, serving in the various buildings in the part of the exhibition south of the central gardens, are one which runs in a straight line along the east side of the Indian Court and on through the next court beyond and another further west. The whole of these feeders consist of lead-covered cable—three-core in the case of the single-phase three-wire feeders and four-core in the case of the three-phase feeders—laid underground in Sykes' patent conduit and provided with a complete system of drawing-in boxes. Brick pits are used at every joint-box and disconnecting-box. A special feature of the lay-out of these feeders is the arrangement of these disconnecting boxes, which are provided wherever a connection is taken into a building, so that by the removal of links any distributing section can be isolated. All the cables were supplied by the Western Electric Co., and were laid by the Reeds Electrical Co., of Southwark. The feeders from the single-phase sub-station range from 0·15 to 0·35 sq. in., and the three-phase feeders vary in size from 0·1 to 0·23 sq. in.

The single- and three-phase feeders, although quite independent, are run in all cases in the same group of ducts, and follow the same route, connections being taken off at the same places, so that at all points served by these sub-stations a duplicate supply is available. At the feeding points, therefore, large double brick chambers are provided, containing the single- and three-phase disconnecting boxes side by side. From these boxes leads are taken in porcelain conduit underground to the actual distributing points within the buildings. The three-phase and single-phase distributing points are, however, kept separate. At each of these points the switch-gear provided is usually as follows, with certain modifications in special instances. The cables first are branched into two, and two separate main switches are provided, one for the arc lighting circuits and one for the exhibitor's circuit. These switches are of a substantial, enclosed design of Messrs. Berry, Skinner & Co., combined with enclosed fuses. Above these switches are one row of switches for the separate arc light circuits. These are of the Cantie quick make and break type, each enclosed in a separate cast-iron case. Each switch has its double-pole fuse in an independent cast-iron case with glass front immediately above it. These fuses are of Messrs. Moy's tubular "no-ark" pattern. At the top of the board, as a general rule, are the line resistances for the arc lamps. The exhibition circuits running around the part of the building in question are taken direct from the other main switch already mentioned without further sub-division, and the circuit for each stand is teed off from these mains. From these circuits all the lighting of the stands is supplied, and small alternating motors, either single- or three-phase, up to 2 h.p.

The wiring in the buildings is all contained in screwed iron gas barrel, with the exception of those parts of the arc circuits up in the roofs, where open wiring of covered wire on bobbin insulators is employed, but no bare wire is used in any part of the exhibition.

The arc lamps are run four in series, and the circuits are arranged so that alternate lamps are on the single- and three-phase services, so that a failure of supply from either source will only extinguish half the lights. Three makes of arc lamp are employed in the exhibition. The "Sunshine" flame lamp by the Electrical Co., alternating flame lamp supplied by the Santoni Arc Lamp & Engineering Co., and the Maxim Electrical Co.'s enclosed lamp. There are also a few continuous-current Santoni lamps.

In addition to the arc and stand lighting, the alternating-current mains will supply from separate distributing points most of the decorative lighting in the part of the exhibition which they serve. This decorative lighting will form an important feature of the exhibition. Practically everyone of the elaborate white buildings is outlined externally by rows of incandescent lamps, varying in number from 2,000 in the smaller buildings to as many as 10,000 in the case of the largest structures. The lamps used are carbon filament 5 c.p. with Edison screw terminals, and the holders are wired in parallel on what is known as "Fairyland" strip. The lighting of the open-air spaces round each building is supplied in an exactly similar way, and many of the distributing boards, as described already, are fixed outside the buildings. In the case of the smaller kiosks, &c., a short length of inch gas barrel is usually run underground from the nearest feeding-point.

Thus far we have only considered the supply to the alternating-current circuits in the southern part of the exhibition, although what has been said regarding the low-tension wiring applies to a great extent elsewhere. The greater part of the rest of the supply, including the whole of the continuous-current light and power circuits, is fed from another sub-station adjoining the Machinery Hall, and the steam- and gas-driven generating sets in the hall itself. For the supply to this sub-station, a set of both single- and three-phase high-tension feeders, at 2,200 and 5,000 volts respectively, are run from the main intake point at the Wood Lane sub-station, following the route marked on the plan, and laid in the same manner as the L.T. feeders. The sub-station itself is divided into two rooms; one of

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these contains a 150-kw. motor generator, manufactured by the General Electric Co., consisting of a standard induction motor of the ordinary slip-ring type, driving an interpole continuous-current 500-volt generator. The induction motor is run direct off the 5,000-volt three-phase circuit without the intervention of transformers. The starter is of the liquid type, and is placed close to the motor. High-tension switchgear of a similar nature to that in the Wood Lane substations is provided. The continuous-current circuit is intended partly for power at 500 volts and partly for lighting at 250 volts, and is, therefore, arranged as a three-wire system. For this purpose a small balancer set, placed in the same room as the G.E.C. motor generator, will be used. The adjoining room in the substation contains two Bruce Peebles-La Cour cascade motor converters, each of 400 kw. capacity, also converting to 500 volts continuous current. It is unnecessary to describe in detail the switch-gear by which any or all of the three converting set can be connected up to the 500- and 250-volt three-wire 'bus-bars from which the continuous-current distributing feeders are taken. The arrangement follows the same general lines as adopted in the alternating-current sub-station. The same sub-station will also give a single-phase alternating 220-volt supply to the neighbouring part of the exhibition from a group of 200-kw. Berry transformers, arranged in a similar way to those in the Wood Lane sub-station. At the time of our visit, however, the arrangements for this were not quite completed, and a 220-volt alternating supply was being taken temporarily over the high-tension mains from the extra transformer, already alluded to, in the Wood Lane sub-station.

The generating plant in the Machinery Hall, to which reference has already been made, will be connected up to the low-tension continuous-current switch-gear in the sub-station, and will form an alternative and additional supply to that given through the converting plant. Current will thus be supplied for the general purposes of the exhibition from two generating sets actually forming part of the exhibits in the Machinery Hall. One of these is a 1,000 h.p. Westinghouse gas engine of the three-crank vertical tandem pattern, direct coupled to a 750-kw. 500-volt continuous-current generator, and supplied with gas from a Mond gas plant exhibited by the Power Gas Corporation, and situated in a separate house close to the end of the Machinery Hall. The other set is a Parsons' turbo-generator set, rated at 1,800 kw. at 500 volts continuous-current, but capable, we understand, of 25 per cent. overload for a considerable period. This set is supplied with steam from a boiler-house near by containing three Babcock & Wilcox double-drum water-tube boilers, each of 10,000-lb. evaporation capacity per hour, and fitted with internal superheaters and automatic chain grates of the firm's latest type. The turbine will exhaust into a Körting ejector condenser, also in a separate building, adjoining the Machinery Hall. These two sets when ready will be connected up to a special switchboard, supplied by Messrs. Crompton & Co., interconnected to the sub-station switchboard in such a way that either the converter or generating plant, or both, can be used on the continuous-current power and lighting load. It is the general intention to take the supply during the day load from the sub-station, and run up the generating plant in the evening.

A number of feeders radiate from the continuous-current boards in the sub-station, some 500-volt only for power purposes and some three-wire feeders from which lighting at 250 volts can be supplied. Amongst these is a special feeder taken right across to the Stadium which is lighted by about 900 flame arc lamps. Another important feeder serving a large part of the northern section of the exhibition is carried round the outer of the two semi-circular avenues known as the Grand Avenue of the Colonies. A special power feeder is run to the "Flip-flap," a remarkable piece of "amusement engineering," near the centre of the exhibition. This machine is driven by a 125-h.p. continuous-current motor. A 250-volt feeder is also run in a northerly direction to the bridge over the lake in the Indian Court, where a charging board is to be provided for the electric launches that will ply on this lake and round the Venetian Canal. Another similar charging station will be established under the Imperial Pavilion. Among other applications of electric power fed from the continuous-current system will be two 40 h.p. motors driving centrifugal pumps for the water supplying the lake in the Indian Court. Most of the amusement devices, including the Canadian Scenic Railway, will also be electrically driven. It should also be said here that the whole of the illuminations in the Court of Honour are to be supplied by continuous current.

In addition to the arrangements made above by the exhibition for power and lighting, a certain number of exhibitors will have their own generating plants. The largest case of an independent plant is that of the buildings devoted to the exhibits of Canada and Australia, which will be supplied from a generating plant consisting of two 100-kw. 230-volt continuous-current dynamos, driven by three-cylinder vertical Westinghouse gas engines. The power and lighting for the *Daily Mail* kiosk, where an edition of that paper will be printed daily, will be derived from a set consisting of a Diesel engine driving a dynamo, manufactured by the Electric Construction Co., capable of an output of 225 amperes at 410 volts, and running at 194 revolutions per minute.

The following are extracts from the regulations for electric power and lighting of the stands, which will be of interest, as showing the conditions under which the supply is given to exhibitors and the care which is being taken to ensure sound work.

The wiring of the exhibitor's space must be carried out by the exhibitor at his own expense, and subject to the rules of the London County Council, London Fire Brigade, local and other authorities, as well as of the Engineer to the Exhibition. The current available will be for motive power in the Machinery Hall 500 volts continuous current; for lighting 220 volts single-phase and three-phase alternating current, 50 periods per second, except in buildings numbered above 50, and those situated in the northern portion of the Exhibition grounds, in which 250 volts continuous current only will be available. Each exhibitor shall supply and erect securely on his stand a hardwood board, having mounted thereon two main single-pole fuses in iron boxes, and a linked double-pole main switch enclosed in a hard wood or metal case; and in addition to this, where the number of incandescent lamps on the stand exceeds 15 lamps (5, 8, or 16 c.p.), a distribution board with a double-pole main fuse way for each circuit of 15 lamps. If the total number of lamps on a stand does not exceed 15, two single-pole encasing type porcelain cut-outs may be used, but the double-pole main switch shall be as specified above. Where conductors enter the back of distribution fuse or switchboards, which are mounted on woodwork, a sheet of asbestos, uralite, or other similar fire-proof material shall be placed behind the conductors. Cut-outs shall be of the high-pressure cylinder type, with tin fuse wire, having a margin of not more than 50 per cent. capacity. All switches must be of quick action, ample dimensions and break, and without intermediate position between "on" and "off." They must be placed out of reach of the public, and must not be beneath counter or in show-cases, but preferably be mounted and protected as distribution boards. Branch switches shall be of the tumbler type high-pressure pattern adapted to carry five amperes.

No bare conductors will be allowed. All conductors shall be of tinned copper, and shall be so proportioned to the work that the current density shall not exceed a ratio of 1,000 amperes to the square inch. All conductors, except flexible cords, shall be insulated with pure and vulcanised rubber, taped, braided, and compounded, and have an insulation resistance of not less than 1,000 megohms per mile. Flexible cord shall be insulated with pure or vulcanised rubber, and covered with stout silk, cotton, or other approved braiding. Its use must be restricted to pendants and portable appliances approved by the Engineer. Wires and cables shall be adequately and firmly fixed, and in all cases where wires are within reach of the public they must

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be enclosed in wood casing or other approved covering. All joints must be soldered, and covered with pure rubber and proof tape. On circuits to carry more than 5 amperes clamped joints must be used. Unencased conductors must be out of reach of the public, securely supported on insulators, and tappings to lamp holders must be made by insulated conductors other than flexible cord, with properly taped joints. Unencased conductors must not be in contact with bunting, gauze, cloth, or other covering material.

Fairyland strips are allowed, but unless the holders are fitted with metal backs must be securely mounted on uralite or similar board or insulators out of reach of the public. No "E.L.B." flexible strip or boards will be allowed, unless in iron cases with glass fronts. Wiring at the back of wood sign boards must be encased. Wood casings with batten holders will be allowed. No imitation candles, shades, or other accessories made in celluloid will be allowed on fittings connected to the circuit, to accumulator batteries, or other source of supply.

If metal tubing be used, both lead and return wires must be in the same tube, and the tubes must be earthed unless exemption be granted by the Exhibition Executive. No socket-connected tubes will be allowed: all tubes must be screw connected, and electrically and mechanically continuous, and must not contain an open seam.

Where externally lighted signs are above 10 ft. from the floor or in positions inaccessible to the public, they may be wired in circuits of not more than 30 lamps of 5 or 8 c.p. Signs lower than 10 ft. will be treated as part of a stand, and must not have more than 15 lamps (5, 8, 16 c.p.) on a circuit. No sign must be fixed direct on woodwork, or within 12 in. horizontally or vertically of wood or cloth work, unless effectively protected by asbestos, uralite, or similar material. Internally lighted signs must be of fireproof construction, and each contain not more than 5 or 8 c.p. lamps; they must be open at the top, and have a number of 1-in. holes in the bottom or sides to permit of thorough ventilation. These lights must not be lighted from the inside without the special written consent of the above-mentioned authorities. No arc lamps will be allowed unless the written consent of the Exhibition Executive has previously been obtained.

Motors exceeding ¼ h.p. must be of the enclosed or enclosed ventilated type, and must be mounted on sheet-iron trays to catch oil. Ventilated openings in motors must be covered with metallic gauze if required by the Exhibition Executive. Such motors must be controlled through d.p. cut-outs, linked switches and fire-proof starting resistance, with "no-current" automatic release. Regulating switches must have the resistance enclosed in fire-proof cases. All switches with projecting handles must be placed in protecting cases, so that the levers cannot be accidentally moved from the "starting" to the "running" position when the circuit is dead. Machinery shall not be driven by electric motors unless the arrangement be approved by the Executive of the Exhibition, and shall conform to the London County Council requirements. If the "starting" current of any motor be excessive in the opinion of the Executive of the Exhibition, it may be necessary to arrange certain times for starting up; and the motor may have to be kept running between certain times, or be run only during certain times as may be arranged.

Neither live transformers nor charged accumulators will be allowed unless special permission be granted by the Exhibition Executive. Where stands are covered in with boarding, the roofing must be of solid construction, and the material be fire-resisting; where fibrous material is used for this purpose, it must be "treated" so as to be fire-resisting in accordance with the rules of the County Council.

The Exhibition Executive reserve the right of supplying and fixing at the expense of the exhibitor a meter for the purpose of registering current which may be consumed by the exhibitor. Should the Exhibition Executive decide in the case of any exhibitor to require him (the exhibitor) to supply and fix the meter, the exhibitor shall do so at his own cost, and the meter shall be of such make as may be approved of by the Engineer of the Exhibition. The reading of the meter so fixed on the exhibitor's stand shall be deemed to show the amount of current consumed, and payment shall be made by the exhibitor to the Exhibition Executive in accordance therewith. Should any meter cease to register, or register inaccurately, the Engineer of the Exhibition shall decide the amount which is payable by the exhibitor.

The Exhibition Executive will also connect the exhibitor's stand with the main circuits in each building, the expenses in connection with which will be charged to the exhibitor, and will be based upon the time occupied and the material used in making the connection; the certificate of the Engineer of the Exhibition shall be accepted by the exhibitor as final evidence of such expenditure.

Tariff of Charges.—For power purposes, 2½d. per B.T. unit. For lighting, 3d. per B.T. unit. Current during the period of the Exhibition, from dusk until close, for a 16 c.p. lamp a payment of 20s. per lamp. For a 8 c.p. lamp, 15s. per lamp.

In conclusion, it may be said that even if electrical engineering be not as well represented among the exhibits as some other branches of industry, the complete way in which the electrical arrangements of the exhibition have been carried out forms an object-lesson in itself. We wish to express our thanks for information given and facilities afforded to our representative by Mr. H. J. Mills, under whose immediate direction the whole electrical installation has been carried out, and to Mr. W. P. Newling, also of the electrical staff of the exhibition. The exhibition is to be opened on Thursday next, May 14th, by the Prince of Wales, and it is hoped that the King and the President of the French Republic will pay State visits.

Telephony in Canada.—A Reuter's telegram states that in the Saskatchewan Legislative Assembly, the Provincial Government has announced that the Bell Telephone Co. is willing to sell its system in the province to the Government.

The Institution of Civil Engineers.—At the annual general meeting of the Institution of Civil Engineers, held on Tuesday evening, April 28th, the result of the ballot for the election of officers was declared as follows:—President: Mr. James Charles Inglis. Vice-Presidents: Mr. W. R. Galbraith, Mr. G. H. Hill, Mr. A. Siemens, and Mr. W. C. Unwin. Other Members of Council: Mr. J. A. F. Aspinall (Liverpool), Mr B. H Blyth (Edinburgh), Mr. C. A. Brereton, Mr. W. B. Bryan, Mr R. Elliott-Cooper, Colonel R. E. B. Crompton, C.B., Dr. G. F. Deacon, Dr. F. Elgar, Mr. M. Fitzmaurice, C.M.G., Mr. A. T. Grant-Dalton (South Africa), Mr. R. A. Hadfield (Sheffield), Dr. C. A. Harrison (Newcastle-on-Tyne), Mr. J. Hobson (Canada), Mr. W. Hunter, Mr. G. R. Jebb (Birmingham), Sir Wm. Thomas Lewis, Bart. (Aberdare), Sir George T. Livesey, Mr. A. G. Lyster (Liverpool), Mr. Thos. Matthews, Mr. A. B. Moncrieff (Australasia), Mr. A. Ross, Mr. J. H. Ryan (Dublin), Mr. J. Strain (Glasgow), Sir Frederick R. Upcott, K.C.V.O. (India), Mr. W. B. Worthington (Derby), and Mr. A. F. Yarrow. This Council will take office on the first Tuesday in November, 1908. The Council have made the following awards for Papers read and discussed before the Institution during the past session:—A Telford Gold Medal to Mr. W. Barclay Parsons (New York), for his Paper on the New York Rapid Transit Subway (see ELECTRICAL ENGINEERING, March 12th, page 394); a Watt Gold Medal to Sir Whately Eliot; George Stephenson Gold Medals to Sir John Ottley, K.C.I.E., Dr. A. W. Brightmore, and Messrs. J. S. Wilson and W. Gore; Telford Premiums to Messrs. F. W. Davis (Darlington), C. R. S. Kirkpatrick (Newcastle-on-Tyne), Hugh T. Ker (Glasgow), G. H. Scott, R. R. Gales, F.C.N. (India), and S. H. Ellis.

Electric Driving in Cotton Mills.—Messrs. Marples, Leach & Co., Ltd., announce that they have secured the contract for the complete equipment of the new mill being erected by the Tyne Ring Spinning Co., Ltd., at Littleborough, near Manchester. This equipment consists of a complete generating plant, including a 1,200 kw. three-phase steam turbo-generator at 50 cycles, 400 volts, a pilot lighting set, condensing plant with electrically-driven pumps, two 400 h.p. three-phase induction motors at 485 r.p.m., two 100 h.p. motors at 360 revs. per minute, one 50 h.p. motor at 360 revs. per minute, and a number of smaller motors. The larger motors will be direct coupled to the driving shafts on the different floors, while the smaller ones will be connected by ropes or belts to the machines which they have to drive. An elaborate engine-room switchboard is being provided for controlling the whole of the power and lighting circuits in the mill, the main lighting circuits being divided into three sets, equally balanced over the three phases, and will be at 230 volts. The contract includes the supply, delivery, and erection of the whole plant, including the wiring throughout. This section of the work, however, Messrs. Marples, Leach & &o., Ltd., will sub-let to local contractors.

Electrical Lectures at the Manchester Municipal School of Technology.—The syllabus of summer evening courses at the Manchester Municipal School of Technology contains particulars of a special course of six lectures on short circuits, which will be given by Dr. E. Rosenberg, and a course of six lectures by Dr. C. C. Garrard on the principles of electrical control. An investigation on the behaviour of insulators, switchgear, &c., on pressures up to 100,000 volts, is in hand under the direction of Prof. A. Schwartz and Mr. J. Lustgarten, in which a limited number of students will be allowed to take part. Other lecture courses comprise "Alternating-current Transmission Problems," by Mr. C. F. Smith; "Electrical Testing," by Mr. A. E. Moore; "Magnetic Measurements," by Mr. W. H. N. James; "Detail Tests on Electric Supply Meters," by Mr. W. Grant; "Photometric Measurements," by Mr. F. Shaw; and "Diseases of Dynamos and Motors," by Mr. J. Davies. The Physical and Electrochemical Laboratories are under the charge of Prof. W. W. H. Gee, Mr. Adamsen, Mr. Butterworth, Mr. J. Bleakley, and Mr. F. Brotherton.

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THE LIFE AND WORK OF LORD KELVIN

The First "Kelvin" Lecture before the Institution of Electrical Engineers

AT the meeting of the Institution of Electrical Engineers last Thursday, Professor Silvanus P. Thompson, F.R.S., delivered the first "Kelvin" lecture. It may be recalled that these lectures, which will be given annually, form part of the memorial to Lord Kelvin, which was recommended by a committee of the Institution in February. The other recommendation was the erection of the statue in a prominent position in London.

Prior to the lecture by Prof. Thompson, Mr. H. F. Parshall presented the Institution with a bronze bust of Benjamin Franklin on behalf of the American Institute of Electrical Engineers. We report the presentation elsewhere.

On December 17th, 1907, aged 83 years, died William Thomson, Baron Kelvin of Largs, when President for the third time of the Institution of Electrical Engineers.

Adequately to set forth the life and work of a man who so early won, and who for so long maintained, the foremost place in the ranks of science, were a task that is frankly impossible; but if we may not attempt the impossible, we may, at least, essay the task of setting down in simple fashion some account of those things which he achieved in the profession represented by this Institution of Electrical Engineers. Let me first set down in briefest outline a sketch of his early life. William Thomson was born on June 26th, 1824, in Belfast, being the second son of James and Margaret Thomson. James Thomson, who was at that time professor of mathematics in the Royal Academic Institute of Belfast, was the son of a small farmer at Ballynahinch, in Co. Down, where his ancestors had settled about the year 1640, when they migrated from the Lowlands of Scotland.

In 1830, when William was six years old, his mother died. His father would never send his boys to school, but taught them himself. In 1832, when William was eight years old, Prof. James Thomson was offered the Chair of Mathematics at Glasgow, and he, and his family of six children, accordingly removed from Belfast. After his removal to Glasgow he still kept the education of his sons in his own hands; and so it happened that in 1834 William Thomson matriculated when in his eleventh year, as a student in the University, without ever having been at school. He early made his mark by his progress in mathematics and physical science, and in 1840 produced an essay, "On the Figure of the Earth," which won him the University medal. His fifth year as student at Glasgow (1839-40) was notable for the impulse towards physics which he received from the lectures of Prof. J. P. Nichol, and from those of David Thomson, a relation of Faraday, who temporarily took the classes in natural philosophy during the illness of Prof. Meikleham. In this year William Thomson had systematically studied the "Mécanique Analytique" of Lagrange and the "Mécanique Celeste" of Laplace, both mathematical works of a high order, and he made the acquaintance—a notable event in his career—of that remarkable book, Fourier's "Theorie de la Chaleur." He borrowed it from the College library, and in a fortnight he had read it completely through. The effect of reading Fourier dominated his whole career thenceforward. He took the book with him for further study during a two months' visit to Germany. During his last year (1840-41) at Glasgow he communicated to the Cambridge and Dublin *Mathematical Journal*, under the signature of "P. Q. R.," an original paper on "Fourier's Expansion of Functions in Trigonometrical Series," which was a defence of Fourier's deductions against some strictures of Prof. Kelland.

He left Glasgow University after six years of study without even taking his degree; and on April 6th, 1841, entered as a student at St. Peter's College, Cambridge. Here he speedily made his mark, and continued to contribute, at first anonymously, to the Dublin and Cambridge *Mathematical Journal*, papers inspired by his study of the higher mathematics and by his love for physics. The analogy of the movement of heat in conductors along lines of flow, and across surfaces of equal temperature, with the distribution of electricity of conductors in such a way that the lines of electric force were crossed orthogonally by surfaces of equi-potential, led to his paper entitled "The Uniform Motion of Heat in Homogeneous Solid Bodies and its Connection with the Mathematical Theory of Electricity." He also formed a close friendship with Stokes, then a young tutor, with whom, until his death in 1902, he maintained a continual interchange of ideas and suggestions in mathematical physics.

Of Thomson's Cambridge career so much has been written of late that it will be very briefly treated here; how he went up for his Tripos in 1845; how he came out Second Wrangler only, being beaten by the rapid Parkinson, and how he beat Parkinson in the Smith's prize competition.

On leaving Cambridge with a college fellowship of £200 a year to maintain him, Thomson went to Paris and worked in the Laboratory of Regnault at the College de France. He was here four months, and made the acquaintance of Biot and of Sturm and Foucault, of whom he spoke in terms of admiration. Thomson was about 21 years old, and had already established for himself a growing reputation for his mastery of mathematical physics. He had published about a dozen original papers, and had experience in three Universities. In 1846, the Chair of Natural Philosophy at Glasgow became vacant by the death of Prof. Meikleham, and Thomson, at the age of 22, was chosen to fill it. This professorship he continued to hold until he resigned it in 1899, after continuance for 53 years. The old College buildings where he lectured and worked for 24 years were ill-adapted for any laboratory facilities, yet he contrived to organise a physics laboratory, the first of its kind in Great Britain, in some disused rooms in a dark corner of one of the quadrangles. In the lecture theatre his intense enthusiasms won for him the love and respect of all students, even those who were hopelessly unable to follow his frequent flights into the more abstruse realms of mathematical physics.

The next few years were years of strenuous work, fruitful in results. By the end of 1850, when he was 26 years of age, he had published no fewer than fifty original papers, mostly highly mathematical in character, and some of them written in French. Amongst these researches there is a remarkable group which originated in his attendance in 1847 at the meeting of the British Association. He had prepared a paper on the exceedingly excellent method, discovered by himself, of treating certain problems of electrostatics by the method of electric images. A more important event was the commencement of his friendship with Joule, whom he met here for the first time. In 1840 Joule had already communicated to the Royal Society a paper on the production of heat by voltaic electricity. He also read papers at the British Association meetings on the "Electric Origin of Chemical Heat" at Manchester in 1842; "On the Calorific Effects of Magneto Electricity," and "On the Mechanical Value of Heat" at Cork in 1843; "On Specific Heat" at Harrogate in 1844; and on the "Mechanical Equivalent of Heat" at Cambridge in 1845. At that time, when there was as yet no doctrine of the conservation of energy, Joule's work was listened to with impatience, and his teachings fell on deaf ears. But Thomson threw himself heart and soul into the new and strange doctrines that heat and work were mutually convertible, though at first he found difficulty in grasping its significance, and for the next six or eight years, partly in co-operation and partly independently, he set his unique powers of mind to unravel those mutual relations. Thomson's mind was essentially metrical; he was never satisfied with any phenomenon until it should have been brought into the stage where numerical accuracy could be determined. "I often say," he once remarked, "that when you can measure what you are speaking about and express it in numbers, you know something about it." It was in this spirit that he approached the subject of the transformation of heat. Temperatures had hitherto been measured by arbitrary scales based on the expansion of quicksilver or of air or other gas, and the quicksilver thermometer scale did not agree precisely with that of the air thermometer. In January, 1848, he communicated to the Cambridge Philosophical Society a paper on "An Absolute Thermometric Scale founded on Carnot's Theory and the Motive Power of Heat Calculated from Regnault's Observations." In this paper he set himself to answer the question, "Is there any principle on which an absolute thermometric scale can be founded?" and arrived at the answer that such a scale is obtained in terms of Carnot's theory, each degree being determined by the performance of equal quantities of work in allowing one unit of heat to be transformed in being let down through that difference of temperature. This indicates as the absolute zero a temperature the point of which would be marked as $-273°$ on the air thermometer scale. Thomson continued to work at the

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subject. He experimented on the heat developed by compression of air, and he verified the singular prediction of his brother, Prof. James Thomson, of the lowering by pressure of the melting point of ice. He gave a thermodynamic explanation of the non-scalding property of steam issuing from a high pressure boiler, and he formulated in the years 1851-54 with scientific precision in a long communication to the Royal Society of Edinburgh the two great laws of thermo-dynamics. In collaboration with Joule, he worked on the thermal effects of fluids under motion, the results appearing between the years 1852–62 in a series of four papers in the *Philosophical Transactions*, and four others in the *Proceedings* of the Royal Society. Thus were the foundations of thermodynamics laid.

In 1852, at the age of 28, William Thomson married Margaret Crum, and resigned his Cambridge fellowship. The happiness of his life was, however, shadowed by his wife's precarious health necessitating residence abroad at various times, and it was at Kreutznach that he made the acquaintance of Professor Helmholtz. A year later Helmholtz again met the Thomsons at Schwalbach. Writing to his father, he described Thomson as certainly one of the finest mathematical physicists of the day, with powers of rapid invention such as I have seen in no other man.

Hitherto, Thomson's work had been mainly in pure science, but towards the end of the fifties, while still in the midst of his thermodynamic studies, events were progressing, which drew him with irresistible force towards the practical applications that made him famous. Indeed, it could hardly be otherwise, seeing that he was a master of whatever he touched. Early in 1853 he had communicated to the Glasgow Philosophical Society a Paper on "Transient Electric Currents," in which he investigated mathematically the discharge of a Leyden jar through circuits possessing self-induction as well as resistance. Faraday and Riess had observed that in certain cases the gases produced by the discharge of sparks through water consisted of mixed oxygen and hydrogen, and Helmholtz had conjectured that in such cases the spark was oscillatory. Thomson determined to test mathematically what was the motion of electricity at any instant after making contact in circuit under given conditions. The result was very remarkable. He discovered that a critical relation occurred when the capacity in the circuit was equal to four times the co-efficient of self induction divided by the square of the resistance. If the capacity was less than this, the discharge was oscillatory, passing through a series of alternate maxima and minima before dying out. If the capacity was greater than this, the discharge was non-oscillatory, the charge dying out without reversing. This beautiful bit of mathematical analysis, which passed almost unnoticed at the time, laid the foundation of the theory of electric oscillations subsequently studied by Overbeck, Schiller, Hertz, and Lodge, and forms the basis of wireless telegraphy.

At the Edinburgh meeting of the British Association in 1854, Thomson read a Paper on "Mechanical Antecedents of Motion of Heat and Light," in which he touched upon the source of the sun's heat and the energy of the solar system, and reverted to his favourite argument from Fourier, according to which, if traced backwards, there must have been a beginning to which there was no antecedent. This was a non-mathematical exposition of work which, as his note-books show, had been going on from 1850 in a very stiff mathematical form, in which Fourier's equations for the flow of heat and solids were applied to a number of outlying problems, including the diffusion of fluids and the diffusion or transmission of electric signals through long cables. He communicated with the Royal Society in 1854 a general investigation of cables under the title, "On the Theory of the Electric Telegraph."

Faraday had predicted that there would be retardation of signals, owing to the coating of gutta-percha acting like the glass of a Leyden jar. Constructing the appropriate differential equation, and using Fourier's integration of it, Thomson drew the conclusion that the time required for the current at the distant end to reach a stated fraction of its steady value would be proportional both to the resistance and the capacity; and as both of these are proportional to the length of the cable, the retardation would be proportional to the square of the length. This is the famous "law of squares" about which so much dispute arose. This Paper was followed by a further research on peristaltic induction of electric currents, communicated to the British Association in 1855, and afterwards in a more mathematical form to the Royal Society. Submarine telegraphy was "in the air."

John and Jacob Brett had pioneered the project for a Dover-Calais cable, and in 1851 Crampton successfully joined England and France. In 1853 Holyhead and Howth were connected by Mr. (later Sir) Charles Bright, and these were followed by the Dover-Ostend and longer cables. Cyrus Field, in 1856, negotiated a cable across the Gulf of St. Lawrence, thus connecting Newfoundland to the American continent. The Atlantic Telegraph Co. was formed to promote a great enterprise to join Ireland and Newfoundland. Field, Brett, Bright, Statham, and Wildman Whitehouse were the chief promoters. Bright was engineer, and Whitehouse, a retired Brighton doctor, was the electrician. In a pamphlet issued by the company in 1857, the statement is made that the scientific world is particularly indebted to Prof. William Thomson for the attention he has given to the theoretical investigation of the conditions under which electric currents move in long insulated cables, and Mr. Whitehouse has had the advantage of this gentleman's presence at his experiments and his counsel upon several occasions. This is one side of the matter. The other side is that Mr. Whitehouse had at the British Association meeting of 1856 read a Paper challenging the law of squares, and declaring that if it were true, Atlantic telegraphy was hopeless. The true significance of this was disposed of by Thomson in two letters to the *Athenæum*. He pointed out that success lay, in the first place, in an adequate section of conductor, and hinted at a remedy deduced from Fourier's equations, which he later embodied in the curb signal transmitter. In December, 1856, he described at the Royal Society his plan for receiving messages, viz., a sort of Helmholtz tangent galvanometer with copper damper to the suspended needle, the deflections being observed by watching through a reading telescope the readings on a scale reflected from the polished side of the magnet, or from a small mirror carried by it. As we all know, he abandoned this subjective method for the objective plan in which a spot of light on the lamp is reflected by the mirror upon a scale. The story of the Atlantic cable, of the failure of 1857, and of the brief success of 1858 has so often been told that it need not be repeated here. Thomson, after the failure of the first attempt, was called upon to take a more active part, and was put in charge of the test-room on board the *Agamemnon* in 1858. Whitehouse was unable to join this expedition, and Thomson, at the request of the directors, undertook the post of electrician-in-charge, without any recompense. After various disheartening mishaps success crowned their efforts. Throughout the voyage, the Thomson mirror galvanometer had been used for the continuity tests, and for signalling to shore with a battery of 75 Daniell cells. The continuity was reported perfect, and the insulation had improved on submersion. On August 5th the cable was handed over to Mr. Whitehouse, and reported to be in perfect condition. Whitehouse at once abandoned the Thomson mirror instrument, and began practising with his own special patented apparatus, using heavy currents and a special transmitter with induction coils. After about a week the reflecting galvanometer and Daniell cells were resumed, and international congratulations were exchanged. But the insulation was found to be giving way, and on October 20th, after 732 messages had been conveyed, the cable spoke no more. It had been destroyed by Whitehouse's use of induction coils, 6 ft. in length, working at some 2,000 volts.

Of the part played by Thomson during the next eight years there is little to speak. Suffice it to say that when the new cable was laid, and the last one recovered and completed, Thomson was the ruling spirit, whose advice was cordially sought and followed. On his return he was knighted for the part he had played so well. He had in the meantime made further improvements in conjunction with Cromwell Varley. In 1867 he patented the siphon recorder, and in conjunction with Fleeming Jenkin, the curb transmitter. Besides all this telegraphic work, he was incessant in research. He had undertaken a series of investigations on the conductivity of copper, he was urging the application of improved systems of metric measurements and the adoption of rational units, and on his initiative was formed the famous Committee on Electrical Standards of the British Association, which, year by year, has done so much to carry to perfection the standards and methods of electric measurement. So early as 1851 he had begun to use the absolute system.

Amongst the activities of these fruitful years was a long research on the electro-dynamic qualities of metals—thermo-electric, thermo-elastic, and thermo-magnetic. This formed the subject of his Bakerian lecture of 1856. He also worked hard at the mathematical theory of magnetism. Faraday's work on diamagnetism had appeared whilst Thomson was a student at Cambridge. It established the fact that magnetic forces were not mere connections at a distance between supposed poles, but connections dependent on the surrounding medium, and Thomson set himself to investigate the matter mathematically. To Thomson we owe the terms "permeability" and "susceptibility" so familiar in the consideration of the magnetic properties of iron and steel.

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In 1859-60 Thomson was studying atmospheric electricity, and for this study he invented the water-dropping collector, and vastly improved the electrometer, which developed into the elaborate forms of quadrant instruments and other types described in the British Association report of 1867. During this work he discovered the fact that the sudden charge or discharge of a condenser is accompanied by a sound; he also measured electrostatically the electromotive forces of a Daniell cell, and investigated the potential required to give a spark of different lengths in air. In these years Thomson was also writing on the secular cooling of the earth and investigating the changes of form during rotation of elastic spherical shells, and if this were not enough to have in hand, he embarked, with his friend, Prof. Tait, on the preparation of a text-book on natural philosophy. In 1867 he communicated to the Royal Society of Edinburgh his famous Paper on "Vortex Atoms." Though he seemed at the end of his life to doubt whether the vortex atom hypothesis was adequate to explain all the properties of matter, the conception remains for all time a witness to his extraordinary powers of mind.

In the winter of 1861 William Thomson met with a severe accident. He fell on the ice when engaged in the pastime of curling, and broke the neck of his thigh. For several months he had to lie on his back, and it was at this time that he adopted the famous green note books which for ever afterwards were the companions of his days. In 1870 Lady Thomson died. In the same year the University of Glasgow was removed to the new buildings on Gilmore Hill. Sir William Thomson had a house here adjoining his laboratory and lecture room.

From his youth he had been fond of the sea, and had early owned boats of his own on the Clyde. For many years his sailing yacht, the *Lalla Rookh*, was conspicuous, and he was an accomplished navigator. His experiences in cable laying had taught him much, and in return he was now to teach science in navigation. First he reformed the mariners' compass; and, dissatisfied with the clumsy appliances used in sounding, he devised the well-known apparatus for taking flying soundings by using a line of steel piano wire. He was vastly interested in the question of the tides, not merely as a sailor, but because of the interest attending the mathematical treatment in connection with problems of the rotation of spheroids. He invented a tide predicting machine, and adopting the beautiful mechanical integrator, the device of his brother, Prof. James Thomson, he invented a harmonic analyser.

In 1874 Sir William Thomson married Miss Frances Anne Blandy, of Madeira, whom he met on one of his cable-laying expeditions. Lady Kelvin, who survives him, became the centre of his home in Glasgow, and the inseparable companion of all his later travels. He built at Netherhall, Largs, a mansion in the Scottish baronial style; and though latterly he had a London house in Eaton Place, Netherhall was the home to which he retired when he withdrew from active work in the University of Glasgow.

Throughout the seventies and eighties Sir William Thomson's scientific activities were continued with untiring zeal. In 1874 he was elected President of the Society of Telegraph Engineers and Electricians, of which, in 1871, he had been a foundation member and vice-president. In 1876 he visited America, bringing back with him a pair of Graham Bell's earliest experimental telephones. He was President of the Mathematical and Physical Section of the British Association that year at Glasgow.

With the advent of electric lighting at the end of the seventies, Thomson's attention was naturally attracted to this branch of the practical applications of science. He never had any prejudice against the utilisation of science for practical ends, and so he scorned not to devise instruments and applications for commercial use. His electrometers, his galvanometers, his siphon recorders, and his compasses, had been made by James White, of Glasgow. In this firm he became a partner, taking the keenest commercial interest in its operations. He gave evidence before a Parliamentary Committee on electric lighting, and discussed the theory of the electric transmission of power, pointing out the advantages of high voltages. In his Presidential Address to the Mathematical and Physical Section of the British Association at York, he spoke of this and of the possibility of utilising the powers of Niagara. He also read two papers, in one of which he showed mathematically that in a shunt dynamo the best economy of working was attained when the resistance of the outer circuit was a geometric mean between the resistance of the armature and of the shunt. In the other he laid down the famous law of economy of copper losses for the transmission of power.

Lord Kelvin's patented inventions were very numerous. Without counting all those since 1900, taken mostly in the name of Kelvin and James White, they numbered 56. Of these, 11 relate to telegraphy, 11 relate to compasses and navigational apparatus, 6 to dynamo machines or electric lamps, 25 to electric measuring instruments, 1 to the electrolytic production of alkali, and 2 to valves for fluids. He was an independent inventor of the zigzag method of winding alternators, which was published under the name of Ferranti's machine, which was manufactured under royalties payable to him.

In 1884 he was revolving over the speculations which later in the same year he was to pour out in such marvellous abundance in his famous twenty lectures at Baltimore on "Molecular Dynamics and the Wave Theory of Light." All his life he had been endeavouring to discover a mechanical explanation for the most recondite phenomena. While Thomson had been seeking to explain electricity, magnetism, and light dynamically, Maxwell had boldly propounded the electromagnetic theory of light. Thomson had never accepted Maxwell's theory. It is true that in 1888 he gave a nominal adhesion, but later he withdrew this, preferring to think of things in his own way. Once Lord Kelvin astonished an audience at the Royal Institution by a discourse on "Isoperimetrical Problems," intended to give a popular account of the mathematical process for determining maxima and minima. On another occasion he entertained the Royal Society with a discourse on the homogeneous partition of space in which the fundamental packing of atoms was geometrically treated.

To the last Lord Kelvin took an intense interest in the most recent discoveries. Electrons, or "electrions," as he called them, were continually under discussion. He prided himself that he had read Rutherford's book on radioactivity again and again, but objected, however, *in toto*, to the notion that the atom was capable of division or disintegration. After taking part in the British Association meeting of 1907, at Leicester, where he entered with surprising keenness into the discussions on radioactivity and kindred questions, he went to Aix-les-Bains for change. He had barely reached his home at Netherhall in September when Lady Kelvin was struck down with a paralytic seizure. Shortly afterwards a chill seized him, and after about a fortnight of prostration he sank slowly and quietly away. He was buried in Westminster Abbey with national honours on December 23rd, 1907. Our sympathies go out to the gracious lady who survives him, and who with such assiduous devotion tended him in his declining years.

Honours fell thickly on Lord Kelvin in his later life. He was President of the Royal Society from 1890 to 1894; he was raised to the peerage in 1892; he was one of the original members of the Order of Merit founded in 1902; was a Grand Officer of the Legion of Honour; and held the Prussian Order *Pour le Mérite*. In 1904 he was elected Chancellor of the University where he had held the Chair of Natural Philosophy for fifty-three years. He had celebrated his jubilee with unusual marks of world-wide esteem in 1896, and finally retired in 1899.

Kindly hearted, lovable, modest to a degree almost unbelievable, he carried through life the most intense love of truth and an insatiable desire for the advancement of natural knowledge. We of this Institution may well be proud of him; proud that he was one of our first members, that he was thrice our President, and that as our President he died. We shall not look upon his like again.

SIR WILLIAM PREECE, K.C.B., F.R.S., in proposing a vote of thanks to Prof. Thompson, said he would be voicing the feelings of everyone present when he said they had enjoyed a delightful hour and a half in listening to the reading of one of the best digested memorials that he had ever listened to, couched in the simplest and most beautiful language, of which Prof. Thompson was a master, touched up with brilliant flashes of scientific truths, and giving an idea of the work of that great man, which otherwise they would have great difficulty in condensing within their own minds. Dr. Thompson had also made the lecture agreeable because he had given delightful little touches of humour which did away with any conception of the lecture being a kind of doleful memorial, and which had left the impression of being a witty and sensible expression of his admiration of the great life which had gone. He himself stood there as one who for over half a century claimed an intimate knowledge and acquaintance with their great chief, but he would not take advantage of the opportunity to say a word of his own feelings in this matter, but would simply say that as a man while Lord Kelvin lived he loved him, and now that he was dead he revered him. It was his duty to propose "That a vote of thanks be accorded to Prof. Silvanus Thompson for the address we have listened to, and to ask his permission for the lecture to be given in the journal of our *Proceedings*."

Prof. F. CAREY FOSTER said he felt it a great honour to second the vote of thanks. To speak at all adequately on the subject in the short time allowed was no easy task, and he thought they must all recognise that Prof. Thompson had most worthily fulfilled that difficult task. He could not quite equal Sir William Preece in claiming half a century's friendship with Lord

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Kelvin, but he could go near to it. He first had the honour of making his acquaintance in 1862, and he would never forget the kindness and generosity which he always showed to younger men. One of the things which he remembered most was his generous appreciation of work which he considered was genuine and true of its kind. Another small point that he might perhaps refer to, in confirmation of Prof. Thompson's lecture, was in regard to mathematical discussions of physics. Lord Kelvin was never satisfied with any mathematical expressions which could not be reduced to arithmetical calculations; a problem, to him, was not solved until it could be reduced to arithmetic. They had heard of his enormous activity; work which any other man would have broken down under; but he was never too full of his own business to be unable to give attention to any claim upon him from others. This was another example of his enormous generosity and kindness. His own thoughts went back to him even more as a man than as an illustrious leader of science, but in both aspects it was a memory that not only they, but the whole nation, might be proud of. They had to thank Prof. Thompson for the most excellent account of this great man whose loss they all feelingly deplored.

PRESENTATION FROM THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

AT the Institution of Electrical Engineers on Thursday, Mr. H. F. Parshall presented, on behalf of the American Institute of Electrical Engineers, a bronze bust of Benjamin Franklin. Mr. Parshall, who is local honorary secretary of the American Institute, said it was his duty and pleasure to make the presentation of this souvenir of the happy remembrances of a trip to England about a year and a half ago. As it would be recalled by those knowing more particularly the circumstances, it was intended to present this on what, perhaps, would have been the most auspicious occasion that could have been in an electrical engineer's life, viz., when Lord Kelvin honoured them by consenting to sit in the chair during the present session. That, alas, was not to be. Both Lord and Lady Kelvin had seen the bust, however, and he had received a note from Lord Kelvin expressing his appreciation and also his admiration of it. When he received a letter from the American Institute of Electrical Engineers, asking him to make this presentation, it stated that the subject was Franklin, and he took the greatest pleasure in making the presentation, since it seemed to him that no more appropriate subject could be found. Franklin, as was admitted both in this country and his own, was the greatest natural philosopher that had been produced on the other side of the Atlantic; Kelvin, they were all glad to admit, was the greatest on either side of the Atlantic; greater than Franklin so far as natural endowments were concerned; greater as a scientist; but still, each the greatest produced in their own continent. So far as Franklin was concerned, it was reasonably stated that he was a British subject; he was, to all intents and purposes. So far as name went, and so far as the name of all principal American scientists went, he was British, but that, they thought, in America in no way detracted. They were only proud that they were British, proud that there was that common ground between them. He therefore requested the Institution of Electrical Engineers to accept the bust as a sincere token of the friendship and esteem of their American brothers, the American Institute of Electrical Engineers.

COL. CROMPTON (President) said the Institution of Electrical Engineers felt very deeply, indeed, this token of respect on the part of American engineers for our great man, Lord Kelvin. They had to thank Mr. Parshall for the very appropriate and kindly way in which he had spoken, and, although they felt that no man could approach our great Kelvin, they felt that if there was another, it was Franklin. He begged that Mr. Parshall would bear to their brothers in America a message of the warm feeling which was felt for them by the members of the Institution. They would never forget their kindly reception at the hands of the American Institute at the time of the St. Louis Exhibition, and it was a poor return they were able to give when the American Institute visited England a year and a half ago. He only hoped there would be another of these meetings, and that the warm feeling that exists, making the two Institutions practically one, would be continued by more and more frequent meetings, and that they might, in the future as in the past, consider themselves almost one body, the presentation that evening being an additional link tying them together.

Wireless Telegraphy.—It is stated that the Admiralty propose to erect a wireless telegraph station at Stoneywood, Aberdeen.

THE MARSEILLES ELECTRICAL EXHIBITION

IN accordance with our previous announcement, an International Exhibition of the Industrial Applications of Electricity was opened at Marseilles on April 19th by M. Chanot, the Mayor of Marseilles, M. Mastier, Prefect of the Department of Bouches-du-Rhône, and other officials. Although the whole of the exhibitors' stands were not yet quite completed, it was evident that this would soon be remedied, for everything was in an advanced state, and great activity was apparent. *L'Electricien* publishes a plan of the Exhibition, which is being held in the Parc du Rond-Point du Prado. The principal building near the centre of the grounds, the Grand Palais, is devoted to industrial and domestic applications of electricity, and the exhibits are divided into the following sections :— Public and private lighting; electrical heating and ventilation for industrial purposes; electrochemistry, electrometallurgy, and allied industries; telegraphy, telephony, bells, and electric clocks; medical electricity; measuring and controlling apparatus; materials and products utilised in the electrical industry; the teaching of electricity. Another large building, named the *Palais de l'Energie*, is devoted to transport and distribution of electrical energy, and the exhibits are classified as follows :— Applications of electric motive power to industry in general; apparatus for hoisting, loading, and unloading; and applications to military and marine engineering and public works. In a separate building are shown exhibits relating to applications of electricity to mines and quarries, and a large section dealing with electric traction. The applications of electricity to agriculture are also represented in another part of the Exhibition, where experimental installations have been put down. A feature of the Exhibition is a collection of historical electrical exhibits, showing the rapidity with which the electrical industry has advanced, and a very complete library and reading-room is provided, where visitors can consult a large collection of electrical works and current electrical literature.

As already announced, a Congress on the Applications of Electricity will be held at Marseilles in September next, and a considerable number of persons have already signified their intention of taking part.

Animated Photography in Natural Colours.—At Urbanora House, Wardour House, on Friday last, Mr. G. Albert Smith gave a demonstration of his system of animated photography in colour. Briefly, the process is as follows :—The photographs are taken with an ordinary bioscope camera on a film which is sensitive to red and yellow as well as blue light. Alternate photographs are taken through yellowish red and yellowish green screens respectively. The film is developed in the absence of all light, and a positive printed. This positive film is projected on the screen, and the photographs which were taken through the yellowish red screen are projected through a yellowish red screen. The intermediate photographs are projected through a yellowish green screen. Owing to the phenomenon of persistence of vision, the two coloured pictures are superimposed on the retina, and the observer apparently sees a completely coloured picture. The speed of projection is about 32 pictures per second. Three consecutive photographs through red, yellow, and green screens respectively would be preferable, but the high speed to secure all three pictures simultaneously on the retina would be impracticable. With two colours, however, an excellent result is obtained. The building is ventilated throughout by means of electric fans (port-hole extraction and pedestal types), and the offices are heated by electric radiators. All machines are driven by enclosed electric motors with enclosed regulators and switches. The printing and drying machines, and also those for perforating the films, are all driven electrically, and the neat and cleanly appearance of the various rooms in the establishment speaks well for this system of driving. Owing to the inflammable nature of the material dealt with, any form of lighting other than electric would have been distinctly dangerous. The studio is equipped with 14 photographic lamps of 25 amps. each, to burn singly on 214 volts, which are separately controlled and regulated from a special D.P. switch fuse board in the room. The theatre and exhibition rooms are each supplied with two 65-amp. projectors, in addition to the usual apparatus used in theatres. The lighting is extensive and various, consisting as it does of about 200 ruby lamps of 5 c.p., 220 carbon filament lamps of 50 to 8 c.p. and 200 tantalum 80 to 30 c.p. patent tubular lamps. All the wires, cables, &c., are contained in heavy gauge Simplex screwed conduit, and no point in any wire has been permitted throughout the work. A switchboard mounted on white marble with tandem knife switches and tubular fuses, in an oak cabinet frame (which swings on a trolley, so as to enable the connections, &c., at back to be conveniently reached) controls the whole. The entire work and installation has been carried out to the specification, and under the supervision of, Mr. E. H. Johnson, and the material, including switchboards, motors, &c., has been supplied by the E.M.F. Manufacturing Co., 10 Ironmonger Lane.

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THE EDISON BATTERY FOR AUTOMOBILES

THE more robust mechanical construction of the Edison alkaline cell is claimed to render it more suitable for use on electric road-vehicles than the ordinary lead accumulator, and although the increased output for a given weight over that of the lead cell is not so great as was at one time expected, yet the output is certainly higher, and there are other advantages which indicate its superiority for automobile work. The Bergmann Elektricitätswerke Akt.-Ges. of Berlin have developed a series of types of electrically-propelled vehicles in which Edison cells are used, and through the courtesy of Messrs. Marples, Leach & Co., of London, who are the sole agents for this country, we are able to give a description of the electrical equipment of some of these cars.

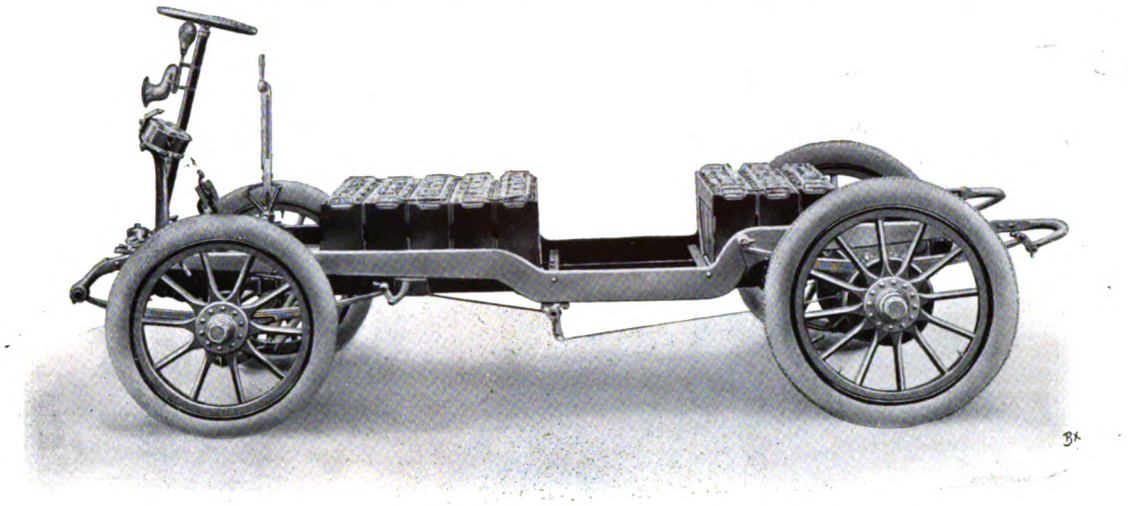


Fig. 1.—Chassis for Landaulette, with Cells arranged under the Seats.

The standard chassis for landaulettes or similar cars for private or public town use is illustrated in Fig. 1. A single motor drives the back axle through single-reduction spur gearing and a differential, the ratio of the gear being 5 : 1. The axles and gear-wheels are of nickel-steel, and roller bearings are provided. The motor has a continuous rating of 5 h.p., but has a one-hour rating of 15 h.p. It is an 80-volt two-pole series motor without interpoles, and runs normally at a speed of 1,500 r.p.m. This chassis can also be obtained with hub-motors in the back wheels, and it is thought by the agents that, in spite of their lower efficiency and the increased weight, these low-speed hub-motors will supersede the single high-speed geared motor for town use.

The crates containing the cells are arranged under the seats, as can be seen from Fig. 1. The number of cells is 64. Each cell has a capacity of 175 ampere-hours, and an average pressure of 1·23 volts. The total capacity of the battery is thus 14 kilowatt hours, or 11 watt hours per lb., which is somewhat higher than the capacity of a lead battery of equal weight. The construction of the cell is shown in Figs. 2, 3, and 4. The nickel-steel plates in which are inserted the perforated steel pockets containing the iron or nickel oxide are assembled and bolted together with a surrounding ebonite frame, as shown in the figures. These cells are manufactured by the German Edison Accumulator Co., and the mechanical design and the composition of the active material are almost exactly the same as of those exhibited at the St. Louis Exhibition in 1904. At any rate, cobalt is not used in the composition for these cells. The electrolyte is a caustic potash solution, and under normal conditions of working the cells should be filled up with distilled water every three weeks. The normal charging current is about 65 amperes, and the charging takes about 3¾ hours. Messrs. Marples, Leach & Co. supply a special filling apparatus. The nozzle of a flexible tube is inserted in the opening provided at the top of the cell, and as soon as the water reaches the tip of this nozzle, an electric circuit is completed and a bell rings. Each cell weighs complete between 18 and 19 lb., and as the cells are arranged in sets of 8 in wooden trays, each tray weighing 160 lb., the battery can be readily removed if necessary. The cells, however, do not require washing out, as it is impossible for any sediment to form at the bottom of the cases. One advantage of the Edison cell is that no objectionable gases are given off during either charging or discharging. The car equipped with the above 64-cell battery can make a run of 56 miles on a level road with a single charge. The maximum speed on the level is about 16 miles per hour.

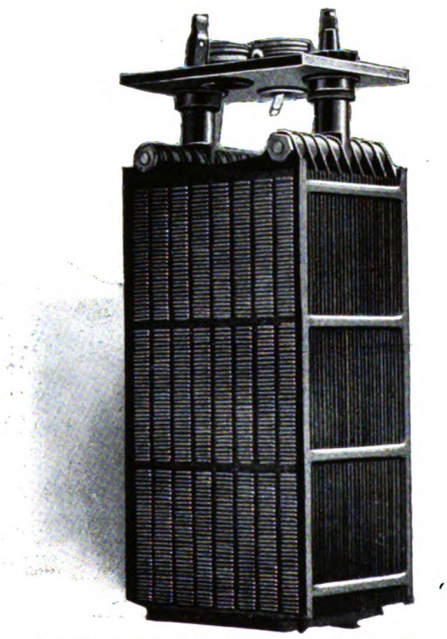


Fig. 2.—Assembled Plates of Edison Cell.

The method of control is very simple, and is as follows:—The battery is divided into two halves, and the series field-winding is also in two halves. On the first

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step of the controller at starting the two halves of the battery are in parallel and the two fields in series; a starting resistance is also in circuit. On the second step the starting resistance is short-circuited. On the third step the two series fields are put in parallel. The two halves of the battery are put in series on the next step with the fields in series, and on the fifth and last step, corresponding to the highest speed, the two halves of the battery are in series and the two series fields are in parallel. The two halves of the battery are in parallel for both backward running steps; the fields are, however, in series and parallel respectively. A series coil for the magnetic blow-out is provided. A new control system has already been designed, in which the regenerative principle will be employed. With regenerative control it is expected that the mileage of the car will be increased to the amount of 15 to 30 per cent. of its present value.

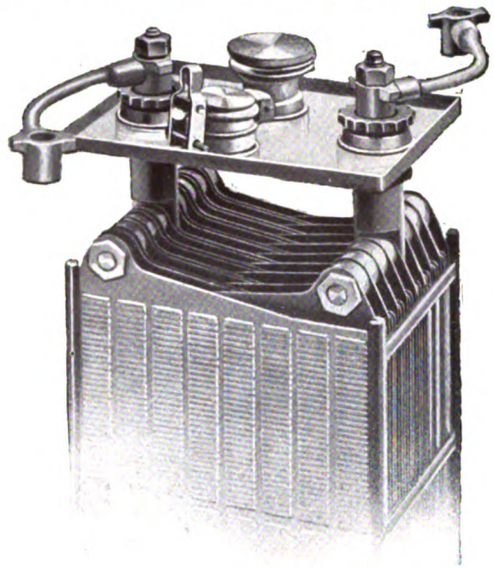


Fig. 3.—Arrangement of Plates and Terminals.

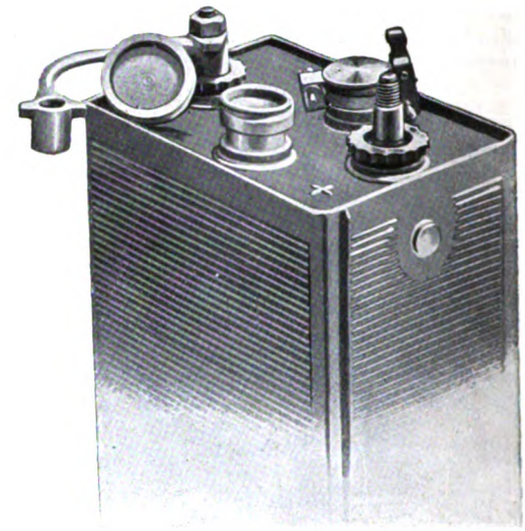


Fig. 4.—Outer Case of Cell.

Besides the light cars of the above type, the company also supplies several types of heavy vehicles. The chassis for a two-ton delivery waggon is illustrated in Fig. 5. It will be noticed that here again only one motor is employed. The motor is geared to an auxiliary axle through differential gearing, and this axle is connected to the back wheels through a chain drive. The battery is suspended from the chassis in a large box, as illustrated in Fig. 5. This two-ton waggon attains a speed of 7½ miles per hour on the level, and with a single charge of 64 cells can cover a distance of 40 miles. The one-ton waggon attains a speed of 12 miles per hour, and covers a distance of 56 miles on one charge. The five-ton waggon is equipped with two motors. The company actually recommends the use of iron tyres for their heavy vehicles, which speaks well for the mechanical construction of the cells.

Experience has shown that the maintenance and repair expenses are remarkably low for these electrically-driven waggons, and the following figures for the cost of running are of interest:—The landaulette car consumes about 120 watt-hours per ton mile, fully loaded and on level roads. If the price of electrical energy is 2d. per unit, this is equivalent to a ½d. for the cost of energy consumed per ton mile, assuming a battery efficiency of 80 per cent. The weight of the chassis illustrated in Fig. 1, with motor but without battery, is 14 cwt. With battery the weight is 25 cwt. The weight of the complete car with motor, battery, body, and all necessary gear is 30 cwt. The car is provided with three brakes, two on the back wheels and one on the motor shaft. No means of braking electrically are provided at present, but, of course, the new regenerative control arrangement provides for this. Messrs. Marples, Leach & Co. are at present moving out of their premises in Victoria Avenue to a larger building in Artillery Lane, E.C., where increased garage accommodation will be available.

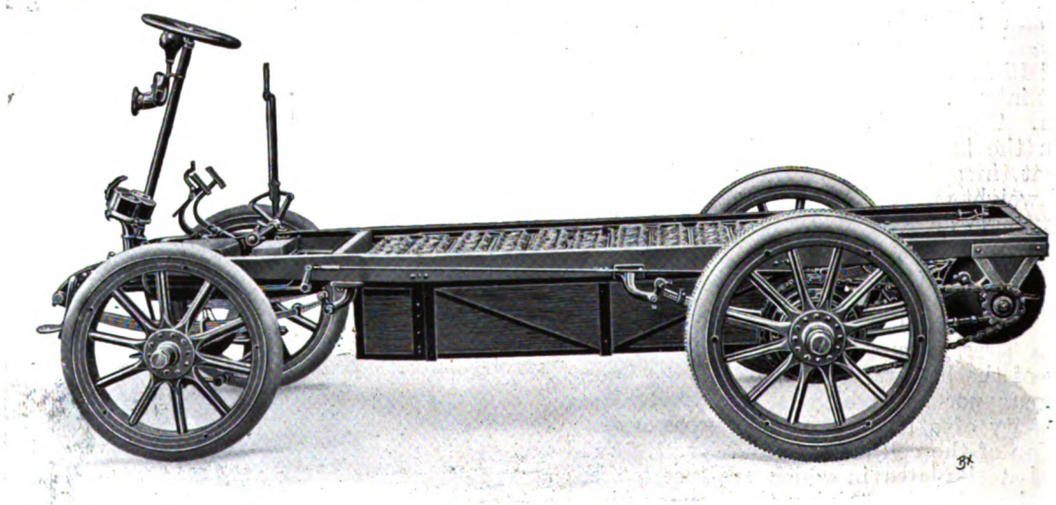


Fig. 5.—Chassis for two-ton Delivery Wagon, showing Battery and Chain Drive.

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SOME LARGE TELEPHONE CABLES

We illustrate below two large telephone cables made by the British Insulated & Helsby Cables, Ltd. Fig. 1 shows, full size, an 800-pair (1,600 wire) cable made of such a size that it can be drawn into a standard 3-in. pipe. Several miles of this cable are in use by the National Telephone Co. and various Colonial and foreign administrations. The conductors weigh 10 lb. per mile, *i.e.*, they are between 22 and 23 S.W.G. Each conductor is insulated by a single layer of manilla paper, applied spirally; the longitudinal method of wrapping with a whipping of thread is only employed for wires of 40 lb. per mile and upwards.

In the earlier telephone cables two layers of paper were almost invariably employed, but it is now found that the single layer is sufficiently strong mechanically, and that, owing to the tighter laying up of the wires that is necessary if the thickness is increased by the second layer of paper, and the fact that the specific inductive capacity of paper is higher than that of air, the cable with the single layer of paper on each wire has a lower capacity and is therefore better for telephonic purposes, in addition to being cheaper. The paper-insulated wires are laid up into pairs and then stranded, the centre core having five pairs and each successive layer six more pairs than the previous one. The lead sheath is 125 mils. in thickness, bringing the outside diameter and the whole cable to 2·625 ins. The lead contains 3 per cent. of tin, which has the effect of hardening it slightly; this is generally considered advisable in large paper-insulated telephone cables on account of the relatively small internal support afforded by the air-space cable. An average wire-to-wire capacity of 0·07 m.f. per mile is obtained and a maximum of 0·08 m.f. per mile. This is extremely low when it is considered how close the wires must be packed to enable 1,600 of them to be contained in a $2\frac{5}{8}$-in. lead tube.

The cable is usually supplied in lengths of 150 to 200 yards; its weight is about 20 tons per mile.



Fig. 1.—800-pair Lead-covered Telephone Cable. Full Size.

Fig. 2 is a full-sized section of a composite telegraph and telephone cable of a type referred to by Mr. F. Tremain in his recent instructive Paper read before the Newcastle Local Section of the Institution of Electrical Engineers (*see* Electrical Engineering of April 2nd, 1908, p. 519). Considerable quantities of this cable are in use by the Post Office on their underground routes, and on one occasion, we are informed, a length of 13 miles, for the section between Bath and Bristol on the Post Office western underground route, was delivered within seven weeks of the receipt of the order. This cable was laid and jointed by the Post Office engineers without a single fault developing throughout its length.

The cable illustrated contains fifteen pairs of 150 lb. twin conductors, seven quadruple pairs or "quads" of eight conductors each weighing 100 lb. per mile, six pairs of 100 lb. conductors; twenty-two single "screened" conductors weighing 200 lb. per mile, for telegraph purposes, and forty-two single-screened 70 lb. conductors—162 wires in all.

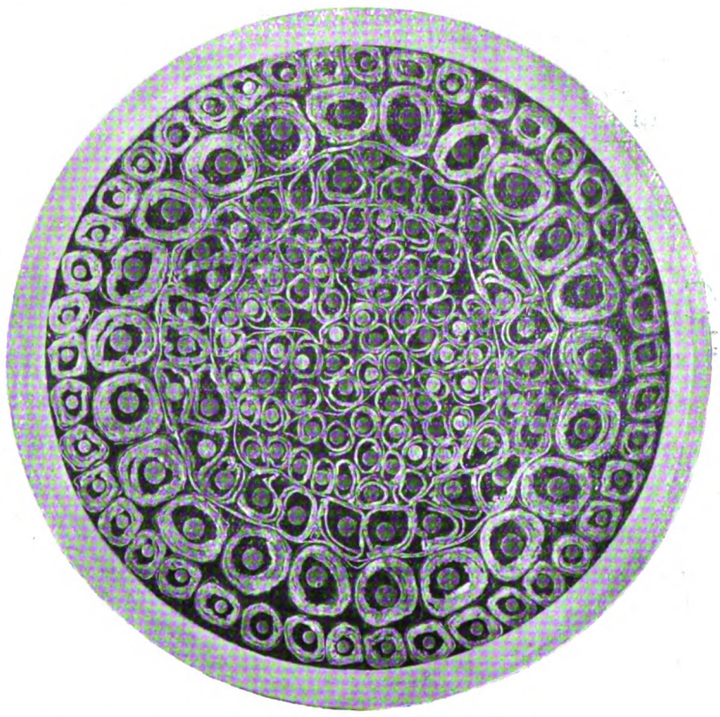


Fig. 2.—A Composite Telegraph and Telephone Cable used by the British Post Office. Full Size.

The telephone wires in the pairs and "quads" are insulated with manilla paper, applied longitudinally, and secured by a whipping of string. A similar longitudinal paper forms the first wrapping of the screened telegraph conductors, but in this case it is covered with three more paper wrappings laid spirally. The first two of the spiral wrappings are laid on so as to leave a helical air space, and the third forms a closed helix. Over this a wrapping of copper tape 3 mils. thick and $\frac{3}{8}$-in. wide, with a 30 per cent. overlap. The copper screening is, of course, to prevent inductive action between neighbouring wires.

The centre core consist of one "quad"—four pairs of 100-lb. conductors laid round a jute core. Surrounding this are six more quadruple pairs of the same size. The interstices left between these six quads are filled up by the six ordinary pairs of 100-lb. conductors as a "worming," making this layer circular. Over this

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comes a layer of twenty-two 200-lb. single-screened conductors (each 350 mils. diameter overall), and the outside layer is made up of the forty-two 70-lb. single-screened conductors (each 225 mils. diameter overall). The screened conductors have a capacity of about 0·125 m.f. per mile; the capacities of the 70-lb. and 200-lb. conductors are practically the same, as the larger diameter of the latter is compensated by the greater distance between the wire and the screening. The 100-lb. telephone conductors have an average wire-to-wire capacity of 0·08 m.f. per mile, and the 150-lb. pairs 0·06 m.f. per mile.

It should be mentioned that the "wire-to-wire" capacities quoted in this article represent the capacity between the two wires of a pair, assuming both to be insulated. The capacity of each wire if its fellow is connected to the remaining wires and earthed, to form the second plate of the condenser, is, roughly, 40 per cent. higher.

As an additional precaution to prevent inductive effects between adjacent pairs of telephone wires, each of the four pairs of each quad are given a different "lay," varying from 7 in. to 12 in., and in laying up the pairs into the quadruple core a different lay varying fom 12 in. to 18 in. is taken in making each "quad." The lead sheathing is 160 mils. thick, and the outside diameter over lead $3\frac{3}{4}$ in., so that the cable can be drawn into a 4-in. pipe. The cable weighs about 34 tons per mile, and is made in lengths of about 150 yards.

SMALL TRANSFORMERS FOR METALLIC FILAMENT LAMPS

CONSUMERS of electrical energy for illuminating purposes are naturally anxious to avail themselves of the opportunity afforded, by the use of the new high-efficiency metallic filament lamps, of reducing their consumption. For the ordinary supply voltages of from 100 to 250 volts, small light units cannot be obtained, and it is necessary either to use a few large units, which gives a bad distribution of light, or in cases of alternating current circuits, to transform down from the supply voltage to 25 or 50 volts and run all lamps on this low-pressure circuit. A description of various types of transformers for this purpose was given in ELECTRICAL ENGINEERING, March 5th, page 351. The high initial cost of changing over a whole installation by making use of a central transformer and replacing all lamps may deter many consumers from considering the use of the new lamps at all, and in many cases it would be advisable to use metallic filament lamps in some places and the cheaper carbon filament lamps in others. Thus, in a basement room or a dark office where a lamp is burning all day long, the initial cost of a small transformer for the single lamp would soon be repaid by the saving in current consumption.

One of the latest types of small transformers for use with single lamps is that manufactured by the London Electric Transformer Co., of 10 City Road, E.C. This transformer is known as the "Adapter Transformer," and is of particularly light and compact construction. The standard type is illustrated in Fig. 2, in which the transformer is suspended from the flexible between the lamp and the switch. It can be placed in any other position, however, the chief advantage of the arrangement shown being that no alteration of the wiring of the room is needed. The transformer is placed in the lamp socket like any ordinary lamp, and the low-pressure lamp is placed in a socket provided at the lower end of the transformer. The diameter outside the cylindrical case is $1\frac{7}{8}$ in., and the total length, including a "turn down" switch, described later, is $5\frac{1}{2}$ in. The weight is about $1\frac{1}{2}$ lb. The small transformers described in the article already referred to were all auto-transformers, with a single winding. The "Adapter Transformer" is, however, a pure transformer with separate primary and secondary windings. An advantage of this arrangement is that the secondary winding is not at the same potential as the primary winding, as is the case in an auto-transformer. As the transformer is placed on the lamp side of the switch, the no-load losses need not be considered.

The construction of the transformer is shown in Fig. 1. A single core of high-grade iron strip is insulated, and first the primary and then the secondary winding is put on. The ends of the strips are then bent round at both ends and both sides to form a closed magnetic circuit. On account of the modern methods of insulation employed in the manufacture of the "Adapter Transformers," a very high space factor is attained. The finished transformer is enclosed in a bright polished brass sleeve, and spun brass caps are fitted to each end of the sleeve. The continuous capacity of the standard type illustrated in Fig. 2 is somewhat over 20 watts, and the usual arrangement is to use one of these in conjunction with one 16 c.p. 25 v. lamp, or two 10 c.p. 25 v. lamps. The transformers can be obtained for primary voltages of from 100 to 250 volts, and for

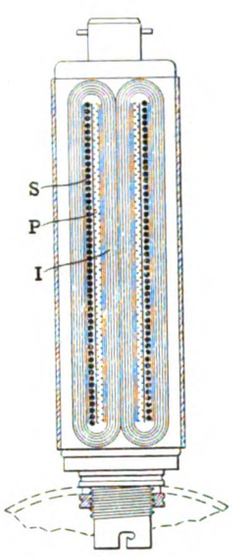


FIG. 1.—SECTION.



FIG. 2.—EXTERNAL VIEW.

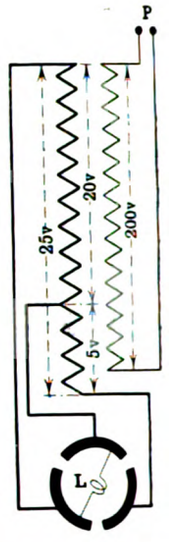


FIG. 3.—DIAGRAM OF CONNECTIONS.

ADAPTER TRANSFORMER WITH "TURN-DOWN" DEVICE.

a secondary voltage of 25 or 50 volts, and for any required frequency.

An ordinary carbon filament lamp consumes 3·75 watts per candle. Most metallic filament lamps consume about 1·2 watts per candle. The efficiency of the "Adapter Transformer" is 85 per cent., consequently the combined transformer and lamp will consume less than 1·5 watts per candle. Thus, in spite of the unavoidable loss in the iron and copper of the transformer (about 3·5 watts in all), a saving of over 60 per cent. is obtained.

At a slight extra cost a turn-down device can be fitted to the transformer; the lamp shown in Fig. 2 is provided with this,

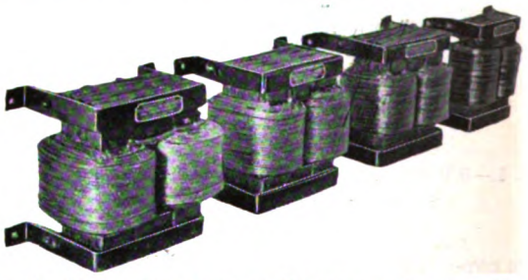


FIG. 4.—SMALL SINGLE-PHASE TRANSFORMERS FOR HOUSE LIGHTING.

but it is not visible. By twisting the lamp socket, the lamp terminals are brought in contact with stationary contacts connected to different points on the secondary winding, as shown in Fig. 3. There are, as shown, three positions: (1) 25 volts (full voltage), corresponding to the full candle-power, say 16 c.p.; (2) 20 volts, corresponding to about 10 c.p.; and (3) 5 volts, which gives a mere glow suitable for a night-light in the nursery or sick room. In many cases, where the lamps are within reach, this means of varying the candle-power of the lamp will be found very convenient. For bedside or table use, the company supplies lamp stands in which the transformer forms the supporting pillar.

An interesting point in the design of the transformers is that, as the transformer is to work only at full load, the value of the no-load pressure is of no account, and any drop can be allowed, so long as the full-load terminal voltage is the proper voltage for the lamp to be used. This permits of a much more economical design, as the only factor to be considered is the heating of the iron and copper and the losses. The latter must, of course, be kept low in order that the watts per candle may,

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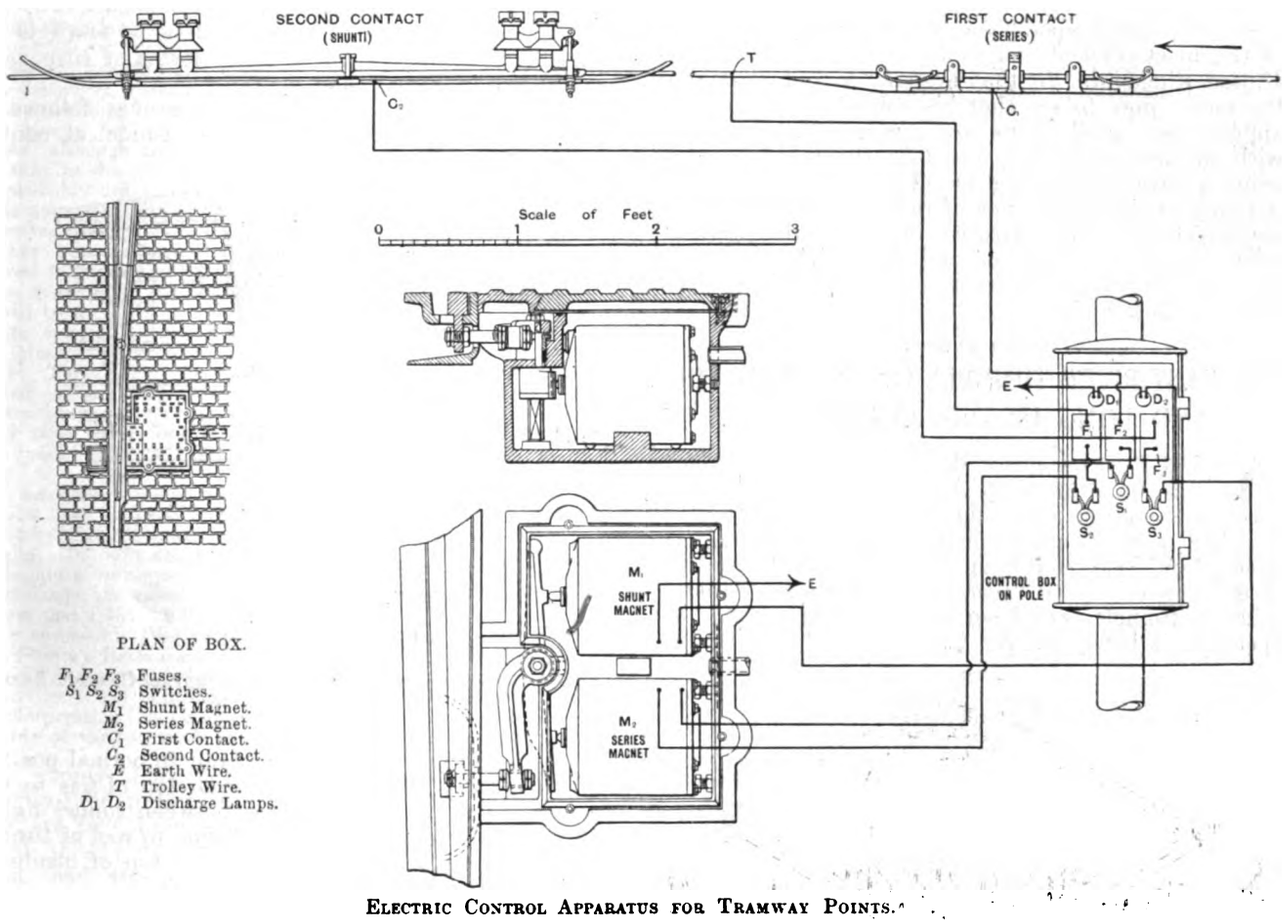
in spite of these losses, be still very much less than the value of 3·75, as obtained with a carbon lamp. As before stated, the losses total to less than 4 watts on full load.

The company also manufacture a line of single-phase transformers for dealing with part or whole of a house system. Four of these are illustrated in Fig. 4. The outputs range from 80 to 5,000 watts; the 80 watt size has a full load efficiency of 88 per cent., and a half-load efficiency of 89 per cent. The larger sizes have, of course, higher efficiencies. These transformers are designed for low no-load losses, as they are supposed to be always in circuit. Thus the iron loss for the 80 watt size is only 3 watts, for the 1,000 watt size 14 watts, and so on. The 160 watt size, which would deal with an installation of 10 16-c.p. lamps, measures only 6 in. by 5 in. by 2½ in. In cases where it has been decided to replace all the carbon filament lamps by metallic filament lamps, it would, of course, be more economical to install a single transformer than to provide each lamp with a separate transformer, and in general it is found that the house wiring is of sufficient size to withstand the slightly increased current density.

THE CONTROL OF TRAMWAY POINTS BY ELECTRICITY

THE development of tramway systems involves in the majority of large towns a considerable amount of branching out from one route into another, and where the service is heavy or rapid the usual method of allowing the driver of the car to carry a rod or lever with which to work the points is hardly practicable from the point of view of loss of time in the operation. When, therefore, the service of cars becomes rapid past any particular point, it has been the custom in the past to station a boy, whose function is to watch for the approach of any car, to determine along which route it must travel, and to arrange the points accordingly in advance of the car. The cost of this arrangement is somewhat in excess of its practical utility where the system is at all complex. The wages of such a lad may range from 8s. to 12s. a week, and a change of individuals is necessary for at least two eight-hour shifts out of the three. In addition to this a uniform has generally to be provided, so that switching arrangements by manual labour on an ordinary tramway system is an expense which may conveniently be cut down.

There has recently been introduced an electrical system of point control operation, the patent of Messrs. Tierney & Malone, and we are indebted for particulars of this apparatus to Messrs. Brecknell, Munro & Rogers, Ltd., of London, E.C., who are the manufacturers of the gear. The illustration shows diagrammatically the arrangement of the control, the direction of the car being indicated by the arrow pointing right to left. The switching lever, which is contained in a street box adjacent to the point, is operated by means of series and shunt magnets, M_2 and M_1 respectively. The series magnet is connected through switch S_1 and S_2 to the trolley wire T, and an insulated strip C_1 respectively. On the arrival of the trolley wire at the strip C_1 current passes from the live wire through switch S_1 to the series magnet back through S_2 to the insulated strip, and thence through the car controller and motors to rail, provided that the controller is at the time in an "on" position. Should, however, the controller be switched off at the moment, no current will pass. The operation of the series magnet is to pull the point over towards the box, allowing the tram to proceed in a certain direction at the junction. Immediately the trolley has passed forward to the second contact past C_1 the shunt magnet comes into operation by means of current passing from C_2 through switch S_3 to the shunt



ELECTRIC CONTROL APPARATUS FOR TRAMWAY POINTS.

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magnet M_1, and so to earth. Should the point have been displaced by the action of the series magnet it will, on the arrival of the trolley, which makes contact between point C_1 and the main trolley wire in passing, switch the point back to its first position.

We have then a device which puts the point in one or other position, according as to whether the motor man has his controller in an on or off position at the moment of passing the first contact. In this way the driver can himself determine in which direction he is going to travel, without appreciably checking the speed of the car. The control box, which is located on the nearest tramway pole, contains, in addition to the switches and fuses, a lamp resistance which forms the discharge to earth for protecting the shunt coil. It will be seen that the return of the tongue is automatically performed by the passage of the car, and is quite independent of any act of the motorman. The price of each of these equipments would be about £70, exclusive of erection and connection, and this small capital charge would speedily be repaid by the saving of time effected in the service, and the abolition of the manual operation with its attendant revenue charges. This system of electric point control is in active operation in Newcastle-upon-Tyne, which town possesses one of the most efficient and rapid services of cars in the United Kingdom. In that system, in order to allow the motor man to see that his point is in order as he approaches, signal lamps are arranged in connection with the control box, operated by the position of the point, a green lamp being placed at the centre and two red ones at either side, one of these being lit, the other extinguished in either position of the tongue. By the relative position of the red and green light, therefore, the motor man can determine how his points stand, even on dark nights.

THE EAST RIVER TUNNELS OF THE NEW YORK AND LONG ISLAND RAILROAD CO.

A PAPER was read by Mr. L. B. Stillwell recently before the New York Railroad Club, in which an account was given of the electrical features of the New York and Long Island Railroad Company's tunnels between New York and Long Island City. An abstract of the Paper is given in the *Street Railway Journal*.

These tunnels have been ready for some time, but operation is being deferred until certain franchise diffi-

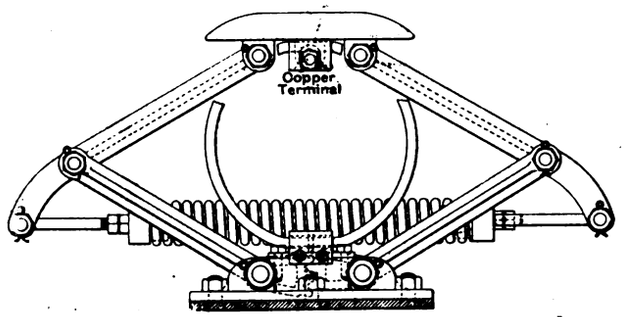


Fig. 1.—Current Collector for Cars running in East River Tunnels, New York.

culties are adjusted with New York City. The cars are of steel construction but of surface type, as many of them will continue as through cars over different routes of the allied New York and Queens County Railroad Company.

When operated over the 600-volt city lines these cars will collect current through the company's standard trolley wheel and pole. The restricted space in the tunnel section made it necessary to add to the cars a more compact and reliable form of current collector. This collector is shown in Fig. 1, and consists of a pantograph similar to that applied on the New York Central electric locomotives, but of smaller dimensions. In its lowest position this contact shoe is only 8 in. above the roof of the car, 11⅜ in. in its normal running position and 1 ft. 4 in. in its highest position.

Current is taken from a contact rail placed in line

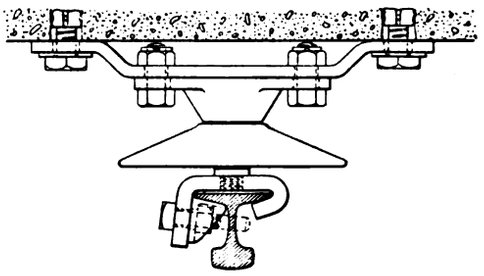


Fig. 2.—Arrangement of Overhead Contact Rail in Concrete Section.

with the centre of the tunnel. This rail is of standard T section weighing 20 lb. per yard, and supported at intervals of 9 ft. The rail is carried head down, and is secured to the insulator and bolted to brackets adjustable in four directions. Two forms of suspension are shown in Figs. 2 and 3.

The principal tunnel dimensions are as follows:—Height from top of ties to roof of tunnel at centre,

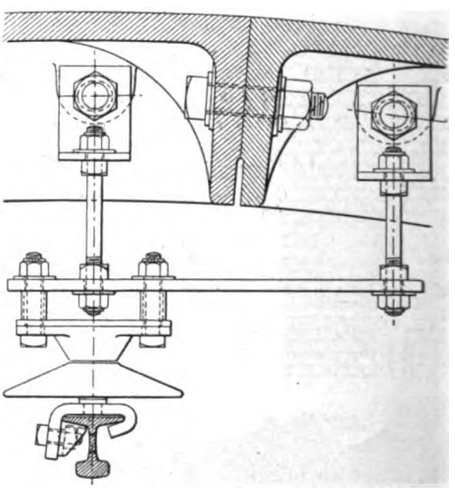


Fig. 3.—Adjustable Bracket for Overhead Contact Rail in Cast-iron Section.

14 ft. 2 in.; height from top of rail to normal position of shoe, 12 ft. 4⅝ in.; height from top of ties to roof of car, 11 ft. 11 in.; distance between tunnel lights, 10 ft. 8 in.; height from top of shoe to roof of tunnel, 15⅝ in.; height from top of shoe to top of insulator, 6½ in.

Royal Institution.—The annual meeting of the members of the Royal Institution was held last Friday, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The annual report was read, and the following gentlemen were unanimously elected as officers for the ensuing year:—President, the Duke of Northumberland; Treasurer, Sir James Crichton-Browne; Secretary, Sir William Crookes; Managers, Sir Thomas Barlow, Bart., Sir George Darwin, the Rt. Hon. the Earl of Halsbury, W. A. B. Burdett-Coutts, Esq., Charles Hawskley, Esq., Dr. Donald William Charles Hood, Dr. Rudolph Messel, Henry Francis Makins, Esq., George Matthey, Esq., Dr. Ludwig Mond, the Rt. Hon. Sir John Fletcher Moulton, Alexander Siemens, Esq., the Rt. Hon. Sir James Stirling, the Rt. Hon. the Earl of Rosse, and Sir William H. White; Visitors, Arthur N. Butt, Esq., Dugald Clerk, Esq., Charles A. Ballance, Esq., John B. Broun-Morison, Esq., Edward Dent, Esq., John Cameron Graham, Esq., Dr. James Dundas Grant, Charles Edward Groves, Esq., Sir Henry Harben, Major E. H. Hills, John List, Esq., Robert Mond, Esq., Francis Lys Smith, Esq., James Swinburne, Esq., and Lieut.-Colonel Sir Frederick Nathan.

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NOTES ON THE LIGHTING OF THE SCOTTISH NATIONAL EXHIBITION

THIS exhibition was opened at Edinburgh on Friday by H.R.H. Prince Arthur of Connaught, and although there is a considerable amount of electric lighting, we cannot but think that the most interesting feature of the exhibition to electrical engineers will be the large employment of gas lighting in the grounds. Electrical engineers should keep themselves fully acquainted with what their competitors are doing, and we therefore need make no apology for giving an account of the gas lighting arrangements before dealing with the electrical distribution.

The site of the Exhibition is the Saughton Hall estate, which is situated at the old cable-car terminus at Gorgie. The main entrance is here, and is lighted with "Vesta Graetzin" inverted self-intensifying gas lamps, each of 400 c.p. The main avenue from this entrance is lighted with Messrs. Keith & Blackman's high-pressure gas lamps, each stated to be of 1,500 c.p. These lamps are carried on standards of graceful design, and are about 15 yards apart, alternately on either side of the avenue. The central square, around which the main buildings are grouped, is also lighted with similar lamps, each standard carrying three lamps here. The cluster of three lamps is stated to give 4,500 c.p. There are 127 of these lamps altogether.

Immediately inside the main entrance is the gas-compressor plant, driven by a small gas engine; this raises the pressure up to from 54 to 62 in. maximum, and is in duplicate. The lamps give a brilliant, hard white light, with an absence of shadows, although the enclosing globes are of clear glass. The effect may be described as more decorative than "illuminative." It is probably unfair to criticise these lamps so early, but some trouble appeared to be experienced on the first two nights, probably owing to mantles breaking; we are informed that 62 in. is a higher pressure than has before been attempted. It also appeared to us that the lamps gave by no means equal candle-powers, some being much more brilliant than others. Doubtless this will be rectified.

There are 36 low-pressure gas lamps in the gardens, these being Messrs. Anderson & Co.'s "Pharos" lamps, giving each 650 c.p. These, being intended to light narrow walks only, are mounted on low posts, hence their illuminating effect compared with arc lamps cannot very well be judged. The bandstand is lighted from the ceiling with 12 "Nero Graetzin" gas lamps, giving each 220 c.p. They are enclosed in obscured glass globes.

The art gallery is lighted with Messrs. J. & W. B. Smith's "Empire" gas lamps of 350 c.p. each. We understand that gas was preferred here to electric light on account of the colour of the light. To light art galleries by gas instead of electric light is certainly a retrograde step, and with the present choice of electric lamps the colour difficulty is certainly non-existent. It is stated that 1,400 candle-power is obtained for one pennyworth of gas consumed! (We suppose 1,400 c.p.-hours are meant.)

The Prince's Restaurant is also lighted with incandescent gas. For the lighting of this building and others, competitive tenders were invited; this building was secured by the Edinburgh and Leith Corporation Gas Commissioners. There are some 700 other gas-lights of various kinds in different buildings.

The supply of electric light and power is obtained from the Edinburgh Corporation, Dewar Place station. There are two main supplies, one low-tension direct-current three-wire supply, with 460 volts across the outers, and the other an alternating high-tension supply at 2,000 volts, feeding static transformers, part of which give a supply at 230 volts and part at 115 volts.

The low-tension supply is run direct from the station, and is carried into a main distributing room in the Industrial Hall. The three cables are here carried round the walls of the room, and tappings are taken off through fuses and meters to the distributors. The feeder cables are lead covered, paper insulated and braided. Where they pass through the exhibition grounds they are drawn into cheap earthenware ducts, which may be abandoned when the cables are withdrawn; a pilot cable has also been run. The capacity of these cables is about 300 kw.

From this central distributing point three-wire circuits have been carried to the various buildings. This part of the work has been carried out by the British Insulated & Helsby Cable Co. Each circuit consists of a two-pole concentric cable and a single cable, the latter being the neutral wire. The cables are plain lead-covered and paper insulated, and are buried in impregnated wooden troughing with a wood cover, but no filling is used. These cables will all be dug up again on the close of the exhibition.

The cables finish in their respective buildings in sealing and dividing boxes, and tailings are taken from these boxes to distributing boards. From the boards two-wire circuits are run at 230 volts for incandescent lighting and small motors, these circuits being balanced against each other. For arc light circuits and larger motors 460-volt mains are run. The wiring consists of rubber cables, mounted on porcelain insulators; the greater part has been done by Messrs. Lowdon Bros., Edinburgh. Each stall is supplied through a Ferranti meter. The high-tension supply is conveyed by two concentric cables, each of 0·1 sq. in. section, run in parallel. These cables are brought in by a different route to the low-tension cables, and, like the L.T. feeders, are mainly drawn into existing ducts belonging to the Corporation; when they enter the exhibition grounds they are pulled into earthenware pipes. A brick building with a galvanised iron roof has been erected for a sub-station. The transformers are arranged in five distinct groups to feed five different circuits, three of which will be at 115 volts pressure and two at 230 volts. Five concentric distributors have been brought to this point by the B.I. & H. Co., laid in wood troughing underground. Both secondary conductors are insulated from earth. The lead of these cables is earthed to a water-pipe, both at the transformer house and at the distributing points. The high-tension cables are run down the centre of the room and a connection is taken through an oil switch and fuse to each transformer. The secondaries of the transformers are led through a switch and fuses to one of five pairs of insulated 'bus bars. A connection is made from each 'bus bar through a meter to the distributor. Any transformer may thus be isolated both on the primary and secondary sides. The total capacity is about 275 kw.

The alternating supply will be chiefly used for outside decorative incandescent lighting, and will probably be entirely switched off during the day-time. There will be some 8,000 lights used for this purpose, but this work has not yet been done, as, owing to the long evenings of the early summer in Scotland, the effect of the illuminations would be largely wasted until August, since the exhibition closes at 10 p.m. each night.

The direct-current lighting is by means of 250 arc lamps and some 5,000 incandescent lamps. The incandescent lamps installed by the exhibition authorities are all of carbon filaments, but many of the stalls are lighted by various kinds of metallic filament lamps. The arc lamps are Messrs. Crompton's "Crompton-Blondel" flame type and Davy's "Sunræ" flame lamp. The "Crompton-Blondel" lamps are run eight in series off 460 volts, and take 7 amps.; they use 15″ single carbons. The Concert Hall is very effectively lit with eight of these lamps suspended from the ceiling. They give a very pleasing white light, which seems to give true colour values. These lamps are also used for lighting the Industrial Hall. The Davy lamps are used in the Machinery Hall, the Winter Gardens, and for outside lighting; they are also very effective. They are connected eight in series and take 10 amperes.

Owing to the recent heavy snow, the outside arc-

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lighting was not completed on the occasion of our visit. It is mainly confined to the outer walks. The whole of the lighting arrangements, together with all the other engineering work in connection with the exhibition, has been carried out under the supervision of Mr. A. C. Freeman, engineer to the exhibition authorities, to whom we are indebted for most of the above particulars.

NEW ALTERNATING CURRENT INSTRUMENTS

Birmingham Discussion

THE Paper on the above subject by Dr. W. E. Sumpner and Mr. J. W. Record, which was read and discussed at the London meeting of the Institution of Electrical Engineers in London on March 19th, was further discussed in Birmingham on April 8th. The Paper itself was given at some length, together with a report of the discussion in London, in ELECTRICAL ENGINEERING, March 26th, page 481.

Dr. SUMPNER, in introducing the Paper by Mr. Record and himself to the meeting in Birmingham, said that the type of instrument to which their Paper referred was one in which the magnetic field was strong and quite independent of the varying properties of iron, so that it was possible to get at the same time both accuracy and sensitiveness. The magnetism was controlled by the voltage, and the complicated relation between magnetism and magnetising current did not at all affect the accuracy of the instrument. To secure this result it was necessary simply to make the resistance of the magnetising or volt coil small compared with its impedance. The winding was of stout copper, and the reluctance of the gap was reduced in every way possible. Only one air gap was used, and the area of the opposed pole-faces was exceptionally large. In this way it was possible in their instruments to secure a magnetic field which was exactly proportional to the voltage. Although this field was in quadrature with the voltage, it was possible to get over quite readily any difficulties which arose through this circumstance and to utilise the instrument as wattmeter, voltmeter, capacity meter, &c., &c. The current for the moving coil of these instruments required to be supplied from some type of quadrature transformer. This apparatus was analogous to a shunt in an ordinary moving coil ammeter, and its purpose was to provide from the main current a small voltage suitable for the moving coil circuit and in quadrature with the main current. A small ring-form transformer was also shown, suitable for threading on to the main conductor or 'bus-bar. The phase meter was an instrument having a polyphase winding, producing a strong rotating magnetic field in an air gap in which a moving coil having inappreciable control was allowed to swing. The theory of such phase meters could be given simply in terms of the double wattmeter method of measuring three-phase power. If the two wattmeters in such a measurement were imagined to be mounted on a common spindle, then the needle attached to this spindle would take up a position in which the forces on the two moving coils were equal and opposite, and it was easy to see that this position of balance could only depend on the phase difference to be measured.

Mr. A. M. TAYLOR (Birmingham Corporation Electricity Works) referred to the fact that at the previous meeting, when these instruments were first shown by Dr. Sumpner, various forms of electro-magnet had been used, including some placed in series with the main circuit. He would like to know whether the authors still recommended this type, or whether possibly they wished to forget having spoken of it on a former occasion.

Mr. J. P. KEMP (Birmingham Corporation Electricity Works), speaking as a Central Station Engineer, said that they owed a great deal to the authors for the science and ingenuity which they had displayed in the construction of these instruments. He was especially interested in the wattmeter, and particularly wished to know whether they had given any attention to watt-meters of the integrating type. Also, could they use existing current transformers when applying these instruments, or was it essential that they should use the particular type which Dr. Sumpner had shown them. In view of the very small amount of room available for instruments on modern switchboards, he would also like to know whether these instruments could be made up in the edge-wise pattern, as this was practically the only possible type of instrument where space was a matter of consideration.

Mr. J. D. COALES (Birmingham University) asked Dr. Sumpner if he would give some idea as to how much current could be taken from the secondary of a quadrature transformer without appreciably reducing the phase difference between the primary and secondary currents below 90°. He said that he had tried the experiment of connecting the main coil of an ammeter transformer in series with the current coil of a wattmeter, and the secondary winding to the pressure coil of the wattmeter. On sending current through the transformer the wattmeter gave a considerable reading, thus showing that the primary and secondary currents were in this case not in quadrature. The secondary winding of the transformer had several hundred turns; and the wattmeter pressure coil a resistance of several thousand ohms.

Dr. D. K. MORRIS (Messrs. Morris & Lister, Coventry) referred to an explanation given previously by Dr. Sumpner of the action of his phase meter, which appeared to be more simple than the theory now given. It was clear that a coil carrying alternating current and placed in a revolving field, but otherwise not subject to control, could only take up a position such that at the moment of maximum current flowing in the coil the field where the coil found itself was zero. If the coil were in any other position, then it would naturally tend to be deflected into that position. This theory seemed quite simple, but as Dr. Sumpner did not give it he would like to know if he regarded it as unsound. He would like further to know if the indications of these phase indicators or power-factor meters depended upon the wave form, so that their calibration would be erratic at certain particular phase indications.

Mr. J. W. RECORD spoke of the instrument when used as a capacity meter, and said that it had this great advantage over other methods of measuring capacity, that the leakage current, if any, through the condenser had no effect whatever on the indication of the instrument. In cases where the capacity was small, it was desirable to use a dividing method by which high tension was used on the capacity to secure sufficient capacity current and low tension on the instrument.

Mr. WILLIAM BREW (Dublin Corporation Electricity Department), in a written communication, dealt generally with the requirements of instruments in generating stations, emphasising the importance of accuracy in voltmeters and wattmeters, upon which depended the regulation of pressure and the determination of units generated. He also made some remarks on the complications that sometimes are necessitated by the non-interchangeability of instrument transformers of different makers. The instruments described by the authors of the present Paper, by eliminating errors due to hysteresis, wave form, periodicity, &c., undoubtedly marked considerable progress towards the simplification of alternate-current working, which had been in the past not altogether free from uncertainties.

Dr. SUMPNER, in reply to the discussion, said that with reference to Dr. Morris's remarks, he had ultimately given up the simple theory of the phase meter dependent on the assumption of a true rotating field, because it was not found accurate enough. With regard to the behaviour with irregular wave form, all phase meters for three-phase circuits were quite correct on all wave forms if they were properly calibrated and if the three-line currents are equal. They were also right on all frequencies. With regard to Mr. Coales's remarks, it was unfortunate that wattmeters generally got the blame for the considerable errors which really arose through the current transformers. In practice it was often the case that it did not much matter whether a good or bad wattmeter was used, since the current transformer would introduce errors entirely throwing into the shade any trifling error which might be due to the wattmeter itself. Replying to Mr. Kemp, they had not yet got edge-wise instruments or an integrating wattmeter on the market. Ordinary current transformers could be used with the new instruments to supply current to the quadrature transformer, which latter must be regarded as the current coil of the wattmeter. Referring to Mr. Taylor, the result of four years' experience was such that they could not recommend the use of series electromagnets for wattmeters. He claimed for their instruments that they were more robust than any alternating instruments having the same accuracy. He thoroughly agreed with, and appreciated, Mr. Brew's communication. The remarks about the commercial importance of accurate measurements on alternate-current circuits were very much to the point, and particularly those in reference to the numerous installations in which the current transformers and wattmeters are supplied by different contractors.

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OSRAM LAMPS FOR STREET LIGHTING

Life Tests and Cost compared with Gas

THE following observations of the life of a number of 100-volt Osram lamps used in pairs for street lighting on a 200-volt 40-period circuit have been sent us by Mr. T. P. Wilmshurst, Borough Electrical Engineer, Derby. In addition to the long average life (1,570 hours) which exceeds the figure usually quoted, a feature noticed was the small diminution of light up to the end of the life in each case. In calculating the above average, no account has been taken of the lamps still burning, so that it is not improbable that a longer test will make the average even higher.

OSRAM LAMPS IN BURTON ROAD, DERBY.

200 volts, 40-period A.C.

Ref. No.	Date installed.	Date of failure.	Hours.
1	Jan. 9, 1908	Still burning	1365
2	,, ,, ...	,, ,,	1365
3	Jan. 17, 1908	,, ,,	1183
4	,, ,, ...	,, ,,	1183
5	,, ,, ...	,, ,,	1183
6	,, ,, ...	,, ,,	1183
7	Feb. 11, 1907	Jan. 8, 1908	3232
8	,, ,, ...	Mar. 12, 1908	4114
9	Jan. 8, 1908	,, ,,	821
10	Sept. 10, 1907	Nov. 16, 1907	757
11	,, ,, ...	,, ,,	757
12	,, ,, ...	Nov. 19, 1907	797
13	,, ,, ...	Feb. 26, 1908	2209
14	,, ,, ...	Jan. 11, 1908	1633
15	,, ,, ...	Jan. 19, 1908	1746
16	,, ,, ...	Jan. 21, 1908	1773
17	,, ,, ...	Feb. 23, 1908	2172
18	,, ,, ...	Jan. 23, 1908	1800
19	,, ,, ...	Jan. 19, 1908	1746
20	,, ,, ...	Nov. 28, 1908	923
21	,, ,, ...	Mar. 1, 1908	2243
22	Sept. 10, 1907	Feb. 1, 1908	1883
23	,, ,, ...	Sept. 11, 1907	7
24	,, ,, ...	Feb. 8, 1908	1923
25	,, ,, ...	Feb. 20, 1908	2135
26	,, ,, ...	Feb. 26, 1908	2208
27	,, ,, ...	Still burning	1859
28	Nov. 16, 1907	,, ,,	1859
29	,, ,, ...	Jan. 12, 1908	716
30	Jan. 12, 1908	Still burning	1059
31	Nov. 16, 1907	,, ,,	2087
32	Feb. 26, 1908	Mar. 6, 1908	110
33	Mar. 18, 1908	April 25, 1908	406

With regard to the comparative costs of gas and Osram lamps for street lighting, we have received some very interesting figures from Mr. George Wilkinson, Chief Electrical Engineer to the Corporation of Harrogate, who has proved conclusively that street lighting by Osram lamps is much cheaper than by incandescent gas mantles.

The comparative figures are given below.

	s.	d.
One 3 ft. gas mantle costs per annum for gas ...	15	0
Mantles, say	1	6
Total for 2,100 hours' burning	16	6

	s.	d.
Electricity at 1½d. per unit, for 35-watt Osram lamp, which gives equally as good light, and often better than a gas mantle	9	3
Renewals	3	0
Total for 2,100 hours' burning	12	3

With regard to the life of the lamp, which appears to have been very satisfactory, Mr. Wilkinson writes:—

"With regard to the life of Osram lamps, this appears to be very satisfactory. They appear to last much longer when used without globes or lanterns, probably due to the cool atmosphere around them; we have numbers of them in the town burning well on to 3,000 hours, and the average is probably over 2,000 hours, excepting in cases of accidental breakage."

ELECTROCHEMISTRY AND ELECTROMETALLURGY

IN the *Papier Zeitung*, **33**, 834, A. Ahlin contributes a Paper upon "Electrolytic Bleach Liquor." As a rule, rock salt is employed to prepare the liquors which upon electrolysis produce the bleaching solution. But as the sodium chloride contains considerable impurities, the results obtained with different samples of rock salt are often very various. The secondary reactions may cause oxidation, that is, chlorate formation, or, on the other hand, reduction of the hypochlorate to chloride. The chlorate formation may be direct according to the following equation:—

$$5OH + Cl = ClO_3 + 2H_2O.$$

Or it may be indirect owing to inefficient circulation of the electrolyte. The author has thoroughly studied the formation of the direct oxidation in Schuckert's apparatus. Reduction is caused by re-conversion of the hypochlorite into chloride, and takes place when the previously produced hypochlorite comes into contact with the hydrogen at the cathode, which at the moment of losing its electrical charge is in a very active condition. One method of preventing the reduction is the addition to the electrolyte of salts which, when their cations are yielded up at the cathode, form insoluble hydroxides, which act as protective diaphragms. As a matter of fact, it is not always necessary to add these salts, as they frequently occur as impurities in the salt employed to make up the electrolyte. The author recommends that the efficiency of each electrolyser should be checked by drawing a curve with chlorine strengths plotted as ordinates and times of electrolysis as abscissæ. By means of such curves it can be shown when any of the electrolysers are not giving normal results. It is also important to give constant attention to the temperature and the alkalinity of the liquor. It is necessary to keep the temperature low, and the alkalinity should also be very slight, such that 1 litre of the solution when coloured with phenolphthalein shall have its colour discharged when two drops of normal acid are added. In any case, before employing the liquors for bleaching, the alkalinity should be neutralised.

Some authorities prefer to have magnesium chloride present, but the author considers its presence objectionable, as it produces heavy deposits upon the cathode, which set up a resistance and impede circulation of the solution. He considers that the anodes, at any rate, should be of platinum, which, if the metal is polished, is very little acted upon even when employed for a long time.

According to F. Mattonet, *Metallurgie*, **1908**, 186, tin can be satisfactorily obtained from its ores by smelting in the electric furnace. Experiments were carried out with various ores in a furnace which was heated electrically. Ores which contain sulphur must first be roasted, and then the ore is mixed with a mixture of three parts of sodium carbonate and four parts of lime, the quantity of this mixture used being sufficient to produce a slightly basic slag. By proceeding in this manner from an ore containing 50·3 per cent. of tin, 7·6 per cent. of iron, 1·9 per cent. of lead, 0·5 per cent. of copper, 3·3 per cent. of zinc, 6·7 per cent. of sulphur, and 11·4 per cent. of silica, a product was obtained which consisted of 97·0 per cent. of tin, 1·8 of lead, 0·2 per cent. of copper, 1·2 per cent. of iron, and was 86 per cent. of the total tin. About 13 per cent. of the tin was lost as dust and by volatilisation; the author considers that this loss could be considerably reduced on a large scale. It was not found possible to obtain a metal free from lead, but by again melting and cautiously cooling, and treating in a manner similar to that employed in the Pattinson desilverising of lead process, pure tin can be obtained in crystals.

In Spain there are not very many electrochemical works, although, as there is a considerable amount of cheap water-power, doubtless in the near future this branch of industry will be increased. We notice that the Compania Electroquimicale of Fix, near Caspe, produced last year 3,000 tons of caustic soda. Solvay & Cie. possess a large salt-producing property at Cabezon del Sat, in the neighbourhood of Torrelavega, where they are putting up a new factory. The firm are stated to be spending £1,000,000 in building and equipping the works. It is hoped that they will shortly commence the manufacture of caustic soda.

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ELECTRICAL SCIENCE

British and American

Inauguration of Lord Rayleigh as Chancellor of the University of Cambridge.—The formal ceremony of the inauguration of Lord Rayleigh as Chancellor of the University of Cambridge took place on Friday last, when, in accordance with custom, the University waited on him. The place chosen for the ceremony was the residence of his brother-in-law, Mr. Balfour, at 4 Carlton-gardens, Pall Mall. Some of the principal heads of colleges and University Professors were present. The vice-Chancellor (Mr. E. S. Roberts) presided, and the Proctors, the Public Orator, the Registrary, and the Esquire Bedells attended in their official capacities. The vice-Chancellor, in his opening speech, referred to the University career of Lord Rayleigh, and spoke of the desirability of the combination of scientific and literary culture. He looked to the new Chancellor to guide their efforts for compassing the re-endowment of the University. The actual ceremony of admission was then performed, and the customary laudatory address in Latin was delivered by Dr. Sandys, the Public Orator. Lord Rayleigh, in his reply, alluded modestly to the part he had played in the past in the affairs of his *alma mater*.

Royal Institution.—On Friday evening last the weekly discourse was delivered by Prof. Larmor; the subject was the life and work of Lord Kelvin. At the outset, Prof. Larmor pointed out how hopeless it was to attempt in one hour to give even an outline account of the numerous discoveries that Lord Kelvin had made in almost every branch of natural philosophy, and most of the hour was devoted to the work done on thermodynamics between 1846—when, at the age of 22, Kelvin was appointed professor of natural philosophy at Glasgow University—and the year 1855. To students of thermodynamics it is rather interesting to note that at first Kelvin denied Joule's contention that heat disappears when work is done by an engine, and adhered for three years to Carnot's conception as given by that writer in the now well-known essay, "Reflexions sur la puissance motrice de feu," in 1824. Kelvin communicated an account of this work of Carnot's to the Royal Society of Edinburgh in 1849, and it was in consequence of his belief in Carnot's theory that he was anticipated by Clausius in the publication of the second law of thermodynamics. His early study of Carnot's essay led him to the conclusion that temperature was dynamical, and thus to the conception of an absolute thermometric scale, independent of the properties of any particular substance. The important principle concerning the availability of energy and the fundamental equation of what is now known as Gibb's theory, which has been applied so largely in recent years to problems in physical chemistry, were given by Kelvin in a Paper in 1855.

In electricity he formed a connecting link between Faraday and Maxwell. His earliest work arose in connection with the laying of the Atlantic cable, and led to his theory of the electric telegraph, to the development of the mirror galvanometer, and to the invention of the siphon recorder. In the siphon recorder we have the principle of the d'Arsonval moving-coil galvanometer, the effect of a weak current being emphasised by using a strong magnetic field. The lecturer expressed some regret that Kelvin devoted so much time as he did to the development of practical matters such as these; the same labour and genius would have proved ultimately more profitable to the world if it had been expended on the advancement of abstract theory.

In these early years of Kelvin's scientific activity he devoted much thought to the constitution of the ether, led chiefly by his belief that all energy was mechanical in character. These efforts to construct models of the ether led him in turn to the discovery and explanation of many curious properties of rotating bodies. Applications of these discoveries are being made at the present time, for example, in the steadying of ships by the use of gyroscopes.

The lecture was illustrated by a number of experiments on the lowering of the freezing-point by pressure, on the porous plug phenomenon with hydrogen, air, and carbon dioxide, and on the stability of rotating bodies.

A New High Resistance.—One of the most satisfactory forms of high resistance is that made by depositing various forms of carbon on glass. One of the best forms hitherto described is made by depositing a smoke-film on glass, hardening it by exposure to alcohol vapour, and then covering it with shellac varnish, rubber varnish, or paraffin wax. But even these resistances increase with the lapse of time. In the April *Physical Review*, G. W. Stewart proposes a new form of carbon resistance, which is, the author declares, very satisfactory. He mixes ordinary lampblack with a commercial transparent lacquer called "Zapon L." The lacquer consists of soluble cotton dissolved in certain mixed solvents, the chief of which is amyl acetate. When the lacquer dries it leaves a film of pyroxyline, which is elastic, does not evaporate, does not crack, is a good insulator, and is unaffected by ordinary changes of temperature. In making high resistances, the mixture of lampblack and lacquer is spread upon an insulating surface by means of a brush. By trial the resistance may be regulated from 3,000 ohm to 3,000,000 ohms for a film 3 mm. long and 2 mm. wide, merely by altering the proportion of lampblack. The author uses hard rubber as the insulating base, and makes the terminals of the resistance of copper plugs screwed into the base. The resistance of the films diminishes at first with time, but later becomes very steady. The variation of resistance with voltage was found by the author to be less than one-half per cent. with 1,000 per cent. variation of voltage. Temperature variations have a negative coefficient of from 0·1 to 0·15 per cent. per degree Centigrade.

Continental

Slightly Damped Oscillations.—In No. 3 of the *Verhandlungen* of the German Physical Society, B. Glatzel describes a new method of obtaining slightly damped electric oscillations. The idea is to excite an oscillation in the primary circuit which does not run off into a damped oscillation, but stops after the first quarter period. The secondary circuit, closely coupled with the primary, then receives a single strong impulse, which produces oscillations of the proper period of the secondary circuit. If the secondary contains no spark-gap, the damping may be very slight, so that here we have a way of producing very feebly damped oscillations. The coupling may be close enough to utilise the whole force of the impulse. There will be no recoil into the primary, since the latter is open. Now, as regards the primary impulse, that may be obtained by an adaptation of the Cooper-Hewitt mercury arc. This has the peculiarity that as soon as the current falls below a certain value, there is not sufficient heat to evaporate the mercury, and the current is broken. This is secured by designing the apparatus in such a manner that the greatest possible amount of energy is absorbed during the first impulse. The oscillations cannot be more rapid than about 50 per second, as otherwise the current remains uninterrupted.

Resistance of Insulators.—The results of some tests of insulators are communicated to the *Comptes Rendus* of April 21st, by F. Nègre. One of the poles of a Wimshurst machine was connected with the neck of a bell insulator, and the other through a galvanometer with the attachment. The tension was measured with an electrometer. A simple bell insulator, 8 cm. in diameter, and a triple bell 11 cm. in diameter, were tested at 5,500 volts. In another series the voltage was carried up to 50,000. In some cases the bells were moistened with vapour or blackened with lamp black. Each insulator has a "critical tension" up to which the insulating resistance is constant. This critical tension varies with the diameter and other dimensions, and with the state of moisture and cleanliness. It was found to be 11,000 volts for a simple bell, 16,000 for a triple bell, and 32,000 for an American type designed for 50,000 volts. After the critical tension is surpassed, the resistance rapidly declines, especially if the insulator is damp or dirty, or has a small diameter. Fine drops distributed over the surface coalesce into larger drops; these congregate on the rim and become pointed. In the dark, brush discharges are seen to start from the points of the drops. These are specially marked when the potential is positive. When it is negative a faint glow takes the place of the brush discharge.

Magnetic Alloys.—The influence of thermal and mechanical history on the hysteresis and other magnetic properties of Heusler's alloys is discussed by Paul Asteroth in No. 2 of the *Verhandlungen* of the German Physical Society. It appears that quenching of the alloys eliminates the hysteresis entirely, the loop being converted into a single straight line. On heating the alloys above the temperature of transformation, cooling them for three hours, and ageing them at a temperature of 140°, the hysteresis loop reappears. The coercive force becomes 18 in a casting, and the remanent magnetism 820. For a wrought piece the figures are 3·5 and 600 c.g.s. respectively. The author points out that the magnetic properties are thus largely within our control. The hysteresis has many analogies with elasticity and crystallisation. It appears that quenching prevents the magnetic molecules from settling into positions in which they can obey magnetising forces. The formation of larger aggregates encourages such mobility, but also increases the viscosity which resists the orientation. The magnetic orientation may also depend upon the rotation of electrons attached to the atoms. If this is facilitated by larger crystalline aggregations, the influence of quenching is quite clear. The elimination of hysteresis is of great theoretical interest.

Street Lighting in the City of London.—At the last meeting of the Court of Common Council, it was decided that the experimental street lighting in Cannon Street, Farringdon Street, and Holborn should be extended for a period of three months. It will be remembered that the original period was from October, 1907, to April, 1908, and we gave full particulars of the lighting in Cannon Street, which is by means of arc lamps on wires attached to the buildings on either side of the roadway, in ELECTRICAL ENGINEERING, Vol. II., p. 693. Some photometric tests of the other experimental lamps were given on page 919 of the same volume.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published April 30th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

3,215, E. RUHMER. The nature of the arc discharge between electrodes in an atmosphere of hydrogen, as used by Poulsen and others, can be varied by altering the electrical conditions of the circuit. The arc may be stable and steady, or oscillatory. Under given conditions there is a critical value of the current, and if the current be increased above this value the hitherto active arc becomes inactive, and oscillations no longer take place. The present invention relates to a method of wireless telephony in which the arc discharge is kept at this critical value, and, by the action of a superimposed microphone current, is caused to become alternately active and inactive. Trains of undamped electric waves are thus sent out corresponding with the undulations of the microphone current. The frequency of the electrical oscillations must be higher than the highest sound tone or harmonic to be transmitted. The microphone current can act either directly or inductively on the arc current, or may be utilised to vary a magnetic field acting on the arc. Four claims, five figures.

8,641, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). An improved method of welding the ends of the leading-in wires to lamp filaments of tungsten or other refractory metals. The leading-in wire of copper or other suitable metal is flattened at its end, and the flat portion is formed into a tube. This tube is bent downwards at right angles to the wire, and forms a socket for the end of the filament. The welding arc is produced between the lower end of the socket and a carbon electrode. The lower end of the tube is fused up into a globule, making good contact with the filament, and, owing to the distance between the arc and the filament, the deteriorating effect of the arc on the latter is avoided. The welding is performed in an atmosphere of hydrogen or other non-oxidising gas. Three claims, three figures.

16,489, SIEMENS & HALSKE AKT.-GES. A process of manufacturing from tungsten compounds a plastic mass, which can be drawn into threads for manufacturing filaments, or which may be used as a binding agent for a paste made of tungsten oxides. Dry acid ammonium tungstate is heated in a flask at a temperature of about 270° C. until no ammonia is evolved. The heating is preferably done in a vacuum. The product, mixed with a little hot water, gives a soft, sticky paste. One claim, no figures.

16,513, W. L. WISE (*C. O. Mailloux*). In order to increase the output of electric railway motors without increasing the dimensions, artificial cooling by means of a draught of air blown through the motors by a fan is sometimes provided. The low pressure and the large volume of air employed makes it necessary to use large pipes. In cases where the space available for these pipes is limited, it has been proposed to use air at a high pressure. The expansion of the air, however, when it reaches the motor, causes it to cool and to produce condensation of moisture which is harmful to the motor. To avoid this, and also the large pipes, the present invention provides for the injection into the motor casing of a small quantity of air under high pressure, which air draws in with it a large quantity of air from the surrounding atmosphere. The injection may be intermittent or continuous, according to the load on the motors. Condensation is avoided, and the amount of air pumped is very small. The intermittent injection may be automatic, the valve opening when the pressure in a reservoir reaches a certain value, and closing again for the pressure to accumulate after each injection. Ten claims, seven figures.

17,655, W. G. HEYS (*Scott Electrical Co.*). An alternating-current flame arc lamp, in which regulation is obtained without any mechanical device. Two or more pairs of downwardly convergent impregnated carbon electrodes are so arranged that the magnetic effects of the separate arcs are added, and become sufficiently intense to lengthen the arcs upon an increase of current. All the carbons are suspended from a carrier free to move downwards by gravity, but held up by a stop on which rests one of the electrodes. A simple striking mechanism, which operates all the carbons simultaneously, is provided. The pairs can be arranged in series or parallel. The magnetic field is further strengthened by the presence of iron links, which are between the carbons just above the arcs, and which are part of the striking gear. Three claims, ten figures.

18,045, FELTEN & GUILLEAUME-LAHMEYERWERKE AKT.-GES. Improvements in alternating-current commutator motors of the inverted repulsion type, in which the current is supplied to the rotor. The main and auxiliary stator windings are usually in series and short-circuited. According to the present invention the stator windings are supplied with an E.M.F. in phase with the main E.M.F., from a transformer in parallel with the mains. On account of the leading E.M.F. induced by the rotation of the armature in the field produced by the auxiliary winding, the power-factor is improved. A third stator winding arranged in the commutation zone is also supplied from a transformer in parallel with the mains. At starting the main and auxiliary windings are short-circuited, and then, as the motor speeds up, the applied voltage from the transformer is gradually increased. One claim, two figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1907 Patents

5,764, MACKENZIE (*Ludwig Bolle & Co. Ges.*). Process for electrically fusing and moulding quartz.
6,034, CRAMP. Single-phase motors.
8,376, VANDERVELL. Electric switches.
8,471, KESSLER & JELICH. Electric alarm bells.
8,504, BROOK & HIRST. Multiple switch.
8,623A, STONE & MIGOTTI. Electrically-driven trains.
8,841, ALLGEMEINE ELEKTRICITÄTS GES. Incandescence bodies for electric lighting and heating purposes.
9,157, BALACHOWSKY & CAIRE. Electrical controlling devices.
9,684, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Machines for insulating conductors.
11,044, TANNER & CLAREMONT. Electric cables.
12,489, CRAMP & SAXON ENGINEERING CO. Armature winding.
12,871, GORNALL & UNION RUBBER & CHEMICAL CO. Electrically heated vulcaniser.
13,582, JONES. Electrical resistances.
15,169, DICKSON. Combined telegraph and telephone.
15,522. MASKELYNE. Electric light switches.
16,530, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Refractory metallic conductors for use in incandescent electric lamps.
16,736, BASTIAN, CALVERT & SANDERS. Fusing glass around conductors.
16,956, ANGOLD & MAXIM ELECTRICAL CO. Arc lamps.
17,012, BEVIS & KRAUSE. Wall plugs and sockets.
18,515, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Protective devices for electric transmission systems.
21,476, BLOXAM (*Siemens & Halske Akt.-Ges.*). Manufacture of electric lamps having metal filaments.
21,811, BENRATHER MASCHINENFABRIK AKT.-GES. Control of electric motors.
22,467, PINOT. Rotary transformers.
22,609, CRAIG. Trolley mechanism for electric cars.
24,670, ELEKTRICITÄTS AKT.-GES. VORM. SCHUCKERT & CO. Arrangements on meters for determining the maximum consumption.
24,807, VIEL. Electric furnace.
25,391, KARNS. Rail bond for rail joint circuits.
25,919, FERGUSON. Electric generators.
26,834, HADDAN (*Synchronous Static Co.*). Production of high-frequency discharges.
27,401, RAWLINGS & SMITH. Electric fuses.
27,447, SIEMENS BROS. DYNAMO WORKS, LTD., & CLIFT. Safety devices for electric winding plants.
28,690, KITSEE. Cable telegraphy.

1908 Patents

401, EDISON. Electrolytes for alkaline storage batteries.
3,465, ANDERSSON. Clutch for electric arc lamps.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patents

19,562, DEUTSCHE GASGLÜHLICHT AKT.-GES. (AUER GES.). Electric incandescent lamps having suspended filaments.

1908 Patents

4,847, WAELDE. Composition suitable for insulating flooring.
6,955, LJUNGSTRÖM. Electrical machines.
8,097, ARTOM. Wireless telegraphy.

Expiring Patent

The following patent expires during the current week after a life of fourteen years :—

9,285 of May 10th, 1894. CARL KELLNER. Compound electrodes of platinum or carbon for electro-chemical or metallurgical apparatus.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ld.	10	7	7%	10⅜—11⅜	
Do. 4½% Cum. Pref.	10	4½	4½%	10—11	
Do. 6% Cum. Second Pref.	10	6	6%	10½—11	
Do. 4½% Debenture, Red.	Stock	4½	4½%	102—105	
Bromley (Kent) E.L.& Power Co., Ld.	5	5⅛	5⅛%	4½—5	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	94—97	-2
Brompton & Kensington E. S. Co., Ld.	5	10	10%	7—8	-¼
Do. 7% Cum. Pref.	5	7	7%	6⅞—7⅜	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	98—101	
Ch. Cross. W. E. & City E. S. Co.	5	5	5%	3⅝—4⅛	
Do. 4½% Cum. Pref.	5	4½	2½%	4⅛—4⅜	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	3⅜—4⅛	-¼
Chelsea Electric Supply Co., Ltd.	5	4½	4½%	3—3⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9½—10½	-¼
Do. 6% Cum. Pref.	10	6	6%	12—13	+¼
Do. 5% Deb. Red	Stock	5	5%	123—126	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	101—104	
City of Durham E. P. Dis. Co.	5	4	2%	3—3⅜	
Do. 5% Pref.	5	5	5%	4½—4⅝	
County of London Elect. Sup. Co. Ld.	10	5	5%	7⅜—8¼	
Do. 6% Cum. Pref.	10	6	6%	10⅜—11¼	
Do. 4½% Deb. Red	Stock	4½	4½%	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	96—99 xd	-2
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅝—⅞	
Do. 6% Cum. Pref.	5	3½	—	½—1	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	55—60	+3
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4⅜—5¼	+⅛
Do. 5% Cum. Pref.	5	5	5%	5—5½	+⅛
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½%	6¼—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	90—93 xd	-2
Kensington & Knightsbridge E. L. Co.	5	10	10%	7⅞—8⅜	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N't'ng Hill E.L. Cos. Db. Rd.	Stock	4	4%	97—101	
London Electric Supply Corporation	3	4	2½%	1—1½	
Do. 6% Pref.	5	6	6%	4½—5	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6¾%	4⅜—5⅛	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D.	100 & 500	4½	4½%	96—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	9¼—10½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	8%	5⅝—6⅛	
Do. £2 Pm.	5	8	8%	5⅝—6⅛	
Do. 5% Pref. (fully paid)	5	5	5%	5⅛—5⅜	
Do. 10/- Pm.	5	5	5%	5⅛—5⅜	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7%	5⅝—6⅜	
Do. 4% Deb. Red	Stock	4	4%	94—98	+1
St. James and Pall Mall E. L. Co. Ld.	5	10	10%	7⅛—8¼	
Do. 7% Non-Cum. Pref.	5	7	7%	6¼—7	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	½—1½	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4%	2⅜—2⅝	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅜—⅝	
Do. 7% Cum. Pref.	1	7	7%	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5%	1⅜—2¼	
Do. 5% Cum. Pref.	5	5	5%	1⅜—2¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¼—8	
Do. 4½% Cum. Pref.	5	4½	4½%	4¼—5¼	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	88—91	-1
Central London	Stock	4	3%	74—77	-1
Do. 4% Preferred	Stock	4	4%	84—86	
Do. Deferred	Stock	4	2%	54—57	
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	81—84	
City and South London Cons.	Stock	2½	4¼%	39—41	
Do. 4% Perp. Deb.	Stock	4	4%	99—102 xd	-2
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1896	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11½d.	⅜—1½	
Gt. Northern, Piccadilly & Brompton	10	4	4%	6—7	
Do. 4% Perp. Deb.	Stock	4	4%	87—90	
Mersey Cons.	Stock	nil	—	1—3	-1
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1%	42—43	-½
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	75—78	-1
Do. 3½% Convertible Pref.	Stock	3½	3½%	73—76	
Metropolitan District	Stock	nil	—	11½—12½	
Do. 6% Perp. Deb.	Stock	6	6%	108—113	
Do. 4% Deb.	Stock	4	4%	no price	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	36—40	
Whitechapel and Bow 4% Deb.	Stock	4	4%	104—107	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅜—⅝	
Do. 5% Cum. Pref.	1	5	5%	1⅛—1⅜	-⅛
Do. 4½% Deb. Red.	Stock	4½	4½%	89—94	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93 - 96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	4—4½	
Do. 5% Perp. Deb.	Stock	5	5%	90—95	-1
Do. 4½% 2nd Deb.	Stock	4½	4½%	69—73	-2
City of Birmingham Trs. Co., Cm. Pf.	5	5	5%	4¼—4⅜ xd	-¼
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	97—100	

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%	%		
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	94—97	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅞—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/6	4/6	⅞—1	
London United Trs., Ld., Cm. Pf.	10	5	5%	6½—7½	+½
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—85	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	-⅛
Do. 5% Cum. Pref.	1	5	5%	⅛—⅜	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	94—97	
National Elec. Construction Co. Ltd.	1	10	2/-	⅞—1	-⅛
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅛—⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅛—⅜	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9⅜%*	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	⅛—⅜	
Do. 4½% Deb. Red	Stock	4½	4½%	93—96	
Provincial Tramways Co. Ltd.	10	3⅜	4%	4⅜—5⅛	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6%	⅜—1	
Do. 4% Deb. Red.	Stock	—	4%	78—82	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1½	
Do. 6% Cum. Pref.	5	nil	—	3½—3⅝	+⅛
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	55—58	
Do. 6% Pref. Ord.	Stock	6	30/-*	99—101	+½
Do. Def. Ord.	Stock	1⅜	1%	13⅜—14¼	+⅛
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3¼—3⅝	
Do. 10% Cum. Pref.	5	10	10%	8—9	-¼
Do. 4% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4½	4/-*	13½—14	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	99½—101½	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	99—101	
Do. do. (Mauritius Sub.)	25	4	4%	98½—100½ xd	-1½
Eastern Ext. Australasia & China	10	7	7/6	13—13⅝	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	100—102	
Eastern Telegraph Co.	Stock	5⅜	7%	131—136	
Do. 3½% Pref.	Stock	3½	3½%	84—87	
Do. 4% Mort. Deb.	Stock	4	4%	100—102 xd	-1
G. N. Tel. Co. (Copenhagen)	10	20	20%	29—31	-2½
Indo-European Telegraph Co. Ltd.	25	13	65/-	53—56	-2
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅜—½	
National Telephone Co., Ltd., Pref.	Stock	6	6%	107—109	
Do. Deferred	Stock	5½	6%	108½—110½	
Do. 6% Cum. 1st Pref.	10	6	6%	10½—12⅜	
Do. 6% Cum. 2nd Pref.	10	6	6%	10½—12½	
Do. 5% 3rd Pref.	5	5	5%	5⅜—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	98—100	
Do. 4% Deb. Red.	Stock	4	4%	101½—103½	
Western Telegraph Co., Ltd.	10	7	7%	13½—13⅝	
Do. 4% Deb.	Stock	4	4%	100—102	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	6%	⅛—⅜	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅝—3¾	
Do. 6% Pref.	1	6	7½d	1⅛—1⅛ xd	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	6½—6⅝	
Do. 6% Cum. Pref.	5	6	6%	5⅝—6½	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	93—98	-2
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—⅜	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅛	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	74—79	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	59—64	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10½—11½	
Do. 5% Cum. Pref.	5	5	5%	5⅛—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106½—108½	
Consolidated Electrical Co., Ltd.	1	3	3½%	⅜—½	-⅛
Crompton & Co., Ltd.	3	5	5%	1⅜—1⅞	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1⅛—1⅜	
Do. 6% Cum. Pref.	1	6	6%	1—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
Edison & Swan United "A," £3 paid	5	4½	2/6	⅜—1	
Do. do. (fully paid)	5	4½	4/2	1½—2⅜	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	¼—⅜	
Do. 7% Cum. Pref.	2	7	—	1¼—1⅜	
Do. 4½ 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8¼	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10½—11½	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—5⅜	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	30—32	-¼
Do. 4% Deb. Bds. Red.	100	4	4%	100—103	
Willans & Robinson, Ord. Shres.	1	nil	5%	1—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3⅜—3½	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

ABERDEEN: *Supply to Tramway Company.*—After considering the question of the renewal of the agreement of the Aberdeen & Suburban Tramway Co. for a supply of electrical energy, the Electricity Committee has decided to recommend that the question be referred to an arbitrator appointed by the Board of Trade. It will be remembered that at the company's annual meeting a complaint was made that it was largely due to the high price of current that the company was not in a better financial position. The intention was then announced that if the price were not reduced, the company would seriously consider the question of erecting its own generating station.

ACCRINGTON: *Tramcar Current Consumption.*—An experiment is being tried by the Accrington Electricity Committee in connection with the current used on the tramcars. It has been decided to fix a meter on a car to test the quantity of current used, and that the drivers be put upon this car in turn and their results noted.

ASTON: *Electricity Accounts.*—The accounts of the electricity undertaking for the year ended March 31st, 1908, show a gross profit of £9,786, against £6,616 for the year ending March 31st, 1907. After deducting interest and sinking fund charges, amounting to £6,659, there is a net surplus of £3,127, against £676 of the previous year. The connections are equivalent to 118,823 8-c.p. lamps, which includes 2,000 h.p. of motors. The total number of units sold was 2,942,384, made up as follows:—Lighting, 632,250; power, 1,113,754; and tramways, 1,196,380. The total for 1907 was 1,996,364 units.

BELFAST: *Cavehill and Whitewell Tramways.*—A Deputation from the Trades Council waited upon the Corporation on Monday with regard to the proposed arrangement with the Cavehill and Whitewell Tramways Co. This Deputation maintained that the price proposed to be paid is exorbitant, and urged the Corporation to proceed no further with negotiations at present, but should wait a few years longer, when they would probably be able to acquire the company's undertaking on much more reasonable terms. The Trades Council, the spokesman stated, was in favour of municipalisation of tramways, and they were not opposed to the municipalisation of the Cavehill and Whitewell lines, but their objection was to the Corporation having to pay too high a price for the undertaking. The Lord Mayor stated that the Council were pleased to have the views of the Deputation, which, he assured them, would be considered at the proper time.

At the weekly meeting of the Tramway and Electrical Committee on Monday, a lengthy communication was read from the Cavehill and Whitewell Tramway Co., on the proposed arrangements for running over the lines of the Corporation, so as to give a through service from Whitewell to the centre of the city. The company asked the Corporation to rent the system for four years, pay 3½ per cent. on the purchase price of £60,000, arranged for last year, but which fell through in Parliament, and some other details. (ELECTRICAL ENGINEERING, April 25rd, p. 639.) It was finally resolved to recommend that a through service be established, the company to receive the receipts on their end of the route, and the Corporation the receipts on their end, on the basis of a threepenny fare, provided that the Corporation be at liberty to purchase the undertaking at £60,000 within the next five years.

BIRMINGHAM: *Certificated Wiremen.*—The Corporation Electricity Supply Department, having decided to draw up a list of wiring contractors who are authorised to carry out work in the city area, has given notice that after June 30th, 1908, installations intended to be connected to the Corporation's mains should be carried out by authorised contractors. Applications from contractors wishing to be put on this list are now being considered.

BOLTON: *Tramway Profits.*—The Finance Committee last Friday approved of the resolution of the Tramways Committee allocating the sum of £9,745 out of the profits for the past year in relief of rates, as against £9,078 the previous year.

BRISTOL: *Electrical Showrooms.*—The Corporation has opened showrooms for the purpose of demonstrating the various uses of electricity.

CARDIFF: *Gas v. Electric Lighting.*—A sub-committee which was appointed to go into the question of lighting the Cardiff and Ely Workhouses, has reported that, after giving full consideration to the estimate of Mr. Arthur Ellis, the Borough Electrical Engineer, for an electrical installation, and also to that of the Cardiff Gas Co., they were confirmed in their opinion that it was not advisable to change from gas to electric lighting.

DARWEN: *Electricity Profits.*—The annual report of the Electricity Department shows a profit of £100 for the year ended March 31st, 1908, compared with £65 for 1907. The loss on the electric tramways will be greater than a year ago.

DUMBARTON: *Tramways.*—The Board of Trade inspection of the tramways from Dumbarton to Alexandria takes place to-day.

EXETER: *Electricity Accounts.*—The accounts of the Electric Lighting Undertaking to March 31st, 1908, show a profit of £2,200, after paying interest and sinking fund to the extent of about £9,000. In considering the question of how to deal with this balance, the committee have taken into consideration the various suggestions for the reduction in price, both to private consumers and to the tramways department, and, after consideration of these, recommend a reduction of ½d. per unit to private consumers, bringing the charge down to 4½d. per unit. The committee did not favourably consider the question of reducing the price to the Tramways Committee, and challenges the Chairman of that committee that, if he had to lay down a new plant to-morrow, and supplied the tramways from a new generating station, he could not produce at prices which he was now being charged by the electric lighting undertaking. The average price charged to tramways in similar towns throughout the country was 1·90d. per unit, whereas in Exeter it was 1·75d. With regard to the power users, instead of the present sliding scale of 2½d. to 2d. per unit, it was recommended that the charge should be 2½d. for smaller users and 1⅞d. for larger users, the scale ranging between these two amounts according to the amount consumed. The report of the committee was adopted at the meeting on Wednesday last week.

HANDSWORTH: *Tramway Purchase.*—An agreement has been come to between the Aston Manor and the Handsworth Urban District Councils, and the British Electric Traction Co., in regard to the purchase by the Councils of the company's tramways in Handsworth. The terms of the agreement set out that the Handsworth Council is to pay to the company £2 15s. per yard run of single track; the purchase money to be paid within one month of the date of the agreement; the tramway company to waive their option to a lease of the tramways so purchased; Handsworth to at once reconstruct and electrically equip the lines; the contract for the reconstruction to be placed within one month from the date of the agreement. The Aston Council is brought into the matter in connection with a proposal for through services over the lines in Aston Manor, provided the Handsworth Council offer similar facilities over certain lines in their district. The agreement, therefore, provides for these through services, which are to be controlled and arranged from time to time by the company's manager, the manager of the City of Birmingham tramways, and the engineer for the time being of Handsworth. In order to encourage traffic, a 2½d. through single fare is to be introduced, of which the British Electric Traction Co. will receive ¾d., the Handsworth Council ¾d., and the city of Birmingham the balance.

IPSWICH: *Tramways Renewal.*—Some months ago Mr. F. Ayton, the Electrical Engineer and Manager, was requested to report upon what provision, if any, should be made for the upkeep and renewals of the plant and machinery of the electric supply and tramways undertaking, in addition to the annual sums for the redemption of capital. Mr. Ayton, in his report, stated that the only portion of the plant in respect of which he considers it is necessary to form a special renewal fund is the tramway track. It appears probable, he says, that judging from the experience of other towns, the whole of the rails will require renewing in 1919, and the estimated cost of carrying out this work is put at £42,500. The Local Government Board has indicated its willingness to favourably consider an application in 1919 for leave to re-borrow the amount of capital that has been repaid, provided the Corporation in the meantime takes steps, by the formation of a renewal fund or otherwise, to raise the balance of the cost of the work. It may be mentioned that in 1919 the Corporation will have repaid in respect of the original loan for the track the sum of £10,408, and there will thus remain the sum of £32,092 to be provided by the Corporation during the next eleven years. As there appears to be little or no probability of the tramways receipts being sufficient to enable this amount to be accumulated out of revenue, Mr. Ayton reports that the only alternative appears to be to levy a rate in aid of such an amount as will have accumulated, at 3 per cent., to produce the required sum in April, 1919. In reporting upon this matter, the Finance Committee recommend that the renewals fund in question should be postponed in view of the fact that without providing anything for this in the current year, the rates of the borough will have to be increased 2½d. compared with last year, due to various other causes. At the last Council meeting the Finance Committee's recommendation was adopted.

KINGSTON-ON-THAMES: *Incorporated Municipal Electrical Association.*—The Electrical Engineer has been authorised to attend the annual convention of the Incorporated Municipal Electrical Association at Nottingham, and has been granted £6 6s. for expenses.

LONDON: *City of London: "Electrical" Fires.*—According to the annual report of the City Coroner (Dr. F. J. Waldo) 145 fires occurred in the City area during 1907. Eleven fires were reported as electrical in origin, and these were inquired into by Mr. A. A. Voysey, the City Electrical Engineer, whose expert investigation reduced the number to be attributed to defective electrical arrangements to five. Nine fires were associated with the use of gas. In thirty cases the cause is unknown.

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Hackney: Tramways and Street Widening.—The Finance Committee has decided that the Borough Council contribute £15,197, being a contribution of one-third of a total estimated expenditure of £45,590, in connection with the widening of certain parts of Mare Street, and Upper Clapton Road, consequent upon the construction for electrical traction of the L.C.C. tramways.

Lambeth: Underground Telegraph Wires.—Applications on behalf of the Postmaster-General for consent to the placing of underground telegraphic wires in a number of thoroughfares, the total approximate length of the wires being 1,127 yards, have been approved by the Borough Council, subject to protective conditions.

Lewisham: Breaking Up of Streets.—The Borough Council have made claims, amounting in the aggregate to £745 10s. 4d., against companies and authorities possessing statutory powers, in respect of the breaking up of roads and footpaths during the quarter ended March 31st. Included in the claims are the following:—South Metropolitan Electric Light and Power Co., Ltd., £96 7s. 11d.; National Telephone Co., Ltd., 19s.; Greig & Mathews (contractors to the General Post Office), £200 9s. 3d.; Westminster Construction Co. (contractors to the General Post Office), £94 17s. 3d.; London County Council, £1 11s. 6d.; General Post Office, £5 3s. 7d.

LEEDS: *Large Power Users.*—As a result of the reduction in the price for power, which took place from the beginning of April, it is stated that negotiations have been opened by several large firms with the Corporation Electric Lighting Department, with a view to a change over to electric driving.

LEYTON: *Electricity Accounts.*—At the last meeting of the Council the Electric Lighting Committee submitted a report from the Engineer, from which it appeared that during the year ending March 31st, 1908, the total number of units generated was 3,604,513, as against 2,366,907 the previous year. The units sold were: private, 880,392 (last year, 871,971); public, 718,158 (last year, 683,319); tramways, 1,705,081 (last year, 497,255), making a total of 3,303,631, as against 2,052,545 in 1907. The total number of consumers connected on March 31st, 1908, was 1,900, as against 1,778 on March 31st, 1907. The maximum lighting load was 944 kilowatts, as against 948 kilowatts in 1907, equivalent to 31,466 and 31,600 8-c.p. lamps respectively, being 46·2 and 49 per cent. of total connected.

Tramway Contract.—The Tramways Committee report that they have had under consideration a claim exceeding £2,000 made by Mr. Manders for work and extras in regard to the permanent way in connection with the tramways undertaking, beyond the contract sum. After full consideration of the matter they recommended that the claim be settled by payment of £1,150, and this has been agreed to. The payment of this £1,150 will bring the amount received by Mr. Manders to a total of £128,631 13s. 10d.

LLANELLY: *Provisional Order Transfer.*—The Urban District Council propose to transfer its electric lighting Provisional Order of 1891 to the Llanelly District Electric Lighting & Traction Co. The Council may re-purchase the undertaking at the end of 30 years or any subsequent period of seven years. The pecuniary consideration for the transfer is the payment to the Council by the company of the amount expended in obtaining the order, and the further payment of the costs of the transfer and applications to the Board of Trade in connection therewith.

MANCHESTER: *Tramways Committee.*—The Tramways Committee has decided to increase their annual grant to the Royal Infirmary, Manchester, from £50 to £100. It has also been decided to allow £25 per annum to the Ancoats Hospital. These grants are in recognition of the good work done by both institutions in connection with tramway accidents.

Electricity Accounts.—After meeting interest and sinking fund charges, and providing 40,000 for renewals of plant, the accounts of the electricity undertaking for the year ended March 31st show a profit of £18,177. Of this £10,000 were allocated to the relief of rates, and the balance transferred to the reserve fund. The increased price of coal involved an extra expenditure of about £9,000. The estimates for the ensuing year enabled the committee to promise another grant of £10,000 in aid of rates.

MIDDLESEX: *Tramways and Private Property.*—In consequence of the Council being compelled by the owners in many cases to purchase the whole of properties when a portion only is required for the purposes of the light railways, the Light Railways and Tramways Committee report that it may be found necessary to apply for an extension of the Council's borrowing powers, under the Light Railways Orders of 1903 and 1907, limited at present to £1,080,000. The Council would, it was pointed out, have to sell the lands and premises which they had been compelled to purchase, and which were not required, and under the 1903 Order it would appear that the Council must apply the sale monies in repayment of borrowed monies. The Clerk had been directed to ask the Local Government Board whether they would favourably consider an application for authority to use monies received from the sale of surplus property in payment of the cost of completing the construction of light railways authorised. If the Board would give its sanction to this course being taken, it might save the Council the expense of borrowing considerable sums for the completion of the lines. The Council decided that application be made to the Board of Trade to extend the borrowing powers under the Orders mentioned by £100,000.

NELSON: *Street Box Explosion.*—As the result of a street box explosion on Sunday, the supply of electricity to the whole town was cut off for a time.

Electricity and Tramway Accounts.—The annual report of Mr. Helm, Electrical Engineer to the Council, states that the result of the year's working is a profit of £591, instead of £408 1s. 2d. estimated, upon the electricity undertaking. It has been decided to allocate £250 to the relief of rates, and £341 to capital charges. Instead of an estimated loss on the year's working of £159 upon the tramway undertaking, there is a favourable balance of £22.

NOTTINGHAM: *Electric Supply Charges.*—A further meeting of the Traders' Associations of Nottingham has been held, protesting against the present system of charging for electricity for lighting purposes. The general feeling is that a flat rate, not exceeding 3d. per unit, should be charged to all consumers. After some discussion this feeling was put into a form of a resolution, with an expression of opinion that discounts should be allowed on quarterly accounts, when they are paid within 21 days, varying from 2½ per cent. on bills up to £50 per annum, and 7½ per cent. up to £150 per annum; above this sum it is suggested that special terms should be arranged.

SALFORD: *Tramway Accounts.*—The total income of the Salford tramway undertaking for the year ended March 31st, 1908, amounted to £244,048. Deducting working expenses, viz., £147,286, there is a gross profit of £96,762. Payments to local authorities for rent of lines, &c., absorb £25,985, and interest and sinking fund charges, £41,971, the net profit thus being £28,806. The Tramways Committee recommend that the Borough Treasurer be instructed to transfer £15,000 to relief of rates, and also a further £3,000 in accordance with a previous promise, and that the balance be placed to the credit of depreciation and renewals fund. The reserve fund stands at £60,000.

STALYBRIDGE, HYDE, &c.: *Joint Tramways Committee.*—At the meeting of the Stalybridge, Hyde, Dukinfield, and Moseley Joint Tramways and Electricity Department on Monday, it was stated that the loss for the past year amounts to £10,000. For the two previous years the losses have been £16,000 and £14,000 respectively.

SUNDERLAND: *Telephone Charges.*—A conference was held at Sunderland last week, at the instance of the Sunderland Chamber of Commerce, with regard to the new telephone charges of the National Telephone Co. Mr. S. J. Goddard, the general superintendent of the company, attended. It appears that the Sunderland Corporation, in return for allowing the company to lay underground wires, were to have certain concessions, but new subscribers are to be placed under the new rates, and this, it was argued, would mean an increase in cost to an ordinary business firm of from £25 to £50 a year. Mr. Goddard, in presenting the case for the measured rate system, said it appeared to the company to be a gross inequality that a large number of calls should be made at the same cost as a small number. The new arrangement was based upon the cost to which the company was put in installing the service, and it was a remarkable thing that subscribers who had previously been upon the unlimited rate, and who had changed over, immediately decreased their calls by quite 25 per cent. From this it was clear that a large number of the calls made by some of the subscribers upon the unlimited rate were unimportant calls. The Town Clerk stated that the main question to be considered was that the company, having secured permission to lay underground wires, and having, in fact, laid these wires, desired to depart from the agreement. The proposal that all new subscribers should be placed upon the new rates was absolutely against the spirit of the agreement.

TORQUAY: *Tramways.*—The Torbay tramway route was opened to the public on Thursday, the official inspection by Major Pringle, on behalf of the Board of Trade, having taken place on the same day. In the evening Mr. O'Hara, the resident engineer of the National Electric Construction Co., was presented with a gold signet ring and an illuminated address from the staff as a token of esteem.

Telegraph Traffic.—An uneventful week has again passed as far as interruptions and restorations of communication are concerned. One cable only has given out, that between Alexandria and Larnaca, on the 29th ult., and a quick repair has been effected. The Via Hanekin and Via Fao routes have again been in trouble, but the interruptions were of short duration only. Direct telegraphic communication has now been opened with Bor, Meshra, Gondekoro, Mongalla, Rumbek, Myolo, Won, and Toni in Bahr-el-Ghazal. Restrictions are still in force on telegrams to Borneo (British), Argentine, Costa Rica, Nicaragua, Honduras, Venezuela, and Hayti, and messages for Cartagena, United States of Colombia, are still subject to delay. President Castro has instructed the Venezuelan Consul at Trinidad not to clear any more British vessels for Venezuelan ports, and, in consequence, senders of telegrams are deprived of the facilities of sending telegrams with instructions to post them at Trinidad.

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TENDERS INVITED AND PROSPECTIVE BUSINESS

AUSTRALIA.—The Board of Trade correspondent at Melbourne (Mr. M. Hirsch) has forwarded particulars of a call for tenders for the supply to the Deputy Postmaster-General at Melbourne of 2,800 jacks in strips of 20; 1 mile of 64-wire switchboard cable; 50 three-conductor cords, 7 ft. long; 96 three-part plugs; and 66 listening and ringing keys. Tenders will be received by the Deputy Postmaster-General, Melbourne, up to 3 p.m. on June 9th.

The Board of Trade are notified by the London representative of the Australian Commonwealth (Capt. R. Muirhead Collins, C.M.G.) that tenders will be received at the office of the Deputy Postmaster-General, Perth, until noon on Monday, September 7th, for the supply of the following telephone material, viz. : 650 wall sets, 150 table sets, 800 protectors, 90 extension switch and bell sets, complete, 30 switchboards for four lines, 20 switchboards for six lines, 5 switchboards for twelve lines, 5 switchboards for twenty-four lines, 20 wall sets for party lines, and 10 table sets for party lines. Tenderers must state the country in which the articles tendered for have been made or produced, and, in the case of manufactured articles, where the material has been made or produced. Tenders must include customs duty, if any. A deposit, equal to 5 per cent. of the amount of the offer, will be required to qualify any tender. Specifications, conditions, and forms of tenders may be obtained at the Commonwealth of Australia Offices in London, 72 Victoria Street, S.W.

Tenders for the following are invited by the Deputy-Postmaster-General, Sydney :—Supply and delivery of eight tons of hard-drawn copper wire (400 lb. per mile), 1½ cwt. of copper tape binding (200 lb. per mile), 1,300 best white large porcelain insulators, and 2,000 tallow-wood crossarms, 5 ft. 2 in., by June 10th, and the supply, delivery, and erection of a branching metallic multiple magneto switchboard by August 12th. Specifications, conditions, and forms of tender may be obtained at the Commonwealth Offices in London, 72 Victoria Street, S.W., where also preliminary deposits on tenders may be paid.

The Commonwealth Government has called for tenders, returnable to the Postmaster-General's Department, 51 Spring-street, Melbourne, on August 26th, for the supply and erection of installations for wireless telegraphy at the following places :—(1) Cape York, (2) Thursday Island, (3) Goode Island, (4) Port Moresby, (5) Fremantle. Tender forms, specifications, and general conditions may be obtained at the offices of the Deputy Postmasters-General of the several States or of the Commonwealth Representative, 72 Victoria Street, Westminster, London. The *Australian Mining Standard* states that tenders must be accompanied by a deposit or receipt for deposit of £100. Deposits on tenders may be lodged with the Deputy Postmaster-General at any of the offices named, or at the office of the Commonwealth Representative in London, but a receipt for such deposit must be obtained and forwarded with the tender. The deposit need not be made in cash, but a banker's certificate should be forwarded by the tenderer to the Secretary, Postmaster-General's Department, to the effect that the amount of the deposit is held at the call of the Secretary to the Postmaster-General's Department. Tenderers must state the name of the country or State in which the apparatus, &c., will be manufactured. The Postmaster-General does not bind himself to accept the lowest or any tender.

BASLOW.—The possibility of introducing electric lighting into this district is being considered by the Urban District Council.

BEDFORD.—Tenders are invited for the supply of about 6,500 tons of Derbyshire and Nottinghamshire coal for the electricity works. Particulars from the Town Clerk, to whom tenders by May 15th.

BELFAST.—Five iron lattice electric light masts, 70 ft. high from ground line, are required by the Belfast Harbour Commissioners. Particulars from the Secretary, Harbour Offices, Belfast, and tenders by May 13th.

BRIDLINGTON.—With a view to installing a Tirrill regulator, the Electricity Sub-Committee and the Borough Electrical Engineer has been authorised to inspect these pieces of apparatus in use at Grimsby and Lincoln.

BRIGHOUSE.—A Local Government Board inquiry was held last week into the application by the Corporation for sanction to borrow £3,624 for the extension of the electricity undertaking. This expenditure is to be incurred in dealing with the distribution of electrical energy, which is to be supplied in bulk by the Yorkshire Electric Power Co. There was no opposition, and the inquiry was terminated.

BRISTOL.—Tenders are invited for (*a*) direct-current works switchboards at the Avonbank electricity works; (*b*) E.H.T. and L.T. sub-station switchgear for Shirehampton; (*c*) D.C. power switchgear for supply to Avonmouth Docks; (*d*) extension of galleries at the Avonbank electricity works. Full particulars from Mr. H. Faraday Proctor, City Electrical Engineer (fee, £2 2s., for each section, returnable), and tenders to the Town Clerk by May 11th, for sections A and C, and May 18th for sections B and D. (See an advertisement this week.)

BURNLEY.—On May 1st Mr. W. O. E. Meade-King inquired, on behalf of the Local Government Board, into an application by the Burnley Corporation to borrow money for various undertakings, including £26,460 for the purpose of the electricity department. £9,560 of this sum is for extension to mains, and for house service connections, and £7,100 for a generating set and pump. The extensions are expected to cover ten years' progress.

COLNE.—There was no opposition at the inquiry on April 30th, at the Colne Town Hall, conducted by Mr. Meade-King, on behalf of the Local Government Board, into the application of the Corporation for sanction to borrow £4,170 for electrical purposes. The loan is required chiefly for the purchase of a motor generator, &c., for motors for hire. A sum of £1,500 had already been sanctioned for motors, this amount having been overspent by £207 16s.

DARLINGTON.—Tenders are invited for a Lancashire boiler and superheater. Particulars from the Borough Electrical Engineer (fee £1 1s., returnable), and tenders to the Town Clerk by May 11th.

DARTFORD.—The Engineer has been instructed to obtain tenders for new condensing plant.

DOVER.—The Corporation invite tenders for the supply of large and small Welsh coal, and 3,000 tons of North Country and Midland or small coal, for the electricity works. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by May 18th.

EDINBURGH.—Tenders are invited for an electrical installation for lighting, heating, and power, at the College of Art, Edinburgh. Full particulars may be obtained from Mr. F. A. Newington, the Borough Electrical Engineer, and tenders to the Town Clerk by May 14th.

The West Calder Co-operative Society has decided to erect a new bakery with power station and electric lighting plant.

HEANOR.—The District Council has appointed a special committee to go into the question of electric lighting.

HULL.—A new sub-station is to be erected at an estimated cost of £10,000.

LIVERPOOL.—The National Telephone Co. contemplates erecting a new exchange in South John Street. It is stated that the proposed exchange will be the finest and most spacious in the North of England, and will form the headquarters of the company in Liverpool.

LONDON: *London County Council.*—Tenders are invited for the wiring and fitting for electric lighting of a tramway car shed at Mare Street, Hackney. Particulars from the Clerk, fee £2 2s., returnable, and tenders by May 12th.

Tenders are also invited for the supply and delivery of about 2,000 tons of steel girder tramway track rails and fastenings required for the electrification of further portions of the Council's tramways. The Council also invite alternative tenders for the supply and delivery of about 5,000 tons of track rails and fastenings. Full particulars from the Engineer to the Council (fee, £2, returnable), and tenders to the Town Clerk by May 19th.

Tenders are invited for the supply and delivery of (*a*) 175 double-deck, roof-covered, electric car-bodies; (*b*) 175 pairs of maximum traction swing bolster trucks; (*c*) 175 complete electrical equipments for operation upon the overhead trolley, surface contact, and underground conduit systems of electric traction. Full particulars from the Clerk to the Council (fee £2 2s. returnable), and tenders by May 9th.

The Council invite tenders for two electrically-driven centrifugal pumps, to be erected at the Greenwich generating station.

NOTICE.

Notice under Section 33 of the Patents and Designs Act, 1907.

NOTICE is hereby given that the following invention is protected by Patent No. 24,923 of 1906 (J. S. Raworth).

In traction systems in which regenerative motors are used, it is possible that the voltage of the system may rise considerably above the normal voltage. To protect the machinery and instruments, connected to the traction mains, from such excessive voltage or reverse current, a diverting circuit, including a resistance and a relay operated switch, is arranged between the positive and negative conductors. The switch is automatically closed by a rise in voltage or a reverse current, and is also automatically opened on the restoration of normal conditions. JOHN E. RAWORTH, Chartered Patent Agent, Queen Anne's Chambers, Westminster, S.W.

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Full particulars from the Clerk to the Council, to whom tenders by May 26th.

Bermondsey.—In regard to the extension of the plant at the electricity works a specification has been approved for a steam dynamo, marine boiler and condenser, and tenders are to be invited for the supply and erection of the same. Alterations are to be made in the electric lighting at the Central Library, at an estimated cost of £19 10s.

Tenders are invited for a boiler, steam dynamo, condenser, and cooling tower. Particulars from the Borough Electrical Engineer (fee, £2 2s., returnable), and tenders to the Town Clerk by May 18th.

Hackney.—The Electric Lighting Committee has decided that a concentric feeder cable, 0·4 square inch section, be laid, at an estimated cost of £1,515.

Stepney.—Mains, necessitated by applications for supplies of electricity, are to be laid in four streets.

MANCHESTER.—In a report by Mr. S. L. Pearce, the Chief Electrical Engineer to the Corporation, a scheme of extensions at the Dickinson Street and Stuart Street generating station is outlined, at an estimated cost of £135,000, for which sum the Electricity Committee recommend an application to the Local Government Board. Part of the proposed expenditure will be in connection with sinking artesian wells at the Stuart Street station. Another item in the proposed loan is for wiring of consumers' premises upon the hire-purchase system. Under the proposed system the consumers will provide the necessary lamps and fittings, and the Corporation will do the wiring, the cost of which will be refunded by instalments.

METROPOLITAN ASYLUMS BOARD.—Tenders are invited for a number of stores, including electrical accessories. Full particulars from the Clerk to the Board, Embankment, London, E.C., and tenders by May 13th.

SALFORD.—The Electricity Committee invite tenders for the supply, delivery, and erection at the Frederick Road generating station of cooling towers, tanks, pumps, and pipe-work. Full particulars from Mr. V. A. H. McCowen, Borough Electrical Engineer (fee, £2 2s., returnable), and tenders to the Town Clerk by May 25th (See an advertisement this week.)

SPAIN.—A public competition will be held at the Junta de Obras (Board of Works) of the port of Tarragona, at 5 p.m. on May 31st, for the purpose of adjudicating the contract for an electric installation for lighting and motive power at that port. Tenders will be received up to the time of the adjudication. Local representation is necessary.

STOCKPORT.—A Local Government Board inquiry will shortly be held into the application by the Corporation for sanction to borrow £10,500 in connection with the electricity undertaking.

TAUNTON.—A Local Government Board inquiry was held on Tuesday into the application by the Corporation for sanction to borrow £2,000 for electric lighting purposes.

UXBRIDGE.—Tenders are invited for wiring, fitting, &c., for new building now being erected by the Uxbridge Joint Hospital Board. Particulars from the Architect, Mr. W. C. Eves, 54 High Street, Uxbridge, to whom tenders by May 14th.

TENDERS RECEIVED AND ACCEPTED

ABERDEEN.—The tender of the British Insulated & Helsby Cables, Ltd., for the supply of cables in connection with the Cults generating station, at £3,575 15s., is recommended for acceptance.

ACCRINGTON.—The Electricity Committee have this week decided that a water-cooling tower to deal with 150,000 gallons per hour be provided with the necessary foundations and enlarged dam. Applications to be made to the Local Government Board for sanction to borrow £1,400 to defray the cost. It was agreed to negotiate with Messrs. Balcke & Co., and Messrs. Worthington, who had submitted the most favourable tenders for the tower.

A quotation has been received from the Brush Electrical Engineering Co., for the supply of two single-decker cars, at £695 each. The electricity sub-committee has been given authority to complete the purchase.

CONDENSING PLANTS.—The Mirrlees Watson Co. Ltd., Glasgow, have recently received orders for a number of condensing plants, among which are the following:—Hendon Paper Works, Sunderland (surface condenser), Messrs. H. Bollinckx, Brussels (surface condensing plant), James Howden & Co., Glasgow (surface condensing plant), the British Thomson-Houston Co., Ltd., for Teesbridge Iron Works (surface condensing plant), W. & R. Jacob & Co., Ltd., Dublin (elevated jet condensing plant).

HULL.—The tender of Messrs. Siemens Bros. & Co., for mains at £592 5s., has been accepted.

LONDON: *Bermondsey.*—The Council has accepted the tender of Messrs. E. Green & Son, at £276 10s., for repairs and providing accessories to the fuel economiser at the electricity works. The following tenders have been received for the supply of insulating box compound:—Rumney & Rumney, £2 11s. 6d. per cwt.; Johnson & Phillips, £5 12s.; W. T. Glover & Co., £2 10s.; W. T. Henley & Co., £2; Siemens Bros., £6 6s.; Geipel & Lange, £1 17s. 4d.; Union Cable Co., £1 8s.; Callender's Cable Co., £2 6s. 8d.; Western Electric Co., £2 16s.; British Insulated Cable Co., £4 4s.; Cables Accessories Co., £2 10s.; Knapton & Co., £2 10s.; Neville, Williams & Co., £3; Turners & Manville, £3 14s. 8d.; British Electrical Trade Supply & Bitumen Co. (provisionally accepted), £1 10s. 6d.; Craig, Sharp, Ltd., £1.

Fulham.—The Electricity and Lighting Committee has accepted the tender of Siemens Bros. for the supply of 100 electric meters, *i.e.*, 50 each of three and five ampere size, at 29s. each. The committee has also decided that an order be placed with F. Pratt & Co., Ltd. (Halifax), for the supply of machines and tools for the workshop at the electricity works, at £140 5s.

Hackney. The Electric Lighting Committee has accepted the tender of J. Hudson & Co. for the supply to the electricity works of 2,000 tons of Broomhill coal, at 12s. 3d. per ton.

Kensington.—The Borough Council Works Committee has decided to accept the tender of Messrs. Crompton & Co., Ltd., to supply and fix lowering contact gear to 23 arc lamps in main roads, at £4 7s. 6d. per lamp.

Paddington.—The Borough Council has accepted the offer of the Metropolitan Electric Supply Co., Ltd., to fix the necessary shafting, poles, electric motors, &c., for driving the chaff-cutter, grindstone, &c., at the wharf, at an initial cost of £20 4s. 7d., and thereafter to supply current at the rate of 2d. per unit or upon the sliding scale, which commences at 3d. and is reduced according to the time the machines are working to a minimum rate of ¾d. per unit. The charge will be based on either scale at the option of the Council.

MANCHESTER.—Messrs. Marples, Leach & Co. have secured the contract for the complete electrical equipment of the new mill which is being erected by the Tyne Ring Spinning Co., Ltd., at Littleborough, near Manchester.

RAWTENSTALL.—The following tenders have been accepted:—Messrs. Chamberlain and Hookham, direct-current meters; General Electric Co., alternating-current meters; Yates & Thom, Green's economiser.

ST. PETERSBURG.—Among recent contracts obtained by Messrs. Ferranti, Ltd., Hollinwood, is that for the supply of 55 transformers for the St. Petersburg Corporation, Russia. The company inform us that owing to the very high Russian import duty, which is assessed upon the *weight* of the articles, light but bad efficiency transformers are at an advantage as regards initial cost, and they state that such transformers have hitherto been exported into Russia. Some time ago Messrs. Ferranti secured permission to submit several special high efficiency type "E X" transformers as samples to St. Petersburg. The tests on these were so satisfactory, and the saving shown to be possible over a number of years was so large, that the result has been that the above contract has been placed.

STOKE-ON-TRENT.—The tenders of Messrs. Willans & Robinson, at £2,265, for a steam generator and condenser; Messrs. Babcock & Wilcox, for a water tube boiler at £1,410; Reason Manufacturing Co., for meters, and of the British Insulated and Helsby Cables, Ltd., for street box fittings and house service cut-outs, have been accepted.

STOWMARKET.—The following tenders have been received for public lighting:—Suffolk Electricity Supply Co. (the Council to provide necessary lanterns, wires, and fittings at an estimated cost of £632), £160; the Stowmarket Gas Co., £247 14s. for one year, and £227 14s. for five years. On the recommendation of the Lighting Committee the latter tender, on the basis of a five years' contract, has been accepted.

WIMBLEDON.—The Electric Lighting Committee has accepted, subject to the usual sanction, the tender of James Howden & Co., Ltd., Glasgow, to supply a turbine, direct coupled to a Siemens single-phase 1,000-kw. alternator and switchgear, with a Worthington condensing plant, and the necessary pipework and valves, for £7,275. A sub-committee inspected the "Curtis" and "Zoelly" horizontal turbines, and gave the preference to the latter. The Electrical Engineer has been authorised to obtain a supply of alkali from Brunner, Mond & Co., Ltd., at £5 per ton.

Birmingham Tramway Accident.—The trolley of an open-car left the overhead wire when the car was proceeding along Coventry Road. Before the conductor, who was on the top of the car, could replace the trolley-pole, the latter caught the span wire. The cast-iron standard supporting the trolley-pole fell on the conductor and two passengers, injuring the latter.

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COMPANIES' MEETINGS AND REPORTS

BARNSLEY & DISTRICT ELECTRIC TRACTION.—At the annual general meeting on Wednesday last week, presided over by Mr. E. Garcke, the report and accounts were adopted. The revenue for 1907 amounted to £9,065, and the expenditure, including £408 placed to renewals accounts, to £7,455. To the balance is added £452 brought forward, leaving a sum of £2,062 available for distribution. Of this £250 have been placed to depreciation and reserve, £350 to sinking fund for redemption of loans, &c., £1,200 is absorbed by preference dividend, and the balance of £262 is carried forward. Provision is to be made for renewals account by setting aside out of revenue 0·5 per car mile for this purpose. The total capital expenditure at December 31st, 1908, was £647,403. The traffic revenue showed an increase of £279 over that of 1906, but the expenditure was higher, chiefly owing to the necessity for a complete overhaul of the cars, and their electrical equipment. There was a net increase in profits of £27 over the previous year of 1906. The company has made application to the Corporation for a revision in the price charged for electrical energy, but up to the present the Corporation have not acceded to this request, and the directors now have under consideration the further steps that can be taken.

BRISBANE ELECTRIC TRAMWAYS.—The annual general meeting was held in London on Wednesday last week, Mr. H. R. Beeton presiding. The accounts for 1907 show total receipts amounting to £159,230, compared with £141,732 for the previous year, and an expenditure of £88,116 compared with £82,770. There was thus a net improvement over 1906 of £12,151. The Brisbane Tramways Co., of which the Brisbane Electric Tramways Co. hold all the shares, has raised its renewals fund to £39,000 by the addition of a sum of £15,000, bringing the total of undivided profits available for renewals, &c., to about £58,000, and had paid in dividends a total for the year of £57,000. This enables them to satisfy debenture stock interest and preference dividends, and to pay a dividend of 4 per cent. on the ordinary shares, and to carry forward £2,130. The chairman, in his speech, stated that the receipts during the first quarter of 1908 show an increase for the same number of days of £5,000 compared with 1907, and the receipts per car mile amounted to 12·2d. compared with 10·77d.

BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING.—The annual general meeting was held on Monday at Hamilton House, Victoria Embankment, London, Mr. J. Annan Brice, M.P., presiding. The Chairman first dealt with the crisis which occurred in the affairs of the American Co. and the bearing which it had upon the British Co. The American Co., he said, was forced, owing to the sudden stringency of the United States money market, to seek the temporary protection of the Courts, but he was very glad to say that the Westinghouse Machine Co. had been relieved from its receivership as from March 31st, and, in the case of the Westinghouse Electric Co., negotiations were proceeding to the same end. In consequence of this state of affairs the English Co. had to consider how they could provide for the future needs of their business. They could not hope to raise further share capital, owing to the conditions of the money market, neither could they issue further debenture stock ranking *pari passu* with that already existing, except at a prohibitive cost. The only solution, therefore, was the creation of Prior Lien Debentures, of which £300,000 had been created, and £250,000 had been placed at £98 per cent. Prolonged negotiations with the receivers of the American Electric and Machine Cos. had resulted in their agreeing to take Traction & Power Securities Co.'s shares at par for the amount shown in the balance-sheet to the credit of this company, namely, £186,374. The whole amount had been liquidated by the transfer of a corresponding amount of those shares at par. This released £186,000 of capital hitherto invested in securities. Dealing with the balance-sheet, which was given in our last issue, he referred to the marked improvement over the last accounts, and to the fact that they had been able to provide not only for interest on debentures and bank loans, but also certain sums for the depreciation of stock on hand and in process of manufacture. During the year 1907 each department of the works, so far as the accounts were concerned, had been run as a separate business, with the result that economies had been effected, which had not been practicable hitherto. The cost of manufacture had been reduced to such an extent that with a pay roll of 2 per cent. less an output having an additional value of 10 per cent. was produced. Economy in maintenance and operation, machinery and tools, had also resulted in a saving of £10,000. Further reductions in the salary list and general expenses had resulted in an additional saving of £26,000. The total output increased by 17 per cent. over that of the previous year. With a view to improved efficiency and economy in manufacture many important lines of apparatus have been re-designed. Several contracts have been taken on the Continent in co-operation with the French Westinghouse Co. In conclusion, the Chairman referred to the death of Lord Kelvin, who had acted as technical adviser to the company since its foundation. The report and accounts were adopted.

CRAIGPARK ELECTRIC CABLE.—At the annual meeting on Monday, the report and accounts given in our last issue were adopted. The Chairman, Mr. J. T. Tullis, stated that the past year had been one of the best years since the formation of the company. During the year the company had joined the Cable Makers Association, for the reason that many of the specifications issued now stipulated that the cable was to be purchased from firms connected with the association.

DIESEL ENGINE.—The accounts for the year ended March 31st, 1908, show a credit balance of £20,731, to which has to be added £3,488, making a total balance of £24,210. A 10 per cent. dividend is recommended, £7,000 is to be placed to reserve account, and £7,209 carried forward. The meeting is on May 14th.

EASTERN EXTENSION, AUSTRALIA & CHINA TELEGRAPH.—The report for the half-year ended December 31st, 1907, shows gross receipts amounting to £304,416, compared with £296,393 for the corresponding period of 1906. Working expenses amounted to £154,203, compared with £139,549. From the balance of £150,212, income tax, payable in England, interest on mortgage debenture stock, and other extraordinary expenses, absorb £19,770, leaving a net profit of £130,442, to which has to be added £74,947 brought forward. One quarterly dividend of 1¼ per cent. has been paid, and the directors now propose to distribute similar dividends, which, together with the interim dividend paid for the first half-year, make 5 per cent. for the year. A bonus of 4s. per share, or 2 per cent., is also recommended. £50,000 have been transferred to the general reserve fund, and £20,389 are carried forward. An expenditure of £28,848, which has been incurred in renewals of the company's cables, has been charged against general reserve fund. Since the close of 1907, the new cable between Java and Cocos Island has been laid and opened for traffic.

EASTERN TELEGRAPH.—The report and accounts for the six months ended December 31st, 1907, shows a revenue of £595,483, from which are deducted £198,229 for the ordinary expenses, and £63,527 for expenditure relating to maintenance of cables, depreciation of spare cable, sundry differences in exchange, and income tax payable abroad, leaving a balance of £333,727, to which is added £41,651 brought from the preceding account, making a total available balance of £375,378. After providing for income tax payable in England, interest on mortgage debenture stock, and dividends on the preference stock, which in all absorb £82,583, there remains a balance of £292,795, out of which the directors have placed £7,000 to the reserve fund for maintenance ships, and £70,000 to the general reserve fund, and have paid an interim dividend of 1¼ per cent. on the ordinary stock, amounting to £50,000. The directors now recommend the declaration of a final dividend on the ordinary stock of 1¼ per cent. and a bonus of 2 per cent., amounting together to £130,000, both payable on the 12th inst., free of income tax, and making, with the three previous payments on account, a total distribution of 7 per cent. for the year ended December 31st, 1907. It is proposed to carry forward the balance of £35,794 19s. 11d. to the next account. The meeting is on the 12th inst.

GREAT NORTHERN TELEGRAPH.—At the annual meeting held in Copenhagen on April 25th, the report and accounts given in our issue for April 9th were adopted. The Chairman and Managing Director, Commodore E. Suenson, D.R.N., in rendering an account of the working of the company during the year 1907, stated that the company's submarine system had not been subject to more frequent interruptions in 1907 than in previous years. There had been sixteen interruptions on eight cables in Europe, and ten interruptions on seven cables in the Far East. Referring to the remarks made in last year's report with regard to the improvement of the Kiachta route, by which the telegrams are transmitted between Peking and England with only two re-transmissions (at Irkutsk and St. Petersburg), the working of this important route between Europe and the Far East had continued to improve, and the same may also be said of the Wladiwostock route. The new cable between Russia and Denmark had to be laid under great difficulties on account of the intricate nature of the Baltic Sea and the laying consequently required a great deal of skill. The length of the eastern section of the cable (St. Petersburg-Libau) is 472 nautical miles, and of the western section (Libau-Stevns) 319 nautical miles. The telegrams between St. Petersburg on the one side, England and France on the other side, can be sent by the new cable with only one re-transmission. Their Iceland cable had a most propitious inauguration last summer, when the Faroe Islands and Iceland were honoured by the visit of H.M. King Fredrik VIII., accompanied by several members of the Danish Parliament. The company had acquired a new building for the company's offices and station at Shanghai, the most important telegraphical centre of China. Parts of this building had been let to the Eastern Extension Telegraph Co. and Commercial Pacific Telegraph Co., by which arrangement the exchange of the telegrams between the three companies will be facilitated. Dealing with the situation in the Far East, the Chairman referred to the difficulties which have arisen in the Far East as a consequence of the great political changes in that part of the world after the war, and of the approaching expiration of the company's exclusive privileges in Japan. The directors had

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been engaged all through the year in complicated negotiations regarding this question, which necessitated their Shanghai representatives spending nearly the whole of the year at either Peking or Tokio. Although the proposals which were submitted to the Imperial Administrations of China and Japan were, in the opinion of the Board, very liberal, still they had been somewhat modified during the negotiations in order to meet the views of the two countries in question, and appeared now to be satisfactory to the former Administration. In Japan, on the contrary, they have been less fortunate, although the negotiations were continued right up to the month of February of this year, when they were suspended in order to be resumed in Europe, during or after the International Telegraph Conference, where all the interested parties will be represented. He could not pass by in silence the remarkable progress of wireless telegraphy during the last year by the opening of a direct public service between Europe and America. It would, no doubt, be remembered that in March, 1903, the Marconi Co. announced the opening of such a service, which, however, failed a few days later. Since then nothing had been heard of it until October, 1907, when the same company advertised the re-opening of the service for press telegrams only. Later on, in February of this year, they extended the service to comprise private telegrams to and from Montreal in Canada. To judge from information obtained from independent and neutral sources, the re-opening of the service after four or five years' silence was still far from being a complete success. Although the rates have been fixed at about one-half of those of the Transatlantic cables, the public, and even the press, had hitherto made very little use of the new service, which suffered from slowness, uncertainty, and want of secrecy. However confident they might feel of the absolute and lasting superiority of the telegraph by wire for the transmission from one country to another of political, commercial, and private communications, the new invention had in the course of a few years made such remarkable progress that it might, nevertheless, in course of time, perhaps, become necessary to reckon with it, not only as a supplementary and auxiliary service, but also as a competitor of the telegraph by wire. The "revenue account" showed that the downward tendency of the traffic receipts had not yet ceased, as they decreased by about £13,200 as compared with 1906. As to expenses, "salaries and wages" had increased by about £6,520, and will continue to grow, the more so, as the enhanced cost of living appeared to have become chronic in Europe. "Expenses of stations, &c.," had increased by about £1,480; "ordinary supervision and maintenance, &c.," had decreased by about £500, and "instruments and cells" by £120. The "maintenance of buildings" had increased by about £1,200, "rates and taxes" by about £1,700, and "travelling expenses" by about £200. "Bank commission" had decreased by about £300, and "sundries" by about £1,700. Altogether the ordinary expenses" were about £8,500 higher than those of 1906. The balance-sheet showed under "assets" that the investments had decreased by about £3,560 on account of drawn bonds. It had been impossible to increase this item, because they had been in exactly the same position in 1907 as in the preceding year, viz., that all the receipts of the reserve fund, and something more besides, had been absorbed by the expenses towards the St. Petersburg-Libau-Denmark cable, &c. The "advances guaranteed by banks" had been reduced by about £55,555, whilst the cash balance had been increased by about £28,000, it being necessary to have funds available, and, lastly, "sundry debtors" had been increased by about £9,000. Under "liabilities" the "reserve and renewal fund" had decreased by about £21,500, on account of the heavy extraordinary expenses. The "dividend equalisation fund" had been increased only by the ordinary interest of its capital, about £14,000. The Board of Directors was, however, happy to be in the position to propose the same dividend and bonus as in the previous year, viz., 20 per cent., of which 5 per cent. has already been paid as interim dividends. The Chairman concluded his speech with expressions of regret for having been obliged on account of failing health to ask for the consent of his colleagues on the Board to his resigning the position of managing director in the course of the present year. The business of the company had gradually developed so much that in the future it would be impossible for one single person to attend to all the details. The Board had therefore decided to substitute for the managing director a Board of Management, composed of several persons who, in view of their personal qualifications and meritorious collaboration with the Managing Director, offered the greatest guarantee for future effective administration of the company.

ISLE OF WIGHT LIGHT & POWER.—The accounts for the year 1907, after providing for debenture interest and loans and preference dividend, show a net profit of £3,190. £2,500 have been transferred to the reserve fund for renewal of plant, £500 written off wiring stocks, and £190 carried forward.

LISBON ELECTRIC TRAMWAYS.—The report for 1907 states that the result of the operations for the past year, after deducting interest and amortisation due on the debentures of "The Companhia Carris de Ferro de Lisboa," and after the payment of £25,000 for interest on the debentures of this company and the payment of London office expenses and directors' remuneration, shows a net profit of £92,805, which, added to £15,711 brought forward, gives a balance of £108,514. From this amount £35,000 has been placed to depreciation, and after writing off £9,077 for renewal of permanent way, the balance of £135,922 is placed to depreciation reserve account. After placing £5,000 to the credit of exchange, there is an available balance of £68,514, out of which the usual preference dividend amounting to £25,555 has been paid, and the directors now recommend the payment of a dividend of 5 per cent. for the year 1907, amounting to £29,709 on the ordinary share capital of £594,188, leaving £13,271 to the credit of profit and loss to be carried forward. Operating expenditure also shows a considerable increase due to the enhanced price of coal and other supplies; but, notwithstanding these drawbacks, the operations of the company during the past year have practically maintained the satisfactory figures of the previous year. Capital expenditure has amounted to £72,271, mainly on additional machinery, rolling stock, cables, and the electrification of the lift on the Elevador Do Carmo. The lease of the Elevador Do Carmo entered into in the previous year has resulted in a fair return being earned on the expenditure incurred. The meeting is on May 15th.

MUSSELBURGH & DISTRICT ELECTRIC LIGHT & TRACTION.—The accounts for the year 1907 show a net revenue, including the balance brought forward, of £3,599. After providing for debenture interest and a 2 per cent. dividend upon the preference shares, there is a balance of £119 to be carried forward. The report makes mention of the fact that the revenue has been affected by the strike in August. At the meeting on Friday the report and accounts were adopted.

NATIONAL ELECTRIC CONSTRUCTION.—The report for the year 1907 shows a gross profit of £29,776, and after deducting expenditure there is a balance of £18,116, to which is added the balance carried forward from previous accounts, making a total of £20,460. The directors recommend the placing of £3,000 to reserve, and after meeting expenses of debenture issue (£2,487), capital charges on town lighting installations (£1,200), debenture redemption fund £1,550), doubtful debts (£500), and depreciation (£673), there is a sum of £9,047 to be carried forward. The report states that the depression that had prevailed during the past year appears to be passing away, and hints at the possibility of commencing some of the concessions which the company secured before the depression set in. The directors anticipate, from negotiations which are now in progress, that at least two concessions will shortly be put into practice. The debenture issue referred to in last year's report was successfully placed. The meeting is on May 11th.

POTTERIES ELECTRIC TRACTION.—The report for 1907 shows capital expenditure of £3,880, mainly on permanent way. The revenue amounted to £111,670, an increase of £2,404 over the previous year, and after deducting expenditure, including £11,381 for debenture and other interest, there is a surplus of £27,874, to which has to be added £616 brought forward. The directors recommend the placing to renewal fund of £5,500, and to depreciation and reserve accounts of £2,500, in addition to a 4 per cent. dividend on the ordinary shares. The amount carried forward is £441. The expenditure upon the improvement, renewal, and repair of the permanent way during the year amounted to £13,773, of which £6,299 has been charged against revenue, and the remainder to the renewals suspension account. An application is being made to Parliament for powers to double any of the existing lines from time to time, as may be required. The meeting is on the 12th inst.

ORIENTAL TELEPHONE & ELECTRIC.—At the annual general meeting held on Wednesday last week, the report and accounts given in our issue for April 23rd were adopted. Mr. B. St. John Ackers, chairman of the company, who presided, stated that the financial crisis in Egypt had not affected the company appreciably, and that, so far from losing ground from that cause, there was very good reason for looking forward to a further considerable access of business very shortly. A lengthy reference was made to the death of the company's chairman, Sir Auckland Colvin, who occupied that position for ten years.

RANGOON ELECTRIC TRAMWAY & SUPPLY.—The report and accounts, which have been made up to November 30th, 1907, in Rangoon, and December 31st, 1907, in Liverpool, have been duly certified by the auditors. During the year 25,000 ordinary shares of £1 each, and 10,000 6 per cent. cumulative preference shares of £5 each, were issued, making the total issued share capital £577,001. The final instalment on these 10,000 preference shares became due on March 26th, 1908. The 25,000 ordinary shares were subscribed for at a premium of £1 per share, and the premium received, £25,000, has been set against the formation expenses, underwriting and brokerage, and costs of share issues, reducing the balance on account of these expenses to £2,606 17s. 11d. Difficulties have been experienced with the machinery, especially the two turbines, causing a delay of several months, and consequent prejudice to the company. It is only recently that these difficulties have been finally overcome, and the company placed in a position to supply a continuous twenty-four hours' service. The machinery is now working satisfactorily. The electric tramway is now completed and running; the final portion of the track (Pootoodoung route, 1·94 single miles) was opened on March 12th, 1908. The measurements are: single track mileage, 24·61; route mileage, 15·95. Notwithstanding that traffic was considerably interfered with during the year, the receipts were very satis-

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factory, and show steady improvement. Under the agreement with the municipality the number of lamps to be installed in the streets total: arc, 350; incandescent, 1,050. A portion of the lamps were lighted on December 16th, 1907. The manager in Rangoon reports that the whole of the municipal street lamps will be completed and in operation at the end of April, 1908. A partial supply over a limited area was commenced in March, 1907, and a 24 hours' supply is now being given. The demand for energy is increasing as rapidly as can be dealt with by the company. The laying of the necessary mains is, however, a tedious process, as this can only be carried on during the dry season. Including the estimated profits for the month of December, 1907, and after deducting the proportions of the expenses in Liverpool and of the debenture interest chargeable to revenue, the profits amount to £7,664, to which is added £1,775 brought forward from last year. Deducting preference dividend to December 31st, 1907, viz., £9,000, there is a balance to be carried forward of £440. The meeting is on the 14th inst.

SOUTH METROPOLITAN ELECTRIC TRAMWAYS & LIGHTING.—The report for 1907 shows a capital expenditure during the year of £40,580, making a total capital expenditure to December 31st, 1908, of £486,800. The total revenue for 1907 amounted to £51,370, and after deducting expenditure, including £6,000 interest on debenture stock, and providing for payments to local authorities under agreements amounting to £1,230, there is a surplus of £8,477, in addition to £339 brought forward from previous accounts. The dividend on the preference shares absorbs £8,386, and there is a balance of £430 to be carried forward. The traffic receipts upon the tramways and light railways, namely, £41,413, are an increase of £23,688 over those of the previous year. The bad weather experienced during 1907 has adversely affected the traffic receipts, but the increased receipts upon the through service of cars between Penge and Croydon indicate that the facilities thus provided have been appreciated by the public. Likewise, the extension of the London County Council tramway system to the company's terminus at Tooting has resulted in increased traffic receipts on the Croydon-Tooting section. In April of this year a parcels delivery system was inaugurated. The receipts from the electricity undertaking during 1907 amounted to £7,371, against £5,435 for 1906, and after deducting depreciation in respect of a battery sold, to the extent of £469, there is a balance of £2,975, compared with £2,671 for the previous year. The connections at December 31st last represented the equivalent of £43,657 8-c.p. lamps, an increase of 59 per cent. over the previous year. The number of consumers were 603 against 472. The meeting will be held on the 11th inst.

WEST COAST OF AMERICA TELEGRAPH.—At the annual general meeting on Thursday, the report and accounts given in our last issue were adopted. Sir John Denison-Pender, who presided, in explaining the decrease in the gross receipts for the year compared with the previous year, stated that both the local and the international traffic had fallen off. In addition the exchange in 1907 was 11¾d., whereas in 1906 it was 14⅛d. With regard to the increase in expenditure, the main cause of this was due to the earthquakes, which had devastated the country and had necessitated much expenditure in repairs.

Bournemouth Tramway Disaster.—On Friday evening last a car, belonging to the Corporation, with about 30 passengers aboard, left the rails on a curve, after descending a steep hill at a high speed. The car was fitted with hand and magnetic brakes, but apparently all failed to act. The car fell into a garden some 20 ft. below the level of the road. Seven passengers were killed, and nine seriously injured. At the top of the hill the system is changed from the overhead trolley to the underground conduit system. When the car left the rails the plough was left sticking in the conduit. The Board of Trade inquiry was opened on Monday by Major J. W. Pringle. One witness said that he believed that the wheels of the car were skidding. The usual speed down the hill was six to seven miles per hour. Mr. Cecil Barber, traffic manager, said, at the inquiry on Tuesday, that both hand and magnetic brakes were fitted, the magnetic brakes, however, depended on the rotation of the motors for the operating current. After the accident the hand brake was found fixed tightly on the eight wheels; the position of the magnetic brake indicated that it was not working at the time of the accident. One of the four magnetic brake shoes was broken before the car went out, but this shoe was purposely disconnected so as to allow the other three to work. Mr. W. B. Lait, depôt superintendent, who examined the car shortly after the accident, found the barrel of the rear controller in the reverse position, which would prevent the magnetic brakes from working. This controller had been found previously to be defective, but had been repaired. The driver who was on the car all the morning of the day of the accident stated that he had descended the same hill three times and had used both hand and magnetic brakes. Another driver who was in charge of the car in the afternoon, stated that he left it at the depôt at about three o'clock, as the controller was defective. The controller was repaired and the car sent out again. An inspector who was on the car at the time of the accident did not think the wheels skidded during any part of the journey.

PARLIAMENTARY INTELLIGENCE

BLACKBURN CORPORATION BILL.—This Bill, which has been before the Police and Sanitary Committee of the House of Commons this week, proposes under part 3 the borrowing of £9,000 for new tramways, repayable in 20 years, and seeks powers to purchase the Blackburn, Padiham, and Whalley Light Railway, which, when purchased, is to form part of the Corporation tramways undertaking. Powers are also taken to run omnibuses in connection with the tramway service.

NATIONAL PHYSICAL LABORATORY.—An account has been ordered of the receipts and expenditure, with balance-sheet, of the National Physical Laboratory for 1907.

PACIFIC CABLE.—In the House of Commons on Monday Mr. Bellairs asked the Under-Secretary of State for the Colonies whether the estimated loss to the British taxpayer of £62,590 on the Pacific cable for 1908-9 was mainly due to the faulty route selected to the barren rock called Fanning Island; and whether it was practicable, and, if so, would the question be considered in conjunction with the Colonial Governments, to underrun and relay the cables to the shipping port of Honolulu, where the American cables land, so as to benefit British shipping, afford alternative routes by the American cables, and gain a fresh route to the Far East. Colonel Seely, in reply, stated that the estimated loss on the Pacific cable for the year 1908-1909 was £69,000, of which only five-eighteenths, or under £14,000, will fall on the British taxpayer. The route viâ Fanning Island was adopted in accordance with the desire of the Colonial Governments concerned that the route should touch only British territory. In the absence of any suggestion from those Governments, His Majesty's Government do not propose to consider the question of relaying the line so as to touch at Honolulu.

PROGRESS OF ELECTRICAL BILLS.—In the House of Commons last week the London United Tramways Bill was read a second time.

SCOTCH PROVISIONAL ORDERS.—The Tramway Provisional Order of the Ayr Corporation came before Commissioners of the Private Legislation Procedure (Scotland) Act last week. The chairman was Sir J. Dewar, Bart., M.P. The order seeks to extend the Corporation tramway system in a number of directions, with the object of more completely connecting up the various lines now working. There was some opposition by the Glasgow and South-Western Railway Co., but after an adjustment of clauses all opposition was withdrawn, and the preamble was found proved.

Another Order dealt with was that of the Lanarkshire Tramways Co., the purpose of which was to extend the time for the completion of certain tramways authorised in 1903. There was no opposition to the Order. It had been found impossible, however, to finish the work by August 11th, 1908, the time given in the Order of 1903. Another purpose of the Order was to run omnibuses in connection with the tramways, whilst it was also proposed to obtain powers for raising additional capital, and also for additional borrowing powers. The original capital of the company was £200,000, the whole of which had been issued, and of the £50,000 borrowing powers, there have been issued £30,400 in debentures. Under the Order of 1903, an additional share capital was authorised, amounting to £216,000, and borrowing powers to the extent of £72,000. None of the latter had been exercised, and there was an unexhausted balance of ordinary capital amounting to £108,000. The promoters desire to increase the share capital by £153,000, and the borrowing powers by £51,000. The reason for this additional capital, it was stated, was that in the Parliamentary estimates of 1903 the engineers only dealt with the construction of the track and the power-house, but when before Parliament certain other matters were thrust upon the company, which caused a great deal of money. The preamble was found proved.

APPOINTMENTS AND PERSONAL NOTES

The Accrington Corporation have decided that the salary of Mr. A. W. Clegg, Assistant Electrical Engineer, be increased from £150 to £165 per annum, with an additional sum of £10 next year.

Mr. Donald M'Coll, formerly chief assistant in the Accountants' Department of the Glasgow Corporation, has been appointed General Manager of the Shanghai Electric Tramways.

The salary of the Wimbledon Borough Electrical Engineer, Mr. H. Tomlinson Lee, having been increased at the last meeting of the Council from £400 to £500 per year, the Electricity Committee has approved the following increases of salary being granted to other members of the staff:—Mr. R. N. Torpy, deputy electrical engineer, £200 to £225 per annum; and Mr. R. W. Klitz, mains superintendent, £175 to £200 per year.

The following increases in the salaries of members of the staff of the Fulham electricity and dust destructor department have been granted:—N. A. Chesterfield, chief clerk (present salary, £180), £10; T. Welch, assistant engineer (£130), £6 10s.; H. Ellis, assistant engineer (£130), £6 10s.; E. Haywood, assistant engineer (£117), £6 10s.; F. J. White, assistant mains superintendent (£125), £5.

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MISCELLANEOUS CITY NOTES

CALCUTTA ELECTRIC SUPPLY CO.—A final dividend at the rate of 9½ per cent. per annum for the half-year to December 31st, 1907, has been recommended. This makes, with the interim dividend already paid, 8 per cent. for the year.

CITY OF BUENOS AIRES TRAMWAYS CO. (1904).—The directors have declared a dividend of 1s. 3d. per share, less tax, for the quarter ended March 31st, 1908.

COMPAGNIE GENERALE DE TRAMWAYS DE BUENOS AYRES.—A statement has been issued by this company, says the *Financial News*, which was formed by Belgian and German capitalists as a tramway trust about a year ago, that the company's capital has been devoted to the acquisition of shares in the Anglo-Argentine Tramways Co., the Capital Traction & Electric Co., the Buenos Ayres Grand National Tramways Co., and the Buenos Ayres Electric Tramways Co. (1901). In addition, the company has acquired the rights to the concessions and all the installations of the Belgo-Argentine Tramways de Buenos Ayres, together with the undertaking, installations, and concession rights of the Buenos Ayres & Belgrano Tramways Co. The price in the latter case amounts to £1,348,000, of which the sum of £1,148,000 has still to be paid. By virtue of the right reserved to it, the Compagnie Générale has decided to pay this balance of £1,148,000 at one time in 1908, instead of making an annual payment of £60,500 down to 1957, but, on the other hand, the company has ceded to the Anglo-Argentine Co. the Belgrano undertaking with all its rights and charges. By reason of the payment of £1,148,000 the Anglo-Argentine Co. will be freed from the date of payment of the annuity of £60,500 which was incumbent upon it. The effect of this cession will be that the Compagnie Générale will become the possessor of 316,000 ordinary £5 shares of the Anglo-Argentine Tramways Co., and in addition to having "B" preference shares, the ordinary shares will assure the company a majority in the Anglo-Argentine Co. The seven tramway undertakings which are sought to be brought under a uniform system of working in Buenos Ayres have a total length of 310 miles, and the duration of the concessions varies from 50 to 91 years.

COVENTRY ELECTRIC TRAMWAYS CO.—A dividend of 3½ per cent. (7s. per share) for the year 1907 is recommended. The sum of £3,900 is placed to reserve for depreciation, and £114 carried forward. The directors propose to apply £4,000 in reduction of the company's indebtedness to the New General Traction Co., Ltd.

EASTERN TELEGRAPH.—The accounts for 1907 show, after making a contribution to the general reserve fund, payment of interest on the 4 per cent. mortgage debenture stock, dividends on the 3½ per cent. preference stock, and 3 interim dividends of £1 5s. per cent. on the ordinary stock to September 30th, 1907, that there is a balance available, to which the directors recommend payments of a final dividend of £1 5s., and a bonus of 2 per cent. (free of tax), making 7 per cent. on the ordinary stock for the year.

RIO DE JANEIRO TRAMWAY LIGHT & POWER CO.—Messrs. Edouard Quellenec and Jean Laval, of Paris, and the Verstraeten of Brussels have been elected directors of the Rio de Janeiro Tramway Light & Power Co., Ltd., to represent the French and Belgian bankers, who have recently taken a large interest in the securities of this company.

MISCELLANEOUS BUSINESS NOTES

EVERSHED & VIGNOLES.—Mr. S. Thomas Pemberton, of Council Chambers, 109 Colmore Row, Birmingham, has been appointed agent to Messrs. Evershed & Vignoles, Ltd., for the Midland counties. He will have his headquarters in Birmingham, and his district will embrace the counties of Warwick, Worcester, Nottingham, Derby, Leicester, Stafford, and Shropshire. Inquiries and orders relating to the firm's measuring instruments, meggers, bridge-meggers, and other manufactures from firms in this district, may be addressed to Mr. Pemberton, and will receive prompt attention.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—The public examination in the bankruptcy of A. F. Mander, trading as Mander Bros., and F. M. Mander, Electrical Engineer, &c., late of 62 Victoria Road, and 258 Lovell Road, Aston, Birmingham, took place at the Court House, Corporation Street, Birmingham, last week. The statement of affairs shows a deficiency of £243. In 1906 debtor started business as electrical engineer with a capital of £30. The business was subsequently turned into a limited liability company, with a capital of £1,000, with the debtor as one of the directors. The examination was concluded.

Ernest Noel Owen, Electrical Engineer, 1 Grove Cottage, Hampstead, has been adjudicated bankrupt. The first meeting of creditors will be held on May 11th at 2.30 p.m. in the Bankruptcy Buildings, Carey Street, London, and the public examination will be held at the same place on June 19th at 11.30 a.m.

Singapore Tramways, Ltd., is to be wound up voluntarily, and Mr. G. G. Walker, 19 St. Swithin's Lane, London, E.C., has been appointed liquidator. Creditors are requested to send in claims by June 20th.

MORDEY-FRICKER PREPAYMENT METER.—The Board of Trade has approved of the Mordey-Fricker electrolytic prepayment meter.

SIMPLEX CONDUITS, LTD.—New premises at 16 Corporation Street, Manchester, and 72A Waterloo Street, Glasgow, have been opened by Simplex Conduits, Ltd., where stocks of conduits, cables, fittings, lamps, &c., are held. The telephone numbers and telegraphic addresses remain as before.

VICKERS, SONS & MAXIM, LTD.—The employees of the Electrical Department of Messrs. Vickers, Sons & Maxim, Ltd., held their second dance in Sheffield on Wednesday last week.

NEW COMPANY

PILGRIM HOUSE.—This company was registered on April 28th, with a capital of £14,000 in £1 shares, to acquire certain freehold premises in Pilgrim Street, Newcastle-on-Tyne (part known as "Pilgrim House"), to adopt an agreement with the Right. Hon. R. S. Watson, W. S. Burton, and P. Corder, and to carry on the business of landowners, builders, contractors, suppliers of electric energy, electricians, merchants, financiers, estate agents, &c. The subscribers are:—W. S. Burton, R. S. Watson, P. Corder, W. H. Golding, T. Jameson, J. J. Bramwell, T. R. Hutchinson. No initial public issue. The number of directors is not to be less than two nor more than five; the first are W. S. Burton, R. S. Watson, and P. Corder. Qualification, 100 shares. Remuneration as fixed by the company. Registered office, Pilgrim House, Pilgrim Street, Newcastle-on-Tyne.

TENDERS INVITED.

(*Continued from page* vi.)

CORPORATION OF BRISTOL.

ELECTRICITY DEPARTMENT.

THE ELECTRICAL COMMITTEE will be glad to receive Tenders for the Supply, Delivery and Erection of the following:—

(*a*) D.C. Works Power Distribution Boards at the Avonbank Electricity Works.
(*b*) E.H.T. and L.T. Substation Switchgear for Shirehampton.
(*c*) D.C. Power Switchgear for supply to the Avonmouth Docks.
(*d*) Extension of Galleries at the Avonbank Electricity Works.

Copies of the Specifications and Forms of Tender, together with the necessary drawings, may be obtained from the undersigned on payment of a deposit of Two Guineas for each section (which will be returned on receipt of a *bona fide* tender), on the following dates:—

(*a*) and (*c*) 11th May.
(*b*) and (*d*) 18th May.

The Corporation do not bind themselves to accept the lowest or any Tender.

H. FARADAY PROCTOR,
City Electrical Engineer.

City Electrical Engineer's Office,
Temple Back, Bristol.

COUNTY BOROUGH OF SALFORD.

ELECTRICITY DEPARTMENT.

THE ELECTRICITY COMMITTEE OF THE SALFORD CORPORATION invite tenders for the supply, delivery and erection at the Corporation Electricity Station, Frederick Road, Pendleton, of the following Plant:—Specification No. V. 16, Cooling Towers, Tanks, Pumps and Pipe-work.

Specification and form of tender may be obtained on application at the office of Mr. Victor A. H. M'Cowen, M.I.E.E., the Borough Electrical Engineer, Frederick Road, Pendleton, on payment of a deposit of two guineas, which will be returned provided a *bona fide* tender has been sent in and not withdrawn.

Extra copies may be obtained at 10/- each, which is not returnable.

Sealed tenders endorsed "Tender for Cooling Towers, &c.," addressed to the Chairman of the Electricity Committee, must be delivered at the aforesaid offices of the Borough Electrical Engineer at or before noon on Monday, May 25th, 1908.

The Committee do not bind themselves to accept the lowest or any tender.

L. C. EVANS,
Town Clerk.

Town Hall,
Salford.

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MARCONI'S WIRELESS TELEGRAPH COMPANY

AT the annual general meeting of Marconi's Wireless Telegraph Co., on Thursday, Sir Charles Euan-Smith, K.C.B., C.I.E. (chairman of the company), presiding, the report and accounts given on page 665 of our last issue were adopted. The chairman, in expressing regret at the long delay which had occurred since last the shareholders were called together, said that up to the middle of last year political considerations weighed with them mainly in deferring the publication of any details connected with the company's position. The question as to the ratification of the Berlin Convention and the extent to which that ratification would be accepted by foreign Governments was still unsettled, and the Government finally announced their intention of ratifying the Convention. Mr. Marconi was on the point of solving the question of Transatlantic communication. The report and balance-sheet had, therefore, been delayed in order that the directors might be able to state to the shareholders that the main object of their enterprise had been achieved.

Giving a general review of the progress of the company, the chairman referred to the cable companies. It was, he said, not till nine to ten years after the first cable was laid that even a minimum of success was achieved, and at one time it was actually in contemplation to take up and sell at scrap value the cable first laid in the bosom of the Atlantic. The Board could afford to rejoice in the success of the cables, because it was the firm opinion of the directors that there was ample room for the profitable operation of both the wireless and cable services. But the memory of the early difficulties and struggles of the first cable company should afford encouragement to them. But the past, he continued, with all its difficulties, its obstacles, and its disappointments, might now be regarded as finished and done with. The tremendous achievement of regular Transatlantic communication was an accomplished fact. Wireless telegraphic communication with the United States of America was now as easy, and, when the contemplated improvements were completed, would, the directors believed, be as rapid and as easily available as that carried on by the cable companies, the difference being that they hoped to accomplish the service which they rendered to the public at a little more than 50 per cent. of the present cost. Henceforward, all the efforts of the directors would be concentrated on turning to profitable account the enormous advance in all branches, and especially in the transoceanic service. The multiplication of facilities was now merely a matter of expenditure, which, as compared with the results that should be realisable from this multiplication and completion of the system, might be regarded as trivial and insignificant. It was, therefore, in a spirit of confidence that the directors solicited the further support of the shareholders and of the general public for the purposes of exploiting the immense resources that had recently been opened up, and of securing substantial returns. The company had been subjected to some criticism, inasmuch as no profit and loss account was issued with the balance-sheet, as had been done on two or three former occasions. In this they acted on advice given, after prolonged consideration, by their solicitors and auditors. As a matter of fact, they had by the sale of shares and in other ways realised an apparent net profit of over £32,000, which has been put back into the capital account, but as the balance-sheet and report would be looked upon as forming the basis for the issue of fresh capital, it was considered advisable not to put anything before the public which could, in any way, be regarded as laying claim to making regular profits. The progress that had been made in their ship-to-shore business in connection with what is now an established "Marconi Wireless Exchange" had been constant. The change in their policy in February last had been productive of promising results. They had accepted, under certain provisos, the principle of intercommunication, and the Post Office, on their side, had acquiesced in, and promised their most favourable consideration and support to, several very important matters. They believed they would also now receive the support of the Post Office, the Colonial Office, and the Admiralty. The Foreign Office had also recently accorded their support in a matter of great importance in a foreign country, which had secured for us another most promising field of action. The general terms in which he had intimated the friendly intentions of the Post Office had been embodied in a letter from the Postmaster-General, which laid down in so many words his willingness at once to enter upon a favourable consideration of many of the points which were submitted for his consideration. As to their general progress throughout the world, they were now securing profitable business all over the face of the globe, America, Canada, South America, France, Italy, Russia, Belgium, and China having all come to the company for apparatus and installations. Their manufacturing depôt at Dalston was splendidly equipped and designed to meet all foreseen demands, and their training school for teaching wireless telegraphy was accomplishing all that they hoped for when it was first installed. In Paris a receiving office had been opened at the headquarters of La Compagnie Française Maritime et Coloniale de Telegraphic sans Fil, 35 Boulevard des Capucines, where messages could be handed in for transmission by wireless telegraphy to passengers on board such ships at sea as may be fitted with their apparatus. As to Lloyd's, their relations with this great association had now been placed on so satisfactory a footing that they hope to avoid in the future the litigation that has been not infrequent in the past. The directors believed they had acted on the best advice obtainable as to the form which the new increase of capital should take, and it was felt that an issue of preference shares to the public bearing a satisfactory rate of interest would be the best course to pursue. It was unnecessary to enlarge on the fact that the expenditure of this money must place the ordinary shares on a far more satisfactory position than they held at present. The directors had every reason to believe that the 10 per cent. which it was proposed to allot as dividend to them after the payment of 7 per cent. on the preference shares would be easily realised.

Mr. G. Marconi, in seconding the adoption of the report, stated that the transmission of messages between Ireland and America was commenced before the stations at Clifden and Glace Bay were completed. The working of the Transatlantic service during the seven and a-half months since it was inaugurated has in every way confirmed the view which he had long held—namely, that wireless telegraphy could furnish, and would furnish, a new and economic method of communication with America and other far distant countries. The experience gained so far had been sufficient to enable him and his assistants to indicate exactly what modifications and extensions of the present equipment of the stations would be necessary for the continuous operation of the stations on a 24-hour day basis at a high rate of speed. For some months past the majority of messages had been carried out across the Atlantic during the daytime, and no interference whatever with the working of the ship to shore stations had resulted from the long-distance Transatlantic stations. No special attempt had been made, so far, to work at high speed, although he had recently been informed that a speed of 24 words per minute had been achieved in communication from Canada to Ireland. He was confident that with slight modifications of the apparatus a speed of at least 30 words a minute could be obtained.

Quite recently he had carried out some tests with short-distance stations, with the result that duplex working was possible. If this were applied to the Transatlantic stations it should double the effective rate of telegraphing. The Italian high-power station at Coltano was nearing completion. Some delay had been caused by the buildings which the Government had undertaken to construct not being ready in time. The installation of electrical plant was now being proceeded with, and the station would be completer by the end of the year. The Italian Government had also entered into a contract for the construction of high-power stations in Abyssinia, Eritrea, and also on the Somali Coast. It was also hoped by the Italian Government that communication might be carried out with ordinary Post Office or commercial services between England and Italy, and negotiations had been going on between the Italian Post Office and the British Post Office in this connection.

During the course of a short discussion Mr. J. D. Rees, M.P., said the Postmaster-General's attitude towards the company was perfectly friendly. Mr. John O'Connor, M.P., expressed the opinion that the directors had been well advised in accepting the Government's condition. Financial conflicts with Governments were always futile and sometimes disastrous. An extra-ordinary meeting was afterwards held, when a resolution to increase the capital by the issue of 250,000 preference shares of £1 each was carried.

Birmingham Local Section of the Institution of Electrical Engineers.—At the annual general meeting held yesterday, the report of the committee was presented. Owing to the loss sustained by the Institution in the death of Lord Kelvin, the President, the Local Section annual dinner was not held this session. The officers for the season 1908-9 are as follows:—Chairman, Prof. G. Kapp. Vice-Chairman, Mr. R. K. Morcom. Ordinary Members of Committee:—Messrs. V. Bornand, A. R. Everest, A. Lindsay Forster, C. W. Hill, J. P. Kemp, Henry Lea, J. F. Lister, Dr. D. K. Morris, Messrs. A. Pearson, M. Railing, A. M. Taylor, J. C. Vaudrey. Hon. Secretary, Mr. H. B. Matthews. In accordance with the rules governing Local Sections, Messrs. A. H. Bate and W. E. Groves retire from the committee, having served in the same capacity for three years consecutively. These gentlemen are eligible for re-election in 1909-10.

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THE MUNICIPAL EXHIBITION

THERE are very few exhibits of electrical interest at the Municipal, Building, and Public Health Exhibition, which was opened on Friday last at the Royal Agricultural Hall. The first exhibit to attract our attention, taking the stands in the order in which they are numbered, was that of Messrs. Mountain & Gibson, Ltd., of Elton Fold Works, Bury, Lancashire. This firm showed several types of traction trucks, and also brakes and sand gear for tramcars. The type of truck supplied by the firm to the London County Council for their new rolling stock is so designed as to allow a large percentage of the weight to the borne by the driving wheels. An entirely new system of brake rigging, adapted to the use of the magnetic brake in conjunction with the hand-operated wheel brakes, has been provided. When the magnetic brake comes into action, the wheel brakes are automatically put into use. The sand gear (Whittaker's) exhibited is of very simple construction, and can be easily fitted to any existing cars. The valve can be operated from either end of the car by depressing a pedal.

The next exhibit of electrical interest was that of the Lahmeyer Electrical Co., Ltd., of 109-111 New Oxford Street, London, W. Apparatus for electrically sterilising water or air by means of ozone is on view. The Otto Ozoniser described in ELECTRICAL ENGINEERING, March 12th, page 392, has been fitted with an improved form of tap in which the contact closing the primary circuit of the transformer is made by the pressure of the water on a tin diaphragm. This is a distinct improvement on the original tap, in which the contact-pieces and wires were exposed. The air ozoniser is constructed on exactly the same principle as the water ozoniser. The air is drawn between the plates between which the discharge is taking place by means of a small fan driven by an electric motor, which, in the case of a continuous-current supply circuit, also operates as a converter supplying the transformer with alternating current.

Messrs. Boulton & Paul, Ltd., of Rose Lane Works, Norwich, exhibited a 1·8-kw. portable paraffin-electric generating set for 65 volts 32 amps. direct current. This set, which runs at a speed of 1,200 r.p.m., is sufficient to supply one hundred 16-c.p. metallic filament lamps. "Chloride" and "Exide" accumulators, manufactured by the Chloride Electrical Storage Co., Ltd., of Clifton Junction, Manchester, are exhibited. The "Chloride" cells are fitted with the patent thin wood separator.

A complete X-ray installation, by Alfred E. Dean, of 82 Hatton Garden, E.C., is on view, and demonstrations are given daily by the staff of the London Hospital. The various methods employed for protecting the operator from the harmful action of the rays are of particular interest. The "Alpha" shield, made of very thick lead glass, effectively cuts off all the rays, except in the one direction, and other protective aprons, gloves, and large screens are on view. Messrs. Heenan & Froude, Ltd., of 4 Chapel Walks, Manchester, exhibit a model of the 100-ton-capacity refuse destructor, as erected for the Wood Green Urban District Council. The principal features of the destructors built by this firm are the undulating construction of the furnace roofs, and the use of steam-driven fans for creating the necessary draught. The air which is taken from inside the building is blown by the fans through heating pipes, and reaches the refuse at a high temperature, thus helping to dry up any moisture and considerably assisting the combustion.

The Tramways Department of the London County Council exhibits a full-size section of the underground construction for their conduit system of tramways. A plough collector complete and one in pieces are also shown. A section model of the "G.B." surface-contact system of electric traction, showing the cable and contact mechanism, is also on view. In connection with the exhibition a municipal conference is being held. A Paper was read yesterday by Mr. Leon Gaster on "Efficient Illumination and Municipal Requirements," and on Monday next Mr. J. S. Dow will read a Paper on "The Measurement of Light and Illumination." Both Papers will be illustrated by demonstrations of various systems of lighting, and several manufacturers of electric lamps are lending lamps and other apparatus for these demonstrations.

NEW PUBLICATIONS

"Questions and Answers in Electrical Engineering." By A. E. Moore and Frank Shaw. (London: Longmans, Green & Co.) 2s. 6d.

"Journal of the Institution of Electrical Engineers," April. (London: E. & F. N. Spon, Ltd.) 5s.

"The Calculus for Engineers and Physicists," by Robert H. Smith. Second edition. (London, Charles Griffin & Co., Ltd.) 7s. 6d.

"Elementary Manual of Applied Mechanics," by Andrew Jamieson. Eighth edition. (London: Charles Griffin & Co., Ltd.) 5s. 6d.

"Science Abstracts," April. Section A, Physics. Section B, Electrical Engineering. (London: E. & F. N. Spon, Ltd.) Price 1s. 6d.

CATALOGUES AND PAMPHLETS RECEIVED

METALLIC FILAMENT LAMPS.—We have received from Messrs. Neville Williams & Co., 11 and 13 Southwark Street, a leaflet containing a price list of metallic filament lamps of British manufacture. These are of the following sizes:—130 volt, 30 c.p.; 50 volt, 16 c.p.; 25 volt, 8, 16, or 25 c.p. A special 25-volt, 15-c.p. lamp is also made for candle fittings. The efficiency is given as 1·2 watts per c.p., and the firm guarantee to replace lamps which break down during the first 100 hours. Another list gives particulars of the automatic transformer switch described in ELECTRICAL ENGINEERING, March 19th, p. 449.

ARC LAMP LOWERING GEAR.—A 44-page catalogue from the London Electric Firm, of George Street, Croydon, deals with the various forms of their well-known "one working part" arc lamp lowering gear. Illustrations and particulars are included of contact devices, counter-weight lowering gear, two-stage lowering gear, stranded wire lowering gear, centre-pole lowering gear, inverted gear, self-sustaining winches, flexible wire rope, guide pulleys, arc lamp brackets, &c. Many of the useful appliances have already been illustrated in ELECTRICAL ENGINEERING.

STORAGE BATTERIES.—A leaflet from the Hart Accumulator Co., Ltd., at Stratford, calls attention to advantages of a new type of separator known as the "Hexite" patent separator, which they are putting on the market.

THE McGRAW PUBLISHING CO.—We have received an interesting booklet from the McGraw Publishing Co. in West 39th Street, New York, describing the large new buildings, where our three American contemporaries, the *Electrical World*, the *Street Railway Journal*, and *Engineering Record* are produced. A complete description of the constructive features of the building and the arrangement of the various departments is given with excellent views of the offices, printing plant, &c., and some historical notes on the development of our great American electrical contemporary.

SINGLE-PHASE MOTORS.—A list is to hand of single-phase motors of sizes ranging from ¼ to 20 h.p., for various voltages and frequencies, which Messrs. E. H. Brook, Ltd., of Colne Road, Huddersfield, have in stock for immediate delivery, together with a price list of standard back gear for fitting to these motors.

The Journal.—Accompanying the last issue (No. 188, Vol. 40) of the *Journal* of the Institution of Electrical Engineers is a most excellent reproduction of a portrait of the late Lord Kelvin, together with a few notes on the life of the late president. The following Papers, with their discussions, both in London and the Local Sections are included: "The Development of Turbo-generators," by Dr. R. Pohl; "Cost of Electrical Power for Industrial Purposes," by Mr. J. F. C. Snell. Two Papers discussed only in the provinces are also given, viz., "Magnetic Oscillations in Alternators," by Mr. G. W. Worrall, and "The Commercial Aspect of Electric Power Supply," by Mr. W. B. Woodhouse.

Claim Against Rand Central Electric Works.—Before Mr. Justice Swinfen Eady, in the Chancery Division of the High Court, on Wednesday, a claim by Mr. Spengel against the Rand Central Electric Works, Ltd., was heard. The question to be determined was the amount for which Mr. Spengel had to prove in the winding-up of the company. He had been appointed general manager of the company, and was to be paid a salary and a further remuneration by percentage on the profits. No question arose now about his fixed salary: the whole question was with regard to his further remuneration. This was to be on the basis of equivalent five per cent. of the surplus net profits of the company. For a time the company carried on business, and in 1907 it was sold to the Victoria Falls Power Co., Ltd. The claimant said that on the sale of the assets the proceeds were more than sufficient in value to repay the capital account, that there was a surplus left, and that he was entitled to a percentage. Plaintiff had an alternative claim. He said that the liquidator, in estimating the profits for the period from December 31st, 1905, to January 31st, 1907, had made a mistake, because he had debited £6 against the profits of the year. His Lordship said the short answer to the first part of the claim was that the claimant had failed to prove that the proceeds of the sale were such as he alleged. As regarded the alternative claim, he was satisfied that the claimant's objection was not well founded. In his Lordship's opinion, the claimant was not entitled to take as the net profit for the 13 months the gross profit. He was bound to allow a proper sum for depreciation, and the £26,000 so-called renewal was, in fact, 13 months' depreciation, and that must be deducted before the net profits were arrived at. The claimant was entitled to £64 6s. 11d., the balance, *plus* £144 12s. in respect of a slip which had occurred. Though in principle the claim failed, the claimant had got something, and his Lordship thought the best course would be to allow him to pay his own costs, and allow the liquidator to take his out of the assets.

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ELECTRICAL ENGINEERING

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SUMMARY

OWING to pressure on our space we have been obliged to hold over a number of interesting letters relating to the suggested use of the term "wire lamp" in place of "metallic filament lamp."

LORD CROMER'S Committee of the House of Lords commenced consideration of the first of the three Electric Power Bills relating to London which have been deposited in Parliament, namely, the London and District Electricity Supply Bill—the Bill known as the Parshall-Hammond Bill. The Hon. J. D. FITZGERALD, K.C., in opening the case for the Bill, said that, now that the London County Council had definitely decided not to introduce another Electric Power Bill, the way was clear for private enterprise. The main feature of the Bill is the low price at which electrical energy is to be sold: £3 per annum per kilowatt of maximum demand, *plus* 0·25d. per unit for untransformed alternating current: £3 10s. per kilowatt, *plus* 0·3d. per unit for transformed alternating current; and £4 10s. per kilowatt, *plus* 0·33d. per unit for direct current. It is proposed that the company shall be empowered to supply direct to all consumers of 250 kw. maximum demand or over, and that for all consumers under this quantity the authorised distributor must supply at a price 1 per cent. above that offered by the power company in respect of each 10 kw. below 250 kw. The object of this clause, Mr. Fitzgerald said, was to do away with the necessity for appealing to the Board of Trade in the case of all small consumers, to determine whether there should be competition, but the promoters offer to agree to the latter alternative, which is the course laid down in a number of existing Electric Power Acts, and is known as the "KITSON" Clause. Another clause in the Bill relates to purchase, and is based upon a tenure of 42 years, at the end of which the company is to be repaid the whole amount of capital expenditure, *plus* any sum that may be necessary to bring the dividends of the company to the equivalent of 6 per cent. if such an amount has not been paid. The clause, however, leaves the question still to be determined by Parliament as to whether purchase shall take place or not, and by whom. Mr. H. F. PARSHALL on Friday dealt with the engineering details of the Bill. The proposal is to erect a generating station at Barking, having a capacity for dealing with a maximum load of 60,000 kw., and ultimately of 120,000 kw. The capital expenditure upon the first stage (60,000 kw.) is put at £2,600,000, and for the completed station £4,270,000. The capital powers of the company are £4,500,000 in share capital and £1,500,000 borrowing powers. The system of generation will be three-phase current at 15,000 volts, and a frequency of 50 cycles. There will be 14 control stations throughout the area,

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to which duplicate mains will be connected, and these in turn will be connected to transformer stations from which the supply will be given. Tables have been put in showing estimated savings to all the existing authorised undertakers if they were to take the whole of their day load from the power company and deal with the peak loads from their own stations. Mr. Parshall added that the estimates of the undertaking have been based upon contracts which responsible firms will be willing to enter into should the Bill be passed. The general feeling on the part of the opposition is that, in the event of the Bill being passed, the purchase clause should be amended to provide that the undertaking should be liable to purchase in 1931, the date when the existing companies' undertakings are purchaseable by the local authorities, and that the terms of purchase should be upon the basis of the Electric Lighting Acts and not upon the basis of the return of capital expenditure. General objection is also taken to the modification of the Kitson clause which is proposed in the Bill. (Page 721.)

A report on the Halifax tramways system was delivered to the Corporation by Major Cardew and Mr. H. Graham Harris last week. The report says that on account of the adverse physical conditions the system must be kept at the highest possible level of efficiency in order to ensure safe and economical working, and that in the past this level has not been maintained. The use of single-deck cars on the steep gradients is advised, and it is recommended that the emergency and the ordinary braking should be performed by one piece of apparatus. The use of different types of controllers is severely condemned. (Page 736.)

The new plant which has been put down in the generating station of the Central London Railway consists of a slow-speed horizontal cross-compound engine directly coupled to a 2,000 kw. three-phase alternator. In connection with this set a condenser of the barometric type and a brick cooling-tower of special design have been erected. The new plant has been provided partly to meet the extra traffic in connection with the Franco-British Exhibition, for which an extension to the line has been made with a new station opposite the Wood Lane entrance to the Exhibition. (Page 731.)

Illustrations and particulars are given of the new 6,000 kw. Willans-Siemens' turbo-alternator at the Manchester Electricity Works, which generates at 6,500 volts and runs at 1,000 r.p.m. An interesting feature in the design of the alternator is the arrangement of the forced ventilation, which is supplied from a special electrically-driven fan plant. A full load steam consumption of 15·85 lbs. per kw. hour is guaranteed. (Page 735.)

It has been found that filaments of the metal tungsten, which in ordinary circumstances and at ordinary temperatures are brittle and cannot be easily manipulated, become sufficiently ductile to permit of their being drawn into finer filaments, which in turn can be bent or coiled to any shape, if they are heated to a temperature just below red heat. It has also been discovered that by the addition of a certain amount of the oxides of certain of the rarer metals, the resistance of tungsten filaments can be considerably increased without decreasing the life of the filaments. (Page 738.)

We are able to publish the experiences of several engineers who have adopted metallic filament lamps for street lighting. In several cases where the lamps are run in series the average life of the lamps has been much improved by care in pairing them suitably. In those undertakings where the lamps have been in use long enough to enable accurate figures of costs to be arrived at, it is evident that this form of lighting is a good deal cheaper than gas. Experience seems to vary as to the effect on the life of the lamps of enclosing them in globes and desirability of allowing a certain amount of play in the holders to allow of movement in windy weather. In order to avoid the inconvenience of series running, 240 lamps are beginning to be adopted. There are a few complaints as to variations in different batches of lamps, and some engineers have purposely underrun the lamps somewhat with a view to obtaining better life at a slight sacrifice of efficiency. On the whole, however, the life records are excellent. (Page 740.)

In a Paper read before the Institution of Electrical Engineers on Thursday last, Mr. G. F. Mansbridge described the methods employed in the manufacture of electrical condensers. In the author's process, used by the Post Office for manufacturing condensers for telegraph and telephone work, metallic tin, precipitated chemically or electrically from a solution of tin in nitrohydrochloric acid, is mixed with an adhesive and pasted on the paper; after drying, the metallised surface is burnished, and forms a coherent thin metallic film. The paper is then subjected to a high voltage, which fuses away the film of metal surrounding the weak spots in the dielectric. The drying, impregnation and compression of the rolled sheets are dealt with at length, particular stress being laid on the fact that too much pressure, although it increases the capacity, considerably decreases the insulation resistance, and also the resistance to breakdown. The author recommended the use of good paraffin in preference to any other wax for condenser work. In the Appendix to the Paper are given the Post Office and National Telephone Co.'s specifications for condensers for telegraphic and telephonic use. (Page 741.)

Under Electrochemistry and Electrometallurgy we abstract two Papers read before the Faraday Society. The first describes a method for determining the boiling point of very small quantities of liquids. The second deals with the industrial uses of ozone, particularly in connection with the purification of potable water. The plant particularly described is that of Siemens & Halske, who have installations for purifying the water of Paderborn and Wiesbaden, and who have worked out a process which is not only economical but is very satisfactory from an engineering and chemical point of view. We also describe a new alloy for soldering aluminium and aluminum alloys. (Page 745.)

Under Electrical Science, in the British and American Section, appear notes on the theory of graded cables, and on a new theory of gravitation. A report of a Paper on continuous Electrical Oscillations and their application, by Dr. H. Manders is also included. In the Papers abstracted in the Continental Section, Galletti describes a method of producing continuous oscillations from a direct-current dynamo, Doumer advances some novel theorems concerning the electrolysis of hydrochloric acid, Austin describes some types of contact rectifiers, and Baumgardt gives a method of obtaining E.M.F.'s of any desired wave form. (Page 747.)

Among the Patent Specifications published on Thursday last is one by the British Thomson-Houston Co. relating to the manufacture of tungsten filaments. Another by the same company describes an improvement in electrolytic lighting arresters whereby the tendency for single cells to increase in voltage and to over-heat is prevented. A specification by C. O. Bastian and others relates to the substitution of copper or other cheap metal for platinum for the leading-in wires of incandescent lamps. The Siemens & Halske Akt.-Ges. have one concerning the use of twisted filaments in lamp manufacture, and one by J. J. Rawlings and R. T. Smith relates to the

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strengthening of fuse-wire at the contact ends. According to a specification by THOMAS A. EDISON, the capacity and life of the nickel element of the Edison alkaline cell can be considerably improved by the addition to the electrolyte of a certain amount of lithium hydroxide. (Page 749.)

THE hire purchase wiring scheme which the Manchester Corporation Electricity Committee put before the Council last week has been abandoned, but the scheme for an artesian well for Stuart Street station and other extensions has been approved.—In connection with the dispute between the East Ham and Ilford Councils, Mr. J. B. Hamilton, the tramway manager to the Leeds Corporation has been asked to act as arbitrator to settle the through-running basis.—No fewer than 210 applications were received for the post of electrical engineer to the Watford Council.—A new installation of electro-pneumatic signalling at the Glasgow Central Railway Station was inaugurated last week. The main frame contains 340 levers.—A new arrangement is proposed between the Bath Corporation and the syndicate which was to acquire the electricity undertaking, by which the payment of the purchase-money is to be spread over a number of years. (Pages 751–753.)

THE East Ham Corporation proposes to expend £4,600 on mains, cooling plant, &c.—The Haslingden Guardians propose to adopt electricity for lighting, &c., at the new infirmary.—A condensing plant is required by the Walsall Corporation.—Extensions of tramways at Southend are contemplated at a cost of £14,000.—The Dartford Corporation will shortly invite tenders for condensing plant.—The Local Government Board has sanctioned the borrowing of £64,317 for new works in connection with the West Ham electricity undertaking.—Messrs. Willans & Robinson have secured orders for a large number of condensing plants, including Johannesburg, Durban, Sydney, and Southampton. (Page 753.)

AT a meeing of the Underground Electric Railways Co. of London, on Monday, the scheme for dealing with the profit-sharing notes, which fall due in June, was sanctioned.—Meetings of the Buenos Aires New Tramways Co. and of the Buenos Aires Grand National Tramways Co. are to be held to-morrow to consider resolutions for raising new capital.—At the meeting of the National Electric Construction Co. on Monday it was stated that the receipts from the Dolter Surface Contact Tramways at Torquay average 12·18d. per car mile. The Dolter system at Mexborough and Swinton is to be replaced by the overhead trolley system. (Page 756.)

THE 6,000 kw. (or to be more accurate, 7,050 k.v.a.) turbo-generator which has just been taken into use in Manchester, is the largest generator in the United Kingdom. From the description which we publish on p 735 of this issue, it will be seen that a notable feature is the provision for cooling by means of a motor-driven fan external to the set. This fan drives air through a duct leading to the alternator, to which the air is admitted through an opening in the bottom. The air is subsequently led away from the alternator through outlets communicating with another duct which conveys the air outside the station. To those who have not closely followed the more recent developments in the design of turbo-alternators, the desirability of the arrangement might at first glance not be apparent; yet the appropriateness or, one might say, the necessity of such an arrangement, if the design of an alternator of this size and speed is to conform to generally accepted modern standards as regards heating and voltage regulation, is now quite universally recognised by the leading firms engaged in the manufacture of this type of apparatus. Although the efficiency of the machine is about 95 per cent., this means that the heat developed at full load is in the order of 300 kw. As a rough means of comparison, the number of watts per ton weight of the machine that can be dissipated in heat may be compared. In slow-speed alternators 1 kw. per ton is rarely exceeded, and the high speed of turbo-driven alternators does not, in itself, permit of working the material at higher watts per ton; for in consequence of the constrained dimensions, it requires the utmost ingenuity to provide any liberal amount of air passages through the interior of the machine, whereas in slow-speed alternators the large diameter and small length conspire in providing ample surfaces which are in constant contact with the surrounding air. The weight of the alternator at Manchester is less than 100 tons, so that the rate of 1 kw. per ton is more than trebled in this case, and some artificial means of cooling become absolutely essential. But quite aside from the local heating of the alternator, there is the closely related problem of maintaining the engine-room at a suitably low temperature. In Manchester, it is true, the engine-room is large, but in a works originally designed for turbine plant, an engine-room containing, say, half-a-dozen 6,000 kw. turbo-alternators would be of by no means extensive dimensions, and, were the heat developed in them to be permitted to remain in the room, and in addition to the heat losses in the turbines and other plant, the temperature would become oppressively high. One can thus realise the great advantage of conducting the heated air outside the station through a duct, so that it shall not come in contact with the air in the engine-room, and it is evident that the artificially-cooled turbo-generator must be regarded as more than a passing fashion in dynamo design.

THE London electric power problem is once again being investigated by Parliament; a Committee of the House of Lords, of which Lord CROMER is chairman, commenced on Thursday last consideration of the three Bills which have been deposited this Session. To a large extent, the position is identical with that of the year 1905, when the Administrative County of London and District Electric Power Bill was first promoted, but in some respects the issue is less involved by the withdrawal of the London County Council from the contest. It is, however, even now not a straight fight between two commercial bodies, for the chief opponents to the Bill may be divided into three factions—two groups of existing supply companies, and the Borough Councils with electricity supply stations. The Bill of the London & District Electricity Supply Co. is in substance similar to that of the Administrative Company, with one or two differences in important clauses, *i.e.*, it proposes to give a supply of electrical energy over an area embracing the whole of the County of London, and a large area in the adjoining counties, to authorised distributors, railways, tramways, canals, &c., and to individual consumers taking 250 kw. and over. The second Bill is promoted by eight of the London electric lighting companies, and this has for its object the linking up of the various generating

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stations and the creation of a Joint Committee to manage the various undertakings as one, while the Bill also schedules a certain area within which practically all the powers sought in the London and District Bill are taken. The Bill also contains clauses enabling other companies, or even local authorities, to come into the Joint Committee if they so desire. The third Bill is promoted by a few of the West-End electric lighting companies, and is a less ambitious "linking-up" scheme, with the object of mutual assistance. The London and District Electricity Supply Bill, the engineers for which are Mr. H. F. PARSHALL and Mr. ROBERT HAMMOND, is being considered first by the Committee, and inasmuch as it proposes to create an entirely new condition of affairs, it may be regarded as the most important. In any Bill of this character the main obstacle to be overcome is how to deal with the large number of existing electric supply authorities in that part of the area which is regarded as the most suitable for power supply. Mr. MERZ took the bold course of dividing the ground into an "industrial" and a "non-industrial" district, and declaring competition practically for all power purposes in the former. The first London County Council Bill was much less heroic, and was confined to supplying the authorised distributors if they required it, and to railways, and so on. This Bill was met with the response from a House of Commons Committee that it was not sufficiently comprehensive, and consequently, in the next year, 1907, a Bill more on the lines of the Administrative Bill of 1905 was introduced, but owing to a change in the balance of political power upon the Council after the Bill had been drafted, it was amended at the last moment to provide for the lease of the Council's powers to a company.

The promoters of the present Bill, therefore, profiting by the experience that has gone before, now propose to supply to all consumers taking 250 kw. or over, and that for all consumers below that amount, the authorised distributor must supply at a price greater by only one per cent. for every ten kilowatts below 250 kw. than the price which the power company could supply the authorised undertaker. In other words, if the authorised distributor refuses to, or cannot, supply at this price from his own generating station, and also refuses to take a supply in bulk to enable him to do so, then the power company may compete. This is an important modification of the "Kitson" clause, which in a number of other power Acts has relegated to the Board of Trade the task of deciding by arbitration when competition should take place between the power company and an authorised distributor in respect of any consumer. Coming to the purchase clause, here again a new proposal is made for the first time. The Bill will leave open for Parliament to decide hereafter whether, and by whom, purchase shall take place at a date not less than 42 years after the passing of the Bill; when this is settled the purchase price is to be upon the basis of the capital expenditure, plus an amount sufficient to give a return upon the capital of six per cent., should this not have been earned by the company. To this many objections have been taken. First, it is contended that the purchase should be upon the terms of the Electric Lighting Acts, as in the case of the London electric lighting companies. The promoters retort that they have a clause limiting the dividends which may be paid upon the ordinary capital to 8 per cent., whereas many of the existing companies have paid much higher dividends, and are allowed to do so under the Electric Lighting Acts. Again, it has been suggested that in the event of the existing companies being purchased in 1931, the undertaking of the power company should be also purchased then. This point of view was put forward by the London County Council, and to judge by Mr. FREEMAN'S questions, the inference is that the County Council is not without hopes that it will be selected as the purchasing authority of all the electric supply companies' undertakings in London when the time arrives. The main opposition is, of course, on the broad principles as to the need for a bulk supply undertaking, and of the equity of allowing the existing authorities, who are admittedly working under legislative restrictions, to be interfered with. With practically the same facts to put before the Committee, the promoters of the Bill have a valuable precedent in the passing of the Administrative County of London and District Electric Power Bill, although it is a feature of Parliamentary procedure that the decision of one Committee in no way binds another Committee. On the other hand, the position of the opposition is considerably stronger than it was in 1905, when most of the supply authorities were somewhat taken by surprise by the boldness of Mr. Merz's methods and doctrines. The position of the Bill, again, is improved by the fact that the London County Council is not now a militant opponent as was the case in connection with the Bill of 1905. Comparatively little progress, however, has as yet been made, and it is understood to be the intention of the Committee to endeavour to evolve a scheme for the solution of the problem from the evidence and facts put before it during the consideration of the three Bills referred to it.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, MAY 14TH.

Iron and Steel Institute.

10.30 a.m. Annual Meeting at the Institution of Civil Engineers, 25 Great George Street, Westminster, London.

7 p.m. Annual Dinner in the Grand Hall of the Hotel Cecil.

Institution of Electrical Engineers.

8 p.m. Ordinary General Meeting at the Royal Society of Arts, John Street, Adelphi, London. Paper to be read:—"Switchgear Control Apparatus and Relays for Alternating-Current Circuits," by Dr. C. C. Garrard.

FRIDAY, MAY 15TH.

Iron and Steel Institute.

10.30 a.m. Annual General Meeting at the Institution of Civil Engineers, 25 Great George Street, Westminster, London.

SATURDAY, MAY 16TH.

Birmingham and District Electric Club.

7 p.m. Meeting at the Colonnade Hotel, New Street, Birmingham. Paper to be read:—"Electrical Porcelain" by H. W. Brady.

THURSDAY, MAY 21ST.

Institution of Electrical Engineers.

8 p.m. Meeting at the Royal Society of Arts, John Street, Adelphi, W.C. Paper to be read:—"Recent Progress in Tungsten Metallic Filament Lamps," by H. Hirst.

FRIDAY, MAY 22ND.

Physical Society.

5 p.m. Meeting in the Physics Laboratory, Royal College of Science, South Kensington. Among the papers to be read is the following:—"On the Production of Small Alternating Currents of variable frequency suitable for Telephonic and other Measurements," by B. S. Cohen.

SATURDAY, MAY 23RD.

Junior Institution of Engineers.

Visit to the Avonmouth Docks Works and Electricity Works, Bristol.

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LONDON ELECTRIC POWER BILLS

A HOUSE OF LORDS Committee, presided over by Lord Cromer, commenced consideration on Thursday of the three Bills relating to the supply of electric power in London, which have been deposited in Parliament this year. The committee is as follows: Lord Cromer (Chairman), Lord Welby, Lord Lytton, Lord Lamington, and Lord Saunderson. Lord Saunderson takes the place of Lord Cobham, who was originally selected. The Bills in question are the London and District Electricity Supply, London Electric Supply, and London (Westminster and Kensington) Electric Supply.

At the commencement, the chairman mentioned the fact that Lord Welby was also a member of the Metropolitan Water Board, which was petitioning against some of the Bills. The committee, said the chairman, did not think, however, that this should deprive them of Lord Welby's assistance on the committee. None of the counsel representing the three Bills raised any objection to Lord Welby remaining on the committee. The Hon. J. D. Fitzgerald, K.C., is leading for the London and District Electricity Supply Bill, Mr. Balfour Browne, K.C., for the London Electric Supply Bill, and Mr. Seymour Bushe, K.C., for the London (Westminster and Kensington) Electric Supply Bill. It was decided to consider the London and District Electricity Supply Bill first, but it is at present not settled whether a decision shall be given on this at the close of the opposition, or whether the decision will be postponed until the evidence for and against all three Bills has been heard.

London and District Electricity Bill

The Hon. J. D. FITZGERALD, K.C., who appears with Mr. Talbot, K.C., Mr. Clode, and Mr. Thomas, said this Bill proposed the incorporation of a company, and to authorise it to construct a large generating station at Barking, in the County of Essex, on the banks of the Thames, and from that to supply electricity in a large area, comprising the whole of the County of London and considerable adjacent districts in Essex, Middlesex, Kent, and Surrey. The supply intended to be given from the proposed station at Barking was, firstly, to authorised undertakers, and, secondly, for power purposes. The Bill was similar in provisions to Power Bills of previous years, but no such scheme had yet been passed for London, although the question of the best method of dealing with the supply of power in London had been before Parliament for four or five years. The present scheme was an attempt to settle the question on workable and business lines, and profiting by the experience of previous years. Of the urgency of the question there could be no doubt. Before dealing with the precise proposals of the Bill counsel briefly sketched the history of electrical legislation, commencing with the Electric Lighting Acts, under which, he argued, all owners of provisional orders were granted them, not as a monopoly, but subject to competition and upon the terms of purchase so far as companies were concerned set forth in the Electric Lighting Act of 1888. In this way, he said, London was now parcelled out between thirteen companies and sixteen local authorities. Having dealt with the general features of the Power Bills in the provinces, the history of the efforts, so far as London is concerned, was reviewed, beginning with the Administrative County of London and District Electric Power Bill of 1905, which was "simply lost by time." In 1906 followed the London County Council Bill, and also the Administrative County of London Bill, but only the former was read a second time and came before a committee of the House of Commons. It was, however, rejected, the committee making a special report, in which they referred to the importance of the subject, and urging that it should not be allowed to drop. In 1907 another Bill was presented by the London County Council, in which it was recommended that the undertaking should be leased to a company. This, however, was not approved by Parliament, and as the London County Council had not provided another Bill, the way was clear for private enterprise to put a scheme before Parliament. Accordingly, the promoters of this Bill presented their scheme as one which would, if sanctioned, give a cheap supply of electricity for all purposes throughout the whole of the area shown on the map. In this area at the present time there were, he said, 66 generating stations, 29 different systems of generation in these stations, and 18 different systems of supply. None of these stations were capable of giving the sort of supply proposed under the Bill; many were badly situated with regard to the supply of coal and water, and in many the plant was obsolete. At the time of the Administrative County of London and District Electric Power Bill the existing companies took up the position that no such scheme was needed, and that they themselves were doing all that was necessary. For all that, however, whilst the Bill was in progress, six of the companies came to terms with the power company, and clauses were inserted by which they agreed to take all additional supply from the power company. The capital expenditure upon the present companies' stations was £47·5 per kw., and of the local authorities £34·2 per kw., or an average of £40·85 per kw. In the station proposed by the present Bill, the expenditure would be from £10 to £12 per kw., and this illustrated the immense saving there was in capital expenditure when generation on a large scale was carried on. The first object of the Bill was to supply electricity to authorised undertakers, but it was quite optional for this supply to be taken. The drawback of there having been no such option in the past was demonstrated by the number of electric power houses which had been erected by railway companies in London, and he would call witnesses from other railway companies who would say that the large capital expenditure involved in having to erect a power station of their own was delaying the working of their lines by electric traction. Of the railway companies which had adopted electricity, the only one that had not erected a power station of their own was the London, Brighton & South Coast Railway, this company having entered into a contract with the London Electric Supply Corporation for a term of years. The other main object of the Bill was to supply factories, and in this connection the promoters were of the opinion that there was an enormous field to be served.

With regard to the price, the second schedule to the Bill, he was informed, prescribed the lowest prices that had ever been put before Parliament in a Bill dealing with the supply of electricity. The second schedule reads as follows:—

SCHEDULE OF CHARGES.

"The charge to be made by the company to any authorised undertaker or to the proprietors or trustees of any railway, tramway, tramroad, canal, or navigation, or to any power user whose maximum demand exceeds two hundred and fifty kilowatts, shall not exceed the following at each point of supply, namely:—(*a*) For a supply of alternating current untransformed at the rate of a fixed sum of three pounds per annum per kilowatt of maximum power required to be supplied, and in addition a sum of 0·25d. per unit for all units supplied to such consumer. (*b*) For a supply of transformed alternating current at the rate of a fixed sum of three pounds ten shillings per annum per kilowatt of maximum power required to be supplied, and in addition a sum of 0·3d. per unit for all units supplied to such consumer. (*c*) For a supply of direct current at the rate of a fixed sum of four pounds ten shillings per annum per kilowatt of maximum power required to be supplied, and in addition a sum of 0·35d. per unit for all units supplied to such consumer."

The average prices now charged by the London Companies, continued Mr. Fitzgerald, varied from 2·47d. per unit to 1d. per unit. It was not unworthy of notice that the St. James, Pall Mall, and Westminster Companies were supplying at the lowest rates in districts which were not industrial at all, where the demand was mainly for lighting purposes, and where the bulk of the income, certainly in the case of the St. James' Company, was earned from electricity for lighting in a purely residential area. Consequently they supplied power at a rate which would not be remunerative if power purposes constituted their main business. Last year the St. James' Co. supplied about 671,000 units at 1d. per power, and over seven million units for lighting at 3·46d. per unit. Consequently it was possible for them, in supplying power in small quantities, to charge at a rate which was not remunerative in itself, but, if the figures of output were reversed, they could not supply the power at this price at all without suffering a loss. As a matter of fact, the chairman of the St. James' Company had admitted this at the annual meeting, when he stated that as long as the supply for power was only 12 per cent. of the whole, and was taken mainly during hours of daylight, it could be regarded in a nature of a by-product, and consequently 1d. per unit was sufficient to cover the extra cost of coal and water for keeping the boilers running, there being no addition to the capital charges. With regard to local authorities, the average price varied from 2·55d. per unit in Stoke Newington, to 0·95d. in West Ham. In only two cases throughout the area did an undertaking have a considerable power load.

Dealing with the most important clauses in the Bill, Mr. Fitzgerald first referred to Clause 52, which reads as follows:—

CLAUSE 52.—CONDITIONS AFFECTING SUPPLY.

"The powers of the company for the supply of electrical energy under this Act shall be subject to the following provisions:—

"(1) Subject as hereinafter in this Act provided electrical energy shall be supplied under this Act only—

(*a*) To authorised undertakers; and

(*b*) To persons requiring a supply for power.

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"(2) The electrical energy supplied to any authorised undertaker may be used for any public or private purpose for which such undertaker is authorised to use the same, and the electrical energy supplied to any person for power may be used by such person for lighting any premises on any part of which the power is utilised. Provided that where electrical energy is supplied to any person for power within an area in which any authorised distributor is authorised by Act of Parliament or Provisional Order confirmed by Parliament to give a general supply of electrical energy, the energy used by such persons for such lighting purposes shall not in any year, except with the consent in writing of such authorised distributor, exceed twenty per centum of the total amount of energy supplied to such person, and save as aforesaid and as hereinafter provided the company shall not supply electrical energy for lighting purposes.

"(3) Electrical energy shall not, save as hereinafter provided, be supplied under this Act by the company (except to authorised undertakers or to the proprietors or trustees of any railway, tramway, tramroad, canal, or navigation lawfully entitled to use electrical energy, or to any power users whose maximum demand exceeds two hundred and fifty kilowatts), in any area being at the passing of this Act the area of supply of any authorised distributors, except with the consent of those distributors. Provided always that the company may supply electrical energy to any person using or desiring to use the same for power at any premises within the company's area of supply under this Act, if such person is unable to obtain at such premises from the authorised distributors within whose area of supply the said premises are situate, a sufficient supply of electrical energy at a price which does not exceed the price at which the company are supplying, or are willing to supply, electrical energy to such authorised distributors by more than one per centum in respect of each ten kilowatts or part of ten kilowatts by which the maximum demand of such person falls below two hundred and fifty kilowatts.

"(4) Any electrical inspector appointed under this Act may from time to time, and on the application of any authorised distributor, shall enter upon and inspect any premises within the area of such authorised distributor in which energy supplied by the company is used, in order to ascertain whether the provisions of this section are duly observed:

"Provided always that nothing in this section contained shall operate to restrict the exercise by the company of any powers which may be transferred to or become vested in them under the provisions of the section of this Act, of which the marginal note is 'Transfer of undertakings of local authorities and others to company,' or of any powers which may be hereafter conferred upon them by any Act of Parliament or Provisional Order confirmed by Parliament."

In sub-section 3 of this clause, Counsel pointed out a variation of the standard Kitson clause, by which the Board of Trade would not be brought into the question of deciding when an authorised distributor is supplying at a reasonable price. This sub-section provided that an authorised distributor must supply a consumer at a certain percentage above the price which he paid the power company, and which would vary according to the amount of the consumption. In this way they thought they had got over the difficulty, which, it had been represented to them, distributors felt themselves to be in, under the standard clause in which the Board of Trade was appealed to to determine each case on its merits. Supposing, for instance, the price at which an authorised distributor was supplied by the power company was 0·5d. per unit, then if the demand of the power consumer was, say, 200 kw., the authorised distributor would be entitled to add 5 per cent., *i.e.*, 1 per cent. for each 10 kw. below 250 kw. If the demand of the power consumer was 100 kw., they would be entitled to add 15 per cent. to the price paid to the Power Company, and if the demand was only for 50 kw. they would be entitled to add 20 per cent. The result was that no question of arbitration could arise; the whole matter was fixed by the Bill. But the promoters were not wedded to this solution of the matter, and if the committee came to the decision that it would be more desirable to insert the ordinary Kitson clause, they would be quite willing to accept it. The figure of 250 kw. had been fixed as representing a very considerable consumer; in many districts in the area scheduled there would be only two or three such consumers, and in some of the districts no such consumer at all.

Clause 61 limits the dividends of the company to 8 per cent., unless a larger dividend be paid at any time necessary to make good the deficiency of any previous dividends.

Clauses 62 and 63 provide for the investment of any surplus dividends in insurance funds, or reserve funds.

Sub-section 3 of Clause 64 prescribes what, in the event of the undertaking being purchased, in fixing the purchase money there shall be deducted a sum equal to the aggregate amount of the value of the investments and moneys representing at the date of the purchase the sinking insurance and reserve funds, and these funds shall remain the property of the company.

Clause 65 is the purchase clause, and we give it in full below:—

CLAUSE 65. PURCHASE CLAUSE.

The undertaking of the company shall be liable to purchase by any county council or joint committee of county councils, body of trustees, or other public authority or body who may be authorised by Parliament to purchase the undertaking (hereinafter called "the purchasing body") on and subject to the following terms and conditions (that is to say):—

(1) The purchasing body may, on giving not less than twelve months' previous notice in writing to the company of their intention to acquire the undertaking, purchase the same at the expiration of forty-two years from the thirty-first day of December, one thousand nine hundred and eight, upon the terms of the purchasing body paying to the company a sum equal to the amount properly expended by the company upon the undertaking, and chargeable to capital account at the date of the purchase as certified from time to time by an auditor appointed as hereinafter provided, together with such a sum (if any) as would be required to make up the aggregate amount of the dividends paid by the company up to the date of purchase to six per cent. per annum, upon the capital from time to time paid up after deducting from the aggregate of those sums the aggregate amount of the value of the investments and moneys representing the sinking fund and the insurance and reserve funds provided for by this Act.

(2) The purchasing body may also, on giving not less than twelve months' previous notice in writing to the company of their intention to acquire the undertaking, purchase the same at the expiration of any period of ten years, subsequent to the expiration of the said period of forty-two years upon the terms of the purchasing body, paying to the company a sum equal to the amount properly expended by the company upon the undertaking, and chargeable to capital account at the date of the purchase as certified from time to time by an auditor appointed as hereinafter provided, after deducting therefrom the aggregate amount of the value of the investments and moneys representing the sinking fund, and the insurance and reserve funds provided for by this Act.

(3) No allowance shall be made to the company for compulsory purchase or for goodwill, or for the prospective or future value of the undertaking.

(4) For the purposes of this section the accounts of the company for each year prior to the date of purchase, including the year in which the purchase occurs, or any part thereof, shall be audited by an auditor appointed as hereinafter provided, and a copy of the accounts as audited shall be filed with the Board of Trade.

(5) The Board of Trade shall, and are hereby empowered to appoint, such person as the Board shall think fit to be an auditor for the purposes of this section, and the remuneration of any such auditor shall be fixed by the Board, and shall be borne and paid by the company in such manner as the Board shall direct.

(6) The purchasing body shall also pay to the company for the materials and stores on hand at the date of purchase a price to be agreed on, or, in case of difference, to be determined by an arbitrator to be appointed by the Board of Trade, and in addition the value of the debts due to the company, the amount of the cash in hand or at the bankers, and securities for money other than those representing the sinking, insurance, and reserve fund provided for by this Act, and the company shall discharge all debts due by the company at the date of purchase and all liabilities with respect to any debenture stock or mortgage debt of the company.

(7) The expression "undertaking" shall, for the purpose of this section, include all rights of generating, purchasing, using, transmitting, transforming, distributing, supplying, and utilising energy, and all other rights, powers, authorities, and privileges of the company, and all such property, real and personal, and all other interests and rights in, to, and out of the property real and personal, and obligations and things in action, as may be in the possession of the company, or belong to them immediately before the date of purchase, and all books, accounts, and documents relating thereto, but subject to all liabilities and obligations of the company other than the debts due by the company, and the liabilities with respect to the debenture stock and mortgage debt of the company.

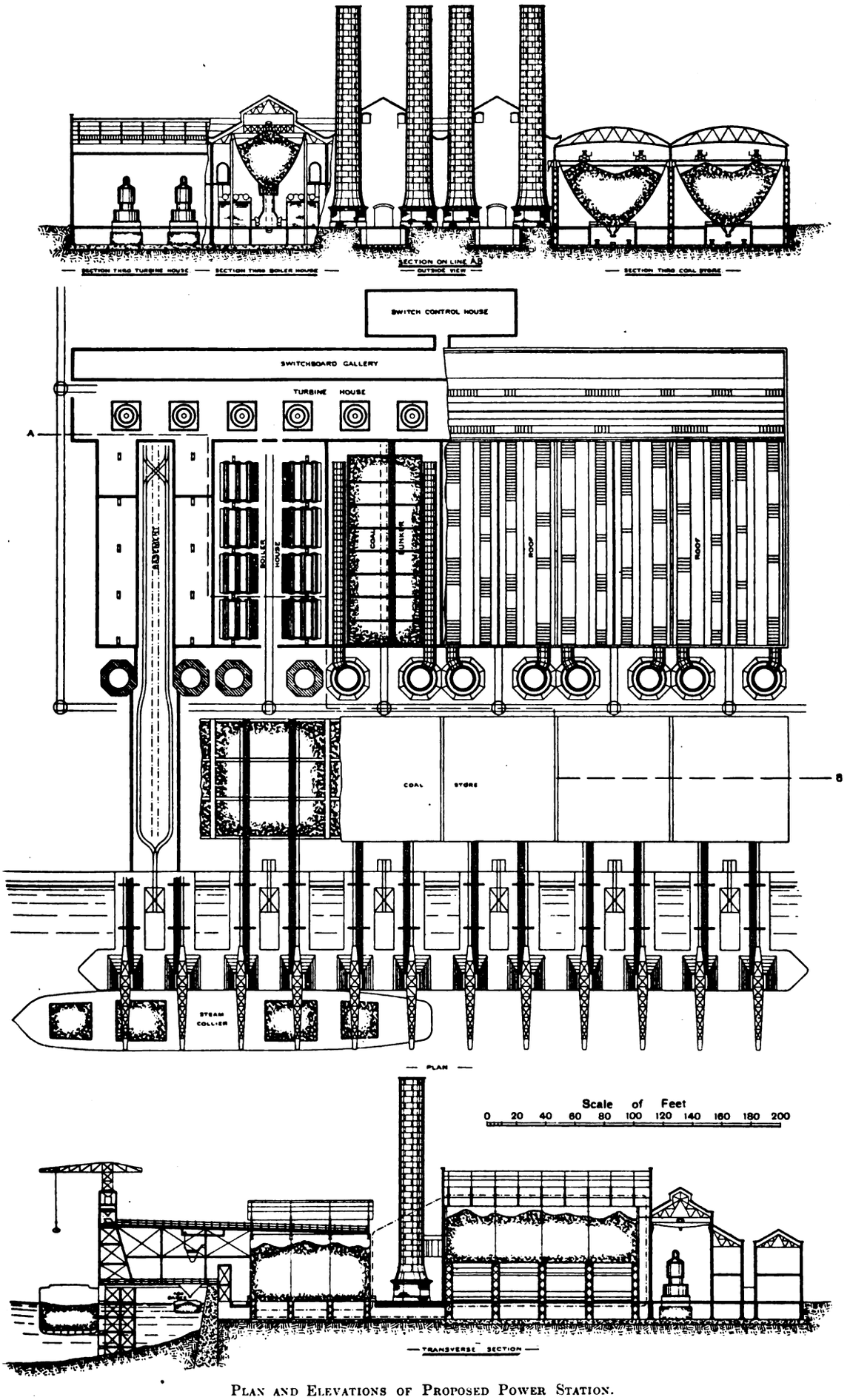
(8) As from the date of purchase, the undertaking shall be transferred to, and vested in, the purchasing body, and such body shall have, and may exercise, all the rights, powers, authorities, and privileges of the company, and shall, to the exclusion of the company, be subject to all the duties, obligations, agreements, and liabilities of the company in like manner as if they were the company's, except the debts due by the company at the date of purchase, and the liabilities with respect to the debenture stock and mortgage debt of the company.

Hitherto, continued Mr. Fitzgerald, there had never been a purchase clause in a power Bill, but with regard to London there had been a strong feeling that some provision as to purchase at the expiration of forty-two years, or a longer period, ought to be inserted, and Clause 65 has been inserted in the Bill to meet this view. The clause, however, left the question as to whether purchase should take place, to the decision of Parliament hereafter.

Clause 66 allows the Board of Trade to revise the maximum prices charged by the company at the end of five years, and recurring periods of five years.

The capital of the company is to be £4,500,000, with borrowing powers of one-third, making a total capital of £6,000,000.

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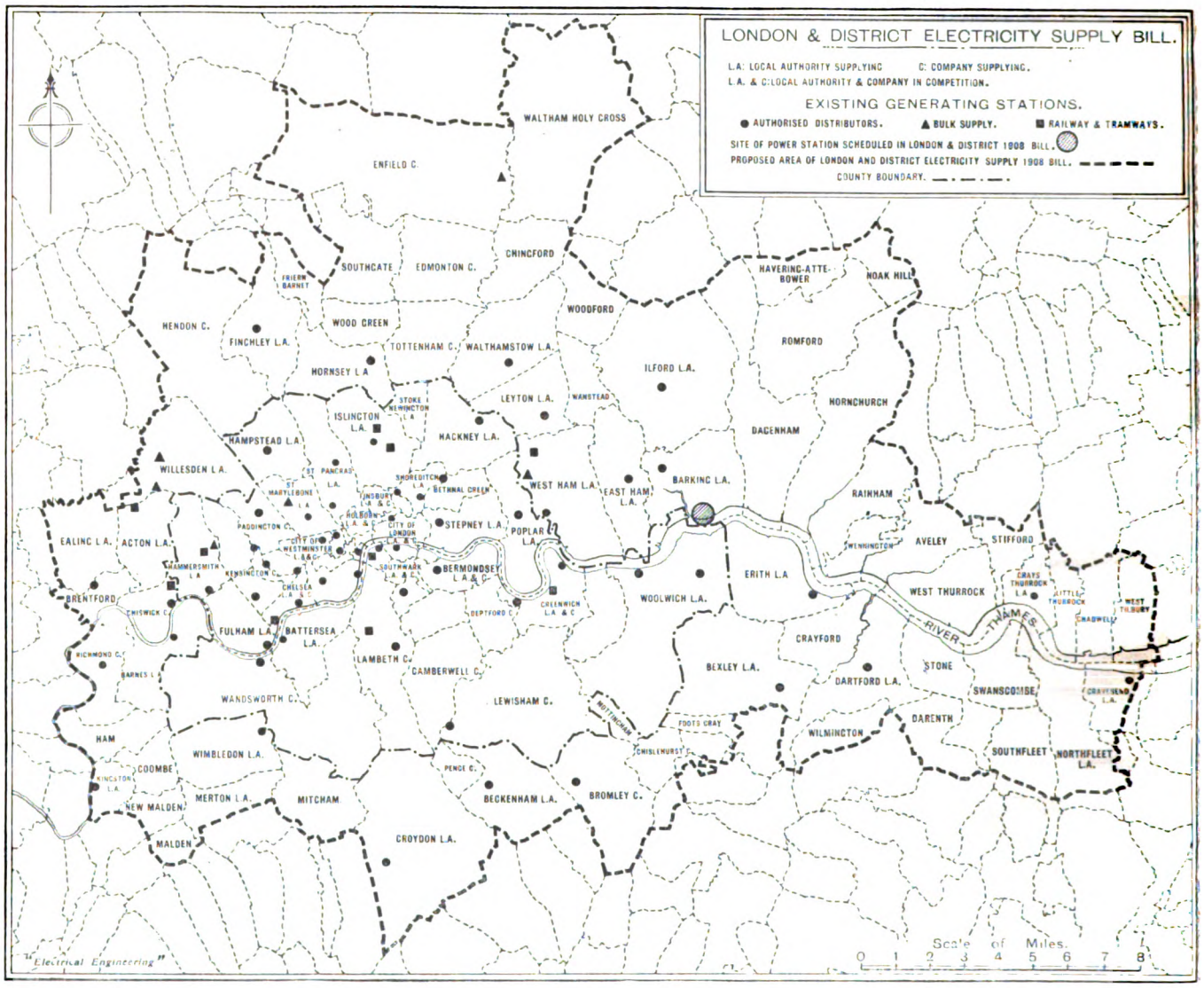
PLAN AND ELEVATIONS OF PROPOSED POWER STATION.

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The promoters believed they would have no difficulty in raising this amount if the Bill passed in substantially the same form as it was now presented.

Dealing with the petitions, Mr. Fitzgerald said that originally 70 petitions had been presented against the Bill, but only fourteen were appearing by counsel, and the opposition so far as the existing companies and local authorities owning electricity works were concerned was on the grounds of competition. He would, therefore, ask the committee to consider what the competition was going to be. It could not be denied that lighting was the main business of the existing authorities, and so far as this was concerned, the power company would not compete for this to any appreciable extent, or, indeed, at all. With regard to railways which the power company hoped to supply, was brought forward to solve. The main proposal of the London (Westminster & Kensington) Electricity Supply Bill was simply to enable each of the companies mentioned in it to supply each other. The other Bill promoted by eight London companies proposed the establishment of a joint committee to manage their undertakings or any others that might come into the scheme, and in fact it only proposed to do, on a larger scale, what the previous Bill proposed to do. No powers were taken for the acquisition of land or the erection of new generating stations, nor to give a large supply in bulk. That it was not the intention under this Bill to deal with the problem in the same way as was proposed by his own promoters, was proved by the statement of the chairman of the Charing Cross Company to his shareholders this year. In this it was stated that there



Map showing Proposed Area of Company's Operations.

there was no serious competition, because none of them supplied railways for power purposes. With regard to tramways, practically all of them were the property of, and were supplied by, the existing undertakers, so that there could be no competition here. Therefore, it seemed to him the only competition would be for the large consumers for 250 kw. With regard to the smaller power users, they could only supply them if the authorised undertaking was not willing to do so at the increased percentage of charge, mentioned in the Bill, above the rate which they could get the energy from the company. Against this limited competition was to be set the enormous advantage which the authorised undertakings would have of having a large company in their midst, and from which they could get a supply whenever they required an additional supply, and in consequence of which they could save much additional capital expenditure, and at the same time would get the energy at a lower rate than if they generated it themselves. With regard to the petition of the promoters of the other two Bills, he said that he did not regard these Bills as competing with his at all, or as offering any solution of the question which his own Bill was no intention of raising the £1,000,000 for which powers were taken in the Bill, or anything like £1,000,000 at once. A few thousand pounds, the chairman of the Charing Cross Company stated, would, in his view, be sufficient. He thought there was no doubt that sufficient electricity was generated at the present time to supply all needs. If the business was to grow and grow to any great extent, then more capital would be wanted, but at the start, the statement continued, it was believed that it would only be necessary to spend a few thousand pounds, which would be required mostly for mains. This, said Mr. Fitzgerald, absolutely demonstrated that this Bill was not attempting a solution of the question at all.

It may be pointed out that although the North Metropolitan Electric Power Supply Co. and the North Metropolitan Electric Power Distribution Co. are not opposing the Bill in the House of Lords, they reserve their right of doing so in the event of the Bill coming before the House of Commons. The opponents to the Bill appearing by counsel are the following:—The London County Council; Islington Borough Council; City Corporation;

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Croydon Corporation; West Ham Corporation; City of Westminster; Shoreditch Borough Council; St. Pancras Borough Council; Hampstead Borough Council; Stepney Borough Council; London, Tilbury, & Southend Railway; and the promoters of the other two Bills which are before the Committee.

FRIDAY, MAY 8TH.

Mr. H. F. PARSHALL, examined by Mr. Talbot, K.C., first of all gave particulars of the number of generating stations in the area, together with the different frequencies and pressures, capital cost per kilowatt and cost of generation. He then went on to make a comparison between the proposal of linking up the existing stations and the erection of a new generating station on modern lines. If all the existing stations had to be interconnected the only proper way to do it would be to put in a system of interconnecting mains between the different points and a system of motor generators. This would involve a new system of transforming plant and a new system of mains. The cost of carrying out this interconnection, apart from the obvious engineering difficulties involved, would be, on a rough estimate, about the same as that required for the undertaking proposed in his Bill; thus there would be no saving of capital at all, whilst the result of linking up the stations would be that the scheme thus evolved would not be a comprehensive one. Linking up did not provide for efficient steam generation, for it only made use of the existing steam units, and, as a matter of fact, a great many of these steam units were obsolete, and a number of the stations were burning twice as much coal per unit generated as a modern plant would. The cost of generation would be considerably greater, for it would involve generation at a considerable number of points instead of in one centralised power house. He, therefore, disagreed with the idea that the Bill of the Electric Supply Companies of London was a bulk supply Bill, first, from the engineering standpoint, and, secondly, from the amount of capital which the Bill proposed, namely, £1,000,000. He considered a proper system for London would require the whole of the £4,500,000 proposed by his own Bill, and if the areas of the two Bills were to be compared exactly, he estimated that it would require £3,500,000 to deal with the electric supply companies' proposed area adequately. The intention of the promoters of this Bill was not that all existing stations should be at once scrapped, but that they should be regarded as peak-load stations, with the works of the power company to fall back on for their normal supply. As an example of the feasibility of this, he mentioned that the Niagara Power Plant supplied a great many horse-power hours throughout the year to a number of steam generating plants. He had satisfied himself that there was a much larger demand to be met in London than the electric lighting companies seemed to think. Official returns showed that at the present time there was from 300,000 to 400,000 h.p. of plant not provided for to-day by electricity, and the owners of many of these plants had told him that they did not use electricity because they could not obtain it cheaply enough. Existing companies were handicapped by the purchase clause, and as they approached the year 1931, when they were all liable to purchase, they would not be in a position to put down new plant as freely as they would otherwise. So much did the companies feel this position in 1905 that no less than six of the leading companies made agreements with the Administrative Company to take any extra supply from the power company when they had reached the limit of their existing plant. The terms of these agreements were similar to those proposed in the present Bill, and he saw no reason why the companies should not enter into similar arrangements with his company.

The promoters of the present scheme had arranged it in accordance with the report of the Committee of the House of Commons, which dealt with the London County Council Power Bill of 1906, and stated that a scheme of this nature should be provided either by the London County Council or by some competitive body of promoters. As an instance of the remarkable disparity between the cost of the existing undertakings and the cost of a new undertaking built on modern lines, he mentioned that the land and buildings, exclusive of plant, of the stations now existing in London, had cost £3,900,000, whereas the erection of a station capable of giving a supply equal to that now given could be erected in one spot upon land which could cost less than £500,000. The position of Chicago some years ago was very similar to that now existing in London. There were a number of small stations supplying on low-pressure systems, but the Chicago Edison Co. erected a large central station such as was now proposed, and the result of the smaller undertakings supplying only their peak loads from their own stations was that in ten years the selling price of electricity to individual consumers was reduced 40 per cent. The Chicago company's bulk supply station had approximately the same capacity as the one now proposed, and it had been completed for a sum within his estimates, so that he knew from actual experience what he was proposing to do. The general price in Chicago was £3 per kilowatt and 0·25d. per unit. Some of the petitions against this Bill had raised the question that it was unwise to rely upon one station for the whole supply of a district, but in reply to this he could only point to the large number of stations which he had designed in similar circumstances, and in connection with which no hitch whatever had occurred. For instance, the whole working of the Central London Railway, Glasgow Corporation Tramways, Dublin United Tramways, and the London United Tramways depended upon individual stations for their electrical energy, and no mishap of any kind had ever occurred. Whilst on this point, he mentioned that the plant for the proposed station at Barking had been arranged on what he called the "Bulkhead" system, the station being split up into sections, as shown in the plan on p. 725, the working of each of which was quite independent of the other. The area proposed in the Bill was the same as that settled by the London County Council last year, and comprised 451 square miles, 117 of which were in the county and 334 without. A map is given opposite.

The tables on pp. 726 and 727 show the main estimates for the undertaking.

In a comparison of present costs of generation of authorised distributors, with the prices contemplated under the Bill, Mr. Parshall showed that the total actual cost of generation incurred by authorised distributors during twelve months ending variously on March 31st, 1907, and December 31st, 1906, was £515,000 for the local authorities and £872,384 for the companies, making a total cost per annum of £1,387,989. The total cost at which a similar quantity of energy could have been supplied to the authorised distributors by a bulk supply undertaking at the prices set out in the Bill was £747,917, showing an actual saving of £640,072, which Mr. Parshall emphasised was a generation loss, and consequently would all have been to the advantage of the consumer. With a capital, however, of £9,500,000 already sunk in generating works, he contended it would be unsound to perpetuate this uneconomical state of things by adding to the generating plant in the various existing generating stations, and all future supplies, he contended, could be more economically drawn from a central generating works. Detailed tables were handed in, showing the savings which would accrue to specific authorised distributors from carrying out this plan. In these tables a comparison was made between the extension of the existing works to deal with increasing load and the taking of the supply from the bulk company instead. The price for the bulk supply, which it is estimated would be obtained, are £3 10s. per kw. and 0·2d. per unit for transformed alternating current and £4 10s. per kw. and 0·22d. per unit for direct current. On a total of 43 undertakings these tables showed that a saving of £224,596 would be made by taking the bulk supply, in comparison with the cost of extending the works, to meet a demand based on the growth of the previous year. Other tables showed a saving to 26 selected local authorities of £56,385 in the present generating costs over the costs they would be put to if they closed their works and took the whole of their supply from the power company, and in the case of thirteen companies the saving on a similar basis would be £96,547.

Other tables worked out the price to authorised distributors, or railways, tramways, canals, &c., upon the maximum prices scheduled in the Bill, from which it was shown that upon a 10 per cent. load factor the total price for untransformed alternating current would work out at 1·07d., and for transformed alternating current 1·25d. per unit, and for direct current 1·56d. per unit; on a 20 per cent. load factor the prices would be 0·66d., 0·77d., and 0·94d. per unit respectively; on a 30 per cent. load factor 0·52d., 0·61d., and 0·74d.; on a 40 per cent. load factor 0·45d., 0·53d., and 0·65d.; and upon 100 per cent. load factor 0·33d., 0·39d., and 0·45d. For bulk supply and large power users the prices are worked out as follows:—10 per cent. load factor, untransformed A.C., 1d. per unit; transformed A.C., 1·15d. per unit; direct current, 1·45d. per unit; 20 per cent. load factor, 0·59d., 0·67d., and 0·83d.; 30 per cent. load factor, 0·45d., 0·38d., and 0·63d.; 40 per cent. load factor, 0·38d., 0·43d., and 0·52d.; 100 per cent. load factor, 0·26d., 0·29d., and 0·54d. In another table Mr. Parshall compared the maximum prices scheduled in his Bill, namely, £3 per kilowatt and 0·25d. with £5 per kilowatt, *plus* 0·35d. per unit in the case of the London Electric Supply Bill, both prices being for untransformed extra high pressure. This comparison showed that upon a 10 per cent. load factor the price in the London Electric Supply Bill would work out at 60·4 per cent. higher than those of the other Bill, and varying from this down to 46·6 per cent. in excess in the case of a 100 per cent. load factor.

The generation at Barking will be upon the three-phase alternating-current system at 15,000 volts and 50 cycles. Referring to the frequency of 50 compared with 25 in the Administrative Company's Bill, Mr. Parshall pointed out that this permitted of better generation with turbine drive, and that, in his opinion, had the Administrative Company been promoting a Bill now they would have adopted a frequency of 50, as this was much more in favour than was the case three years ago. The coaling at Barking would be carried on direct from the ocean-going steamers. There would be 14 controlled stations, to which duplicate mains would be connected, but the actual supply to the consumer would be given from transformer stations connected to the control stations. His intention was to lay plenty of ducts when the roads were first opened, so that fresh mains could be drawn in as the business increased without interfering with the roads again. All the estimates, Mr. Parshall stated, had

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been based upon offers from firms who had expressed their willingness to carry out the work upon certain prices should the Bill be passed.

MONDAY, MAY 11TH.

Lord CROMER, the Chairman, at the commencement of proceedings said he wished to raise a question of some importance to the promoters, to which he did not press for an answer which would cut off the supply of anything to a town, but he would like to hear the opinion of counsel upon these points.

Mr. FITZGERALD, K.C., for the promoters, said he thought he could answer the question at once. The Barking station was arranged in separate units, and the breakdown of one did not interfere with the working of the others. This was the method by which any ordinary contingency would be met. If the committee went further, however, and included the case of warships

Table I.

DETAILS OF THE OUTPUT OF THE PROPOSED BARKING STATION.

Upon these figures are based the Estimates of Capital Expenditure, Revenue, and Working Expenses shown in Tables II., III. and IV.

	Stage A			Stage B		
Total Plant Capacity installed (normal rating)	72,000, kilowatts.			144,000 kilowatts.		
" " " (overload rating)	90,000 "			180,000 "		
Maximum Load on Generating Works	60,000 "			120,000 "		
Power required for loss in Transmission and Transformation at maximum Load	6,000 "			12,000 "		
Maximum Load delivered to Consumers	54,000 "			108,000 "		
Extent to which the sum of the maximum demands reached by individual Consumers at any one time in the year is estimated to exceed the maximum simultaneous load	1·5.			1·66.		
Total of the Maximum Loads reached by individual Consumers at some time during the year	81,000 kilowatts.			180,000 kilowatts.		
ENERGY SOLD :—						
Authorised Distributors –	Kilowatts.	Load Factor. Per Cent.	Units.	Kilowatts.	Load Factor. Per Cent.	Units
Direct Current	27,000	25	59,130,000	55,000	30	144,540,000
Transformed Alternating	24,000	25	52,560,000	50,000	30	131,400,000
Power Users	15,000	25	32,850,000	35,000	25	76,650,000
Railways	15,000	35	45,990,000	40,000	40	140,160,000
Totals	81,000		190,530,000	180,000		492,750,000
Units Generated (including full load and light load losses in transmission and transformation—i.e., 12 per cent.)	216,500,000 units			560,000,000 units.		
Resultant Works Load Factor	41·2.			53·3.		

Table II.

ESTIMATED CAPITAL EXPENDITURE FOR WHOLE UNDERTAKING.

	Stage A. Maximum Load on Works 60,000 kilowatts.	Stage B. Maximum Load on Works 120,000 kilowatts.
	£	£
Land, Generating Station, Buildings, River Work and Coal Stores	263,000	439,000
Plant at Generating Station	469,910	933,370
Transmission and Distribution System	987,502	1,527,137
Substations, Buildings, Switchgear and Transforming Plant	451,660	708,463
	£2,172,072	£3,607,970
Engineering, Supervision and Contingencies, 10 per cent.	217,207	360,797
Preliminary Expenses, Interest during Construction and Working Capital ...	210,721	301,233
TOTALS	£2,600,000	£4,270,000

immediately. The committee wished to know what would happen in the event of anything occurring which completely cut off the supply from the Barking station. How would London and the whole area get on with regard to electric supply, assuming that the present authorised distributors took advantage of the facilities offered? Supposing we were engaged in a war with a foreign Power, and the mouth of the Thames was left temporarily unguarded; what was going to happen in the event of a foreign warship being able to steam up the river as far as Barking and shell the station? also in the event of anarchists attacking the premises with bombs, or in the event of a strike? He believed that it was a penal offence under the Criminal Law Amendment Act to create a trade combination landing a force and taking possession of the station at Barking, he was afraid the supply would be stopped. Generating stations were substantially required to be in a place where there was a plentiful supply of coal and water. If there were to be more than one station, and the hypothetical ship of war could destroy one, it could destroy the others equally well. Therefore the construction of two stations, one at Greenwich and another at West Ham, as was proposed in the Bill of the Administrative County of London and District Company's Bill, would not alter this condition of things. And the same applied to anarchists. With regard to a strike, this again would equally affect several stations as one, for it would be a strike among the employees of the company.

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Mr. BALFOUR BROWNE, for the Electric Lighting Companies, said that neither New York, Paris, and Berlin relied on one station. With regard to strikes, although the Criminal Law Amendment Act applied to gas and water companies, it did not apply to electricity.

Mr. PARSHALL stated that Mr. Balfour Browne was wrong with regard to New York. The Riverside station of New York supplied the whole of that district.

Mr. PARSHALL'S cross-examination was then opened by Sir RALPH LITTLER, K.C., on behalf of the City Corporation, who first intimated that his main point of objection to all the Bills was that the City Corporation wished to be excluded.

forward without the City, said that there were a large number of factories whom it would be desirable to supply. He denied that the effect of the Bill would be to postpone the purchase powers of the City Corporation for 42 years.

Mr. BALFOUR BROWNE, for the promoters of the London Electric Supply Bill, first put questions to show that the difficulty of supplying the existing authorities with their varying voltages and frequencies would be as great with the new power scheme as if the existing companies were to link up, but with this Mr. Parshall disagreed. On the question of the cost of linking up, Mr. Parshall estimated that the cost of linking up would be about £40 per kw., including extra generating plant,

Table III.

ESTIMATED REVENUE ACCOUNT.

Stage A. Maximum Load on Generating Works, 60,000 kilowatts.

EXPENDITURE.		REVENUE.		
To operating costs:—	£	By energy sold to:—	Pence per Unit sold.	£
COAL, 2·5 lbs. per Unit generated, at 12s. per ton	144,978	AUTHORISED DISTRIBUTORS—		
WATER, OIL, WASTE AND SUNDRIES	5,000	Direct Current at £4 10s. and ·22d., 25 per cent. load factor, 59,130,000 units	·7132	175,702
GENERATING WORKS—Wages	10,280	Transformed Alternating Current at £3 10s. and 2d., 25 per cent. load factor, 52,560,000 units	·5836	127,800
REPAIRS AND RENEWALS	10,000	POWER USERS—		
WAGES AND REPAIRS ON TRANSMISSION SYSTEM	20,000	Transformed Alternating Current, average maximum load, say 70 kilowatts at £3 10s. and ·2d., plus 18 per cent. 25 per cent. load factor, 32,850,000 units	·688	94,252
MANAGEMENT, INSURANCE, RENTS, RATES AND TAXES	65,000	RAILWAYS—		
	£255,258	Transformed Alternating Current at £3 10s. and ·2d., 35 per cent. load factor, 45,990,000 units	·474	90,825
To Provision for Renewals on basis of— Years of Life				
Buildings 60				
Plant 25				
Cables 30				
Meters 10	37,170			
Total Working Expenses	£292,428			
Net Profit	196,151			
	£488,579	Total Units sold, 190,530,000	·616	£488,579

Table IV.

ESTIMATED REVENUE ACCOUNT.

Stage B. Maximum Load on Generating Works, 120,000 kilowatts.

EXPENDITURE.		REVENUE.		
To operating costs:—	£	By energy sold to:—	Pence per Unit sold.	£
COAL—2·3 lbs. per Unit generated, at 12s. per ton	345,000	AUTHORISED DISTRIBUTORS—		
WATER, OIL, WASTE AND SUNDRIES	12,000	Direct Current at £4 10s. and ·22d., 30 per cent. load factor, 144,540,000 units	·631	379,995
GENERATING WORKS—Wages	18,234	Transformed Alternating Current at £3 10s. and ·2d., 30 per cent. load factor, 131,400,000 units	·5196	284,500
REPAIRS AND RENEWALS	20,000	POWER USERS—		
WAGES AND REPAIRS ON TRANSMISSION SYSTEM	27,000	Transformed Alternating Current, average maximum load 70 kilowatts at £3 10s. and ·2d., plus 18 per cent. 25 per cent. load factor, 76,650,000 units	·688	219,922
MANAGEMENT, INSURANCE, RENTS, RATES AND TAXES	165,350	RAILWAYS—		
	£587,584	Transformed Alternating Current at £3 10s. and ·2d. load factor 40 per cent, 140,160,000 units	·4397	256,800
To Provision for Renewals on basis of— Years of Life				
Buildings 60				
Plant 25				
Cables 30				
Meters 10	63,845			
Total of Working Expenses	£651,429			
Net Profit	489,788			
	£1,141,217	Total Units sold 492,750,000	·556	£1,141,217

Consequently he would not himself ask questions on engineering matters at this stage. Some questions were therefore put bearing upon the need for including the City, and the congestion of the streets in relation to the laying of mains. Sir Ralph Littler pointed out that, in consequence of this, the City Corporation had been granted special powers of control and regulation in the laying of mains.

Mr. PARSHALL, whilst admitting that the scheme could go

which it would be necessary to install if the problem was to be dealt with in an efficient manner. Exact figures were not obtainable, because he did not know in what manner the matter would be dealt with.

Mr. BALFOUR BROWNE pointed out that this figure must be erroneous, because all the companies had land and buildings available for extensions. He failed to see, he said, how the promoters were going to give a supply at a cheaper rate by

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incurring a capital expenditure of £6,000,000 on top of the £20,000,000 already spent by the companies and local authorities, the interest upon which had to be paid in any event.

In the course of a long series of questions relating to Mr. Parshall's estimate of the amount of other forms of power in factories in the area, viz., 300,000 to 400,000 kw., Mr. Parshall stated that he was unable to give the sources of his information, as much of it was given confidentially. He had also to some extent relied upon information given him in connection with the London County Council Bill last year, and upon a return of the factories in Greater London issued by the Home Office. He had personally visited many factories to satisfy himself of the accuracy of some of the figures given him, and a number of the owners of such factories were going to give evidence as to their willingness to take a supply if the Bill were passed. For instance, Messrs. Bryant & May's had 200 h.p. supplied from producer gas, with which they were by no means satisfied, and although Messrs. Maple's cabinet factory had their own electrical plant, they would come and express their willingness to take a supply from the power company. In arriving at the total horse-power not dealt with electrically in factories, the following allowance in h.p. per head had been the basis according to the different businesses:—Chemical works, 0·75 h.p.; breweries, 1½ h.p.; general engineering, 0·5 h.p.; printing, 0·25 h.p.; builders' materials, 2 h.p.; textile works, 1 h.p. The average power in London was about 50 h.p. per factory.

Mr. BALFOUR BROWNE pointed out that Mr. Merz put it at 50 h.p. in 1905, and if the estimate was coming down he did not see the need of a new power company.

Asked as to the origination of the idea of promoting this scheme, Mr. Parshall said it came about in a general way after the London County Council Bill was rejected last year, and it was decided that the London County Council did not intend to promote another Bill. The promoters are Sir Hugh Bell, Mr. R. W. Blackwell, Mr. Guinness, M.P., Sir Robert Miller, Mr. G. D. Rowe, and Mr. O. H. Smith. As some of these gentlemen are to be called later, Mr. Balfour Browne, who questioned the stability of the promoters, refrained from pursuing the point.

Mr. PARSHALL was then questioned as to Chicago. He said a number of companies combined and built one large bulk generating station, a point which Mr. Balfour Browne suggested was in favour of the Electric Supply Companies Bill. With regard to New York, Mr. Parshall said that the Riverside station dealt with all lighting and power; the Ninety-sixth Street station with the tramways; the "Interborough" station with the underground railway system in its entirety; the Seventieth Street station with the overhead railway system, and another station supplied the New York Central Railroad. In Paris there had been an amalgamation of the electric supply companies. In Berlin there were two stations, and if there were a strike at one of them it would be impossible for the other to maintain the whole of the load, as neither was large enough.

The effect of metallic filament lamps upon the output of stations in the future was next touched upon by Mr. Balfour Browne in an endeavour to show that this would alter the whole effect of the tables of increase in the future, but Mr. Parshall was of the opinion that the tables could very well stand. In reply to another question he stated that all these tables had been prepared from balance sheets. Mr. Balfour Browne upon this pointed out that whereas the tables gave the working costs of the Metropolitan Electric Supply Co. at £50,001 for the year 1906, they were, in fact, only £44,418. To this Mr. Parshall replied that he had been unable to obtain any exact figures from the company, and that he had been obliged to calculate as nearly as possible from the accounts.

Mr. BALFOUR BROWNE: If all your other figures are calculated the same way, I do not quite see their value?—With the exception of a few cases which are indicated in the tables, all the figures are correct.

Dealing with the Board of Trade return of the electricity supplied in London (ELECTRICAL ENGINEERING, February 13, 1908, p. 227), Mr. Balfour Browne pointed out that the average cost for all purposes was 2·839d. per unit, and that, assuming all the savings suggested by the promoters could be effected, the cost would only be reduced to 2·5d. per unit. Mr. Parshall replied that this would be 10 per cent., or £225,000, a quite satisfactory result to himself.

Asked as to whether he had had any experience of a scheme similar to this, Mr. Parshall replied that no one had, but that he had had experience as near to it as possible.

With regard to the cost of the mains system, it was pointed out that the cost of the trunk mains was estimated at £650,000, whilst £937,000 had been allowed for distributors. Mr. Balfour Browne pressed Mr. Parshall for the complete details of this latter, and after some hesitation it was agreed that they should be handed in. Similarly, at the request of the Chairman, Mr. Parshall will prepare a statement giving as much information as he feels he can of the material used in arriving at the quantity of power in London not dealt with electrically.

With regard to prospective consumers, Mr. Parshall said that none of the authorised distributors had been negotiated with, but in view of what happened in connection with the Administrative Company's Bill of 1905, he saw no reason why, in the event of the Bill passing the House of Lords, similar agreements should not be entered into with his company on similar terms. With regard to railway companies, the Central London Railway Co., although it had its own power station, would save £20,000 a year by taking current from the power company, and witnesses would be called to say that the company would be prepared to do this.

Mr. Balfour Browne here stated that the witness had expressed the opinion that the majority of large consumers were inside the County of London, and that people employing several hundred men would come and state their present position with gas engines and other forms of power, and say that if they could get a cheap supply of electricity they were prepared to take it. He wished to make an application to the Committee that the promoters should furnish him with the names of these people in order that his clients might see whether they had not absolutely refused to take a supply on any terms. The whole of the districts of the companies which he represented had been canvassed, and the Committee would hear that many of the power users had refused to take electricity even when offered very low terms

Mr. FITZGERALD, for the promoters, objected to doing this, and said that the proper course was for him to call his witnesses and for the opposition to cross-examine. If it was necessary for any witness to be recalled, he would have no objection.

Mr. BALFOUR BROWNE said that not one of the thirty power companies, working independently of a distribution company, had paid a dividend except the North Metropolitan Power Co. The South Wales Power Co., which was one of the most promising of all had been disintegrated and broken up.

Mr. PARSHALL, in reply to this, said that he had frequently advised people to keep their money out of electric power schemes, and, as a matter of fact, he did this when he was called in to advise in connection with the South Wales scheme. He admitted he had never found it easy to persuade people to find money for these schemes, nor, he added, for any other purpose.

Mr. SEYMOUR BUSHE, for the Kensington and Knightsbridge, and Westminster Electricity Supply Companies, first put questions to show that as the Barking power station of the promoters was eight miles away from his area, it would not pay the company to lay mains into Westminster for the exceedingly small power load which existed. He said that out of 194 persons using power in his area, no less than 145 took electricity from the two companies which he represented, and, as a matter of fact, according to Mr. Parshall's tables, the small power users would have to pay 1·159d. per unit, against 1d. which they were now being supplied at.

Mr. PARSHALL pointed out that the prices in question were the maximum under the Bill, whereas the maximum which the electric lighting companies could charge was 8d. per unit.

Further questions were directed to showing that the clauses with regard to supply in the Bill were so framed as to force existing undertakers to take a supply in bulk from the company on the threat of competition if they did not. To this Mr. Parshall replied that the clauses had been drafted to ensure the small power user getting a supply of electricity at a cheap rate. He admitted that the Bill proposed to deal direct with railways, and with individuals, and that he did not know of any other power Bill which did this.

With regard to supply to authorised undertakers, Mr. Bushe pointed out that in Westminster the local authority happened to be an authorised undertaker, and that the companies carried out the street lighting under contract. In these special circumstances, Mr. Parshall admitted that the power company could compete with the electric lighting companies for lighting. Mr. Bushe also put the possibility before Mr. Parshall of his power company purchasing, say, the London Electric Supply Corporation (at present in competition with the Westminster Company), and so to compete more effectually with the Westminster Company himself, to which Mr. Parshall replied that the consent of the Board of Trade would have to be obtained to any such proceedings.

Mr. BUSHE: In all these circumstances you are not surprised that we look upon your coming with considerable apprehension?—I should have thought you would have looked upon us with considerable pleasure, considering the advantages we can offer you.

Mr. ERSKINE POLLOCK, K.C., cross-examined briefly on behalf of the Middlesex County Council, urging that as the County was already served by two power companies, namely, the North Metropolitan Electric Power Supply Co., and the Metropolitan Electric Supply Co., it should be excluded from this Bill. Mr. Parshall refused to strike out Middlesex.

Mr. FREEMAN, K.C., on behalf of the London County Council, indicated that his opposition to the Bill was with regard to certain clauses, and that if these were not amended to meet his wishes he should ask for the Bill to be thrown out. He asked Mr. Parshall if it would not have been possible to have provided a schedule of prices for small users, with a condition making it compulsory upon the company to supply them on their agreeing to take a supply for a certain definite period.

Mr. PARSHALL thought this was by no means an impossible question, and promised to consider it.

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Mr. FREEMAN next intimated that the London County Council was in favour of the Kitson clause in its original form in preference to the modified one in the Bill.

Mr. PARSHALL said that personally he had no very great objection to the Kitson clause, but he had come into contact with hardly anybody who was in favour of it.

In answer to other questions, Mr. Parshall said that there was no intention of desiring to pay 8 per cent. interest on capital during construction, and that if the drafting of the Bill permitted of this it would be altered.

Mr. FREEMAN next dealt with the purchase clause. The purchase clause in the Bill of the Administrative Company was, he said, on the terms of the electric lighting Acts, namely, the payment of the then value of the plant, &c., without any allowance for goodwill. The promoters in this case stipulated for the return of their capital expenditure and a sufficient sum to bring their dividends up to 6 per cent., if such an amount had not been paid. Why, he asked, should not the established law be followed in this case?

Mr. PARSHALL said he did not know that there was any established law on this point, as no power company was liable to purchase.

Lord WELBY said that the difference between the two clauses was that the administrative company's clause prevented purchase of obsolete plant, whereas this clause did not.

Mr. FREEMAN said there was no obligation in this case to keep the plant in proper condition.

Mr. PARSHALL said the clause would not be fair if the plant was not maintained in proper working order.

Mr. FREEMAN, in referring to the fact that the existing electric lighting companies were purchasable by the local authorities in 1931, asked Mr. Parshall if, assuming a purchasing authority was created to acquire all the existing companies and wished to acquire the undertaking of the power company at the same date, did he think he ought to have such an amount for goodwill as would represent the period between 1931 and the expiry of the forty-two years, in the proposed purchase clause.

Mr. PARSHALL said that the difficulty was the great uncertainty as to what the "then value" meant. This made all the trouble in financing undertakings. The promoters thought the "then value" should mean the money properly spent on the plant providing it had always been maintained in good working order.

Lord WELBY suggested that there should be a definition of "properly expended" in the purchase clause, based upon what any first class firm of accountants would allow as having been properly spent on the undertaking.

Mr. FITZGERALD said he read this as "properly expended" on capital account, and it was not an auditor's duty to go into this at all.

Mr. FREEMAN said he wanted to make quite sure that when the time for purchase arrived, the purchasing authority would not be required to pay for machinery which, although perfectly properly bought at the time it was purchased, would then be obsolete, and ought to have been renewed some years ago.

Mr. FITZGERALD said that in no previous power Bill had a purchase clause been inserted. If the promoters had followed the precedent they would have promoted their Bill without any purchase clause, but in regard to London there seemed to be a strong opinion that there ought to be a purchase clause. If they proceeded on the basis of the water and gas companies, they would get profits, whilst there would at the same time be taken into account the question of obsolescence. With regard to electric lighting, the existing companies which were purchasable at the "then value" of their undertakings had been paying 10 per cent., 12 per cent., and 14 per cent., quite properly, but against this the promoters were asking only for limited dividends. The promoters regarded this clause as a much better one for all concerned than the terms of the electric lighting Acts. For instance, assuming that at the time of purchase there were £5,000,000 of capital paying 10 per cent., the purchasing authority would make an admirable purchase. The promoters were not departing from any ordinary practice in this matter, but were making a concession that had not been asked of any promoters of any power Bill that had been passed. With regard to the Administrative Company's Bill of 1905, this was brought in on the footing of an ordinary power Bill, and it passed Lord Camperdown's Committee of the House of Lords without any purchase clause in it. On second reading in the House of Commons it was opposed, and during the second reading debate a Member of the House, who was authorised to speak for the promoters, agreed to assent to a purchase clause being inserted. Consequently, the Bill passed the House of Commons Committee with a clause which was not, as had been stated, similar to the terms of the Electric Lighting Acts, nor was it the same purchase clause as it was now proposed to insert.

Mr. FREEMAN asked that the clause contained in the Bill of the Administrative Company of 1905 should be inserted in this instance.

TUESDAY, MAY 12TH.

Mr. FITZGERALD, referring to the question of strikes, mentioned by the Chairman yesterday, stated that, although there would be no objection on the part of the promoters to the insertion of a clause making it a criminal offence on the part of an employee to strike and cause a cessation of supply, he thought this must be brought about by a public Act of Parliament and not in a private Bill. With regard to the estimate of horse-power in London, about which there was so much discussion yesterday, he mentioned that this was based primarily upon the return of the Home Office to the London Traffic Commission, and also upon information acquired by the London County Council as the authority under the Factories Act with regard to means of escape from fire. It was this latter information to which there was an objection to publication. The object of the estimate was to show that there was a large demand in the area not already catered for.

Mr. WEDDERBURN, K.C., on behalf of the Croydon Corporation, put several questions to show that the promoters were asking for powers which the existing distributors did not possess, and which would enable the promoters to compete unfairly with the existing distributors.

Mr. FITZGERALD, for the promoters, said that all the provisions of the Bill were substantially the same as in all power Acts, and that the provisions of Electric Lighting Provisional Orders were always different. All the standard clauses of Power Bills were settled years ago by Sir James Kitson's Committee.

In answer to another question, Mr. Parshall thought the financial promoters of the Bill would have no objection to the insertion of a clause stipulating that a certain proportion of the capital must be raised in cash within a certain period of the passing of the Bill.

Mr. BLENNERHASSETT, K.C., for the Westminster City Council, in the course of his cross-examination, indicated that the Council had the right to purchase not only the seven companies supplying electricity in their area under the Electric Lighting Acts, and also upon similar terms, but also the bulk supply station of the Central Electric Supply Co. Consequently, Westminster, being in this exceptional position, the Council should be cut out of the area in so far as the power company should not give any supply there except to the Council, should they desire it. Mr. Parshall, asked if he would agree not to attempt to purchase any of the undertakings serving Westminster without the Council's consent, and so not to prejudice the Council's right of purchase, said he would prefer to leave this in the hands of the Board of Trade.

Mr. MORTEN, for the West Ham Corporation, directed his questions to the large number of docks, railway stations, and power users in that district, all of which the power company could compete for. He also pointed out that in certain cases, unless the Corporation supplied at exactly the present works cost, they would be compelled to take from the power company. Mr. Parshall said if they obtained a supply cheaper than they could generate it for themselves, it would be a good thing for the consumer. On the question of breaking up tramways, it was pointed out that the Bill exempted the general law with regard to breaking up streets. Mr. Parshall said it was not intended to break up streets for laying mains without the consent of the Corporation.

Mr. FITZGERALD offered to give a protecting clause for the tramways.

Mr. A. B. CAINE, for the Marylebone Borough Council, went through the history of the purchase, by the Council, for the portion of the Metropolitan Electric Supply Co.'s business, for £1,125,000, on arbitration terms, of which, he said, the useful plant only represented £200,000, leaving about £1,000,000 for goodwill. Was it fair, under the circumstances, that this power company should come in and compete? In common with all other cross-examining counsel, Mr. Caine disputed the accuracy of the figures in the tables in so far as they related to his district, and endeavoured to show by his questions that the savings to the various authorised distributors, indicated in the tables of the promoters, did not, in fact, exist. On the other hand, Mr. Parshall maintained that the figures, which were based on the latest published returns, were correct. Mr. Caine also raised the question as to whether the "standby" clause in the Bill was applicable to an authorised distributor, and that it might possibly happen that the power company would, seeing that all authorised distributors could be held to have a separate supply, refuse to supply upon the schedule of prices. Mr. Parshall, however, expressed his willingness to supply an authorised undertaker during his peak load upon the same terms as during the day time.

In reply to Mr. COURTHOPE MUNROE, for the St. Pancras Borough Council, Mr. Parshall agreed, if it could be shown that the Power Company offered no present or prospective advantage to the power users in that area, that the committee would be justified in saying they should leave St. Pancras alone. On the question of prices, Mr. Munroe pointed out that immediately after the passing of the Administrative Bill in 1905, St. Pancras adopted the prices in the Bill. Following on this, Messrs. Scott & Middleton, who were constructing a tube railway station in the borough, and were using current day and night, asked to be taken off the 1d. per unit, and put on the same terms as those in the Administrative Bill. The result was that the price worked out at 1·9d. per unit, and they came to the Council, cap in hand, and asked to be charged 1d. per unit. In another case the price to the same firm worked out at 2·1d. per unit.

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Similarly, Messrs. Moy's, Ltd., asked to be taken off the 1d. per unit flat rate, but their price worked out at 1·57d. on a 10·2 per cent. load factor. At Oetzmann's, also, instead of 1d., on Mr. Merz's scale, the price came to 2·1d. per unit on a 6·7 per cent. load factor.

Lord SAUNDERSON pointed out that, according to the tables, as the load factor increased the price decreased, and that these cases were low load factors.

Mr. MUNROE said the large number of power users in London had a low load factor, and his object was to show that, inasmuch as the charges in the present Bill were similar to those of the Bill of Mr. Merz in 1905, no benefit would be conferred upon St Pancras, and therefore that district should be omitted.

Mr. PARSHALL said he was not surprised at the results given by Counsel upon such load factors. With regard to the case of the tube railway construction work, it had always paid to put down independent plant for these purposes.

Mr. WILLIAMS, for the Stepney Borough Council, suggested, in his cross-examination, that the reason for the promoters taking five years in which to acquire the necessary land for the generating station at Barking was that the financial position was doubtful. The land, he said, was in the hands of one owner, and the matter could be very quickly settled. Mr. Parshall asked Counsel to wait until he had heard the financial evidence.

At the end of a long series of questions on matters of detail, and many references to the agreement entered into between the Stepney Council and the Administrative Co. of 1905, Mr. Fitzgerald, for the promoters, said that if Mr. Williams would submit a clause on the lines of that of 1905, he would be prepared to consider it.

To Mr. SAUNDERS, for the Islington Borough Council, who was endeavouring to ascertain how much must be added by the authorised distributor to the price paid the Power Company before distribution, Mr. Parshall said that, as an abstract theory, it did not follow that anything need be added, and yet a profit might be made. The authorised distributor had the benefit of the better load factor, and the difference between the station load factor and that of the consumer left a margin of 20 per cent. to 25 per cent. Mr. Saunders said the average difference between the consumer's load factor and the station load factor in Islington was two per cent. or three per cent. Another point raised by Counsel for Islington was that the purchase clause of the Bill was precisely the one first proposed by the promoters of the Administrative Bill, and that this was rejected by Sir James Kitson's committee in preference to the one finally accepted, which was upon the terms of the Electric Lighting Acts.

This closed the cross-examination.

WEDNESDAY, MAY 13TH.

Mr. PARSHALL was re-examined by Mr. Fitzgerald, and Mr. R. Hammond gave evidence in support of the Bill. A full report will appear in our next issue.

THE REPORT ON THE HALIFAX TRAMWAYS

MAJOR CARDEW and Mr. H. Graham Harris, who were recommended to the Halifax Corporation by the Institution of Electrical Engineers and the Institution of Mechanical Engineers respectively for the purpose of conducting an inquiry on the working and management of the Corporation tramways, particularly with regard to the safety of the public, delivered their report to the Corporation on Thursday last. The tramways at Halifax are on the overhead trolley system, and have a total length of route of thirty-seven miles, representing fifty-two miles of single track. Steep gradients are very much in evidence, the gradient on some portions of the route being as steep as 1 in 9. It will be remembered that in October last year a serious accident occurred in Halifax, due to a car getting out of control and running backwards down a gradient of 1 in 10 on Pye Nest Road (*see* ELECTRICAL ENGINEERING, Vol. II., pages 669, 694, and 735, and for the complete report of Lieut.-Col. E. Druitt on the accident, see the same volume, page 1023). With reference to the difficult conditions of the tramway system, the present report says:—

"Generally speaking, it may be said that your tramway routes are bordering upon the limit of possible safe working by electric cars fitted with ordinary flanged wheels running on grooved rails; for not only are the gradients steep, but the hills are long and with many curves, and the exudations from the soil and deposits from the air and from other traffic frequently produce a greasy surface on the rails. Safety can only be secured, even with every possible mechanical safeguard and with the most careful regulations, by constant and unremitting attention to the maintenance of the efficiency of every working part of the cars and stock, including also that of the human element of "drivers" and "conductors."

It is pointed out in the report that such a system as that of Halifax must necessarily be somewhat more expensive as regards working costs than a system in which there were fewer heavy gradients, but the expense in the case of Halifax appeared excessive. Attention is drawn to the increase in the consumption of energy per car mile over those of previous years, and also to the increase in the number of accidents. It is also stated that the undertaking has not been maintained at the level of perfection which was essential to economy and safety. The following is an abstract of that part of the report containing the recommendations of the experts:—

With regard to the permanent way, the joints should be properly anchored in all cases where relaying is undertaken, and granite setts should be used exclusively in the paving of all steep grades exceeding 1 in 20, and of curves of short radius. The surface of the rails on all steep grades should be washed and swept, and for this purpose a tank car sweeper is recommended. The cars are stated to be of fairly suitable design and size, but single-decked cars are recommended, the increased height of the centre of gravity with double-decked cars being distinctly prejudicial to the efficiency of the brakes. It is strongly urged that no cars with covered upper decks (of which pattern the Corporation possess two) should be allowed to run on the routes with steep grades. Emphasis is laid on the point that all controllers should be absolutely similar in their modes of working (it will be remembered that the braking movements for the two controllers on the car which ran back in October were quite different). According to the report the Corporation have in use controllers of five different patterns. The motions of most of these types are similar on the forward steps, but for braking the movements were entirely different. Dealing with brakes, Major Cardew and Mr. Harris strongly emphasise their opinion that every car should be fitted with an efficient emergency brake and an adjustable brake for continuous use, and that these brakes should form one piece of apparatus. The latest form of "Spencer" track-brake fulfilled the necessary conditions more satisfactorily than any other brake which the Corporation had in use, but it requires to be handled promptly and by a skilled driver. A satisfactory magnetic track-brake is more rapid and powerful than any hand-brake could possibly be. An improved form of sand-gear is recommended, which would not only deliver the normal quantity of sand under normal conditions, but would also in emergencies deliver a much larger quantity in front of the wheels, whether the car were running forward or backward, and which could be operated from either end of the car.

On the question of upkeep and repairs, the report runs as follows:—

"We would most strongly impress upon the Committee the necessity for more careful attention to the upkeep and cleaning of the motors and all accessories than appears to have been exercised in the past. Numerous motors under repair were shown us in which there was evidence of damage caused by the motor having been allowed to run too long without attention. These remarks also apply to the rheostats, cut-outs, wiring, and electrical and mechanical equipment generally."

Glasgow Local Section of the Institution of Electrical Engineers.—The annual report of the Glasgow Local Section of the Institution of Electrical Engineers, which was submitted to the general meeting last Tuesday, records the holding during the session of six meetings, and the discussion of three Papers, two of which had previously been read in London. The membership of the section shows a steady increase, and now numbers 294 (including 83 students). Among the social functions held during the session have been the annual dinner and a smoking concert. No further nominations have been received for office-bearers for the next session beyond the list already given (ELECTRICAL ENGINEERING, April 30th, page 667), so that these gentlemen are duly elected. The Glasgow students' section has held six meetings, and had three visits to works, &c.

Assessment of Wakefield Tramways.—In the House of Lords on Friday last, the case of Wakefield Corporation *v.* Wakefield and District Light Railways Co. was heard before the Lord Chancellor, Lord Macnaghten, Lord James of Hereford, and Lord Atkinson. This was an appeal from a decision of the Court of Appeal, which affirmed an order of the King's Bench Division, dated April 10th, 1906. The justices for the city of Wakefield held that certain of the Tramway Co.'s lines laid in streets in Wakefield should be assessed at their full net annual value. The King's Bench Division reversed this decision, holding that the lines should be assessed at one-fourth part only of their net annual value, in accordance with Section 211 of the Public Health Act, 1875. Their lordships affirmed the judgment of the King's Bench Division and the Court of Appeal, and the appeal was dismissed.

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THE CENTRAL LONDON RAILWAY

New Generating Plant and Shepherd's Bush Extension

A LARGE new generating set, complete with special condensing plant and a new cooling tower, has just been added to the equipment of the power-house of the Central London Railway, of which, owing to the courtesy of Mr. H. F. Parshall, we are able to publish some illustrations and interesting details. Before, however, setting forth the actual particulars of the new plant, a few facts concerning the existing plant, working of the railway and the circumstances which led up to the necessity for extensions will not be out of place.

The railway was opened for traffic in August, 1900, and, as is well known, is worked by direct current supplied from a number of sub-stations along the route, which in turn receive their supply from the generating station at Shepherd's Bush in the form of three-phase alternating current at 5,000 volts and at a periodicity of 25 cycles per second. The principal sub-stations are at Notting Hill Gate, Marble Arch, and the Post Office, and at these points are placed at the bottom of the lift shafts. There is also a fourth sub-station at Bond Street, which is situated at the surface, and which acts as a stand-by, this being necessary owing to the space at the other sub-stations being too limited to accommodate the required spare plant. The position of the Bond Street sub-station is approximately at the middle of the line, and the whole of the railway can be supplied from this point in cases of emergency. It also serves as a distributing centre for the lighting of the tunnels and the working of the lifts. The sub-stations

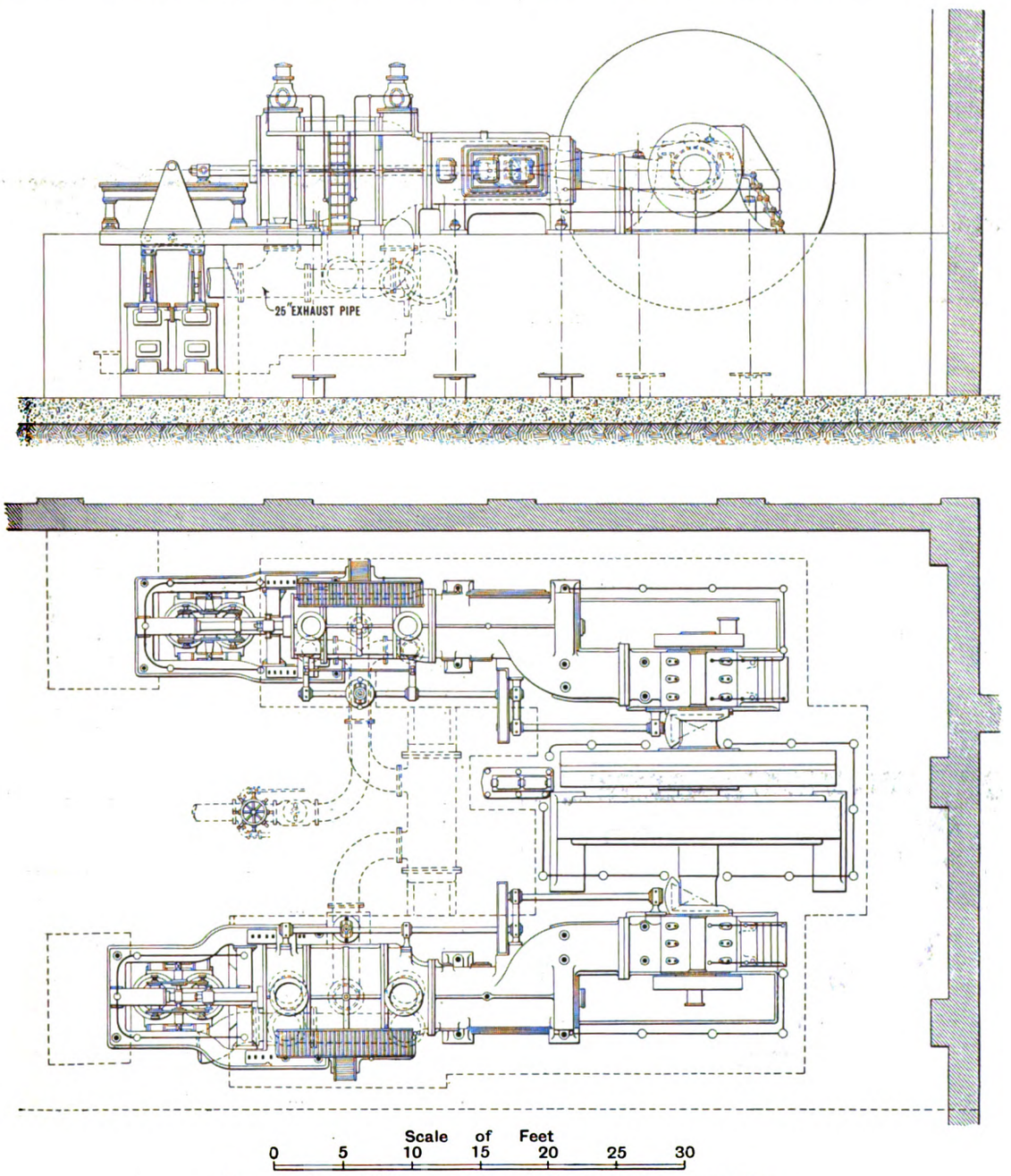


FIG. 1.—NEW 2,000 KW. MUSGRAVE-B.T.-H. GENERATING SET.

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are equipped with static transformers, which transform the current from a pressure of 5,000 volts to 330 volts, and with rotary converters, which receive the three-phase alternating current at a pressure of 330 volts and convert it to direct current at 500 to 550 volts for supply to the collector rail.

This system of generation, distribution, and working the railway is that which has since been adopted by the Metropolitan District Railway, the Metropolitan Railway, the Great Western Railway, and by the newer tube railways in London, and may practically be regarded as the standard system throughout the world wherever the service is a severe one involving frequent stops and rapid acceleration. This system for this purpose is claimed to be the most reliable, the cheapest in first cost, and most economical in operation. The problem of long-distance traffic is, of course, essentially distinct.

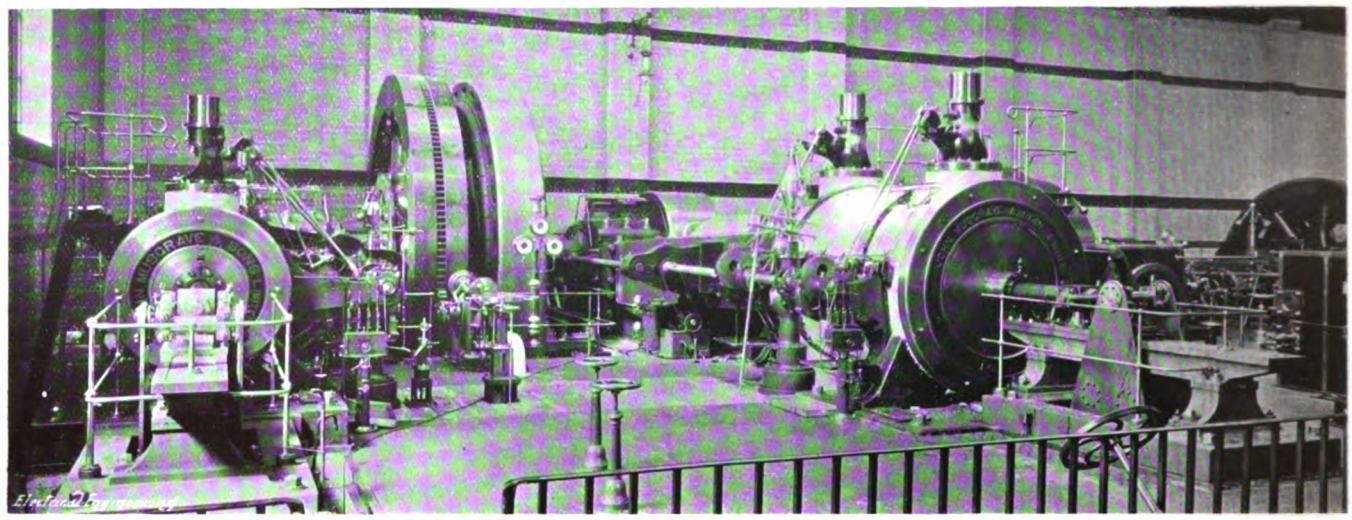


FIG. 2.—NEW 2,000 K.W. MUSGRAVE–B.T.-H. GENERATING SET.

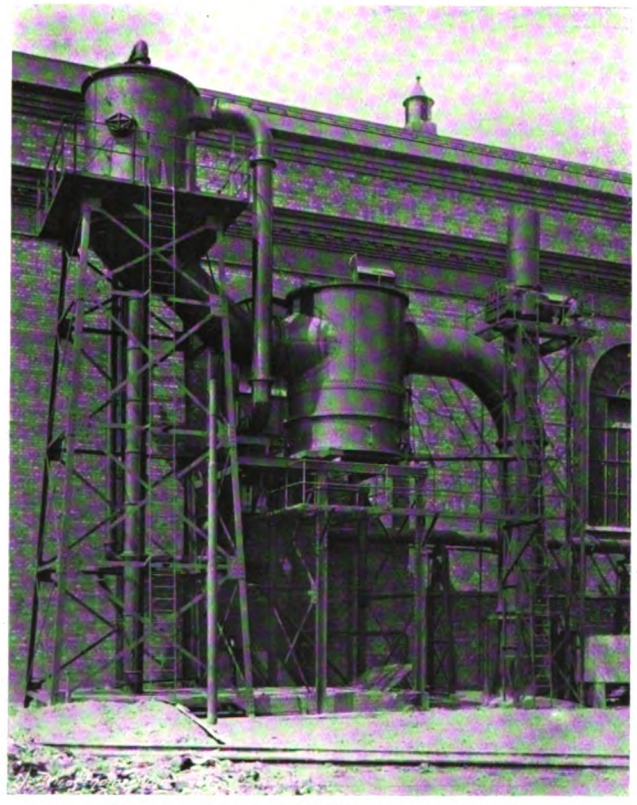


FIG. 3.—BAROMEIRIC CONDENSING PLANT.

The following is a table showing the cost of operation per train mile, per car mile, and per ton mile, together with the percentages for 1905, that is for the year during which the extensions were decided upon. The figures for 1907 are still better; the total cost of operation was 6·848d. per train mile, made up of 3·991d. charged against generating station, 0·412d. charged against sub-stations, 2·2d. against locomotion, including motor-men's wages, inspection, lighting and repairs to motor-cars, and 0·245d. for superintendence. Stated in percentages the generating station costs are 58·28 per cent., sub-station costs 6·01 per cent., locomotion 32·13 per cent., and superintendence 3·58 per cent. The total cost of running the line for the year 1907 was 2s. 10d. per train mile, including management, rates, and taxes. It will be seen, therefore, that the toal cost of operation in terms of the total cost is 20·1 per cent. The generating station costs are 11·7 per cent., sub-station 1·2 per cent., and locomotion expenses 6·5 per cent. It should be particularly noticed that the sub-station costs are a very small proportion of the whole cost of running the line.

TABLE OF WORKING COSTS, CENTRAL LONDON RAILWAY.

	Amount. £	Per train mile. d.	Per car mile. d.	Per ton mile. d.	Per-centages.	Per-centages.
1. Generating station—						
a. Operation	1441·0	3·21	—	—	37·2	—
b. Repairs	173 0	0·385	—	—	4·47	—
	1614·0	3·595	0·513	0·0287	41·67	—
2. Substations and distribution—						
a. Operation	119·8	0·267	—	—	3·08	—
b. Repairs	88·4	0·195	—	—	2·25	—
	208·2	0·462	0·066	0·0037	5·33	—
1+2. Generation and distribution ...	1822·2	4·057	0·579	0·0324	47·0	—
3. Locomotion—						
a. Operation	1033·0	2·3	--	—	26·75	54·0
b. Inspection and lighting	170·8	0·38	—	—	4·42	9·0
c. Repairs to motor cars and steam locos.	710·0	1·58	—	—	18·33	37·0
	1913·8	4·26	0·61	0·0341	49·5	100·0
4. Superintendence ...	136·2	0·303	0·043	0·0024	3·5	—
Totals	3872 2	8·620	1 232	0·0689	100·0	—

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service, higher acceleration, and consequently increasing the maximum load on the power-station. The maximum load in 1902 was 3,850 kw.; in 1903 this was increased to 4,000 kw.; in 1904, 4,500 kw.; in 1905, 4,600 kw., with a momentary load of 6,000 kw. The capacity of the generating station before the installation of the new plant was 5,100 kw. in six units of 850 kw. each, so that the margin of plant capacity was insufficient for the safe and efficient working of the line.

With a view to meeting any further increase in the load, and to provide for the additional traffic anticipated in connection with the Franco-British Exhibition, an additional unit of 2,000 kw. was considered advisable, this size being determined by the load during the slack hours, and arrangements were made for installing a unit of this size, complete with condenser, pumps, cooling towers, &c.; extensions were not, however, required in the boiler house. A drawing of the set is given in Fig. 1, and Fig. 2 is reproduced from a photograph taken just before its completion.

The engine was built by Messrs. T. Musgrave & Sons, of Bolton, and is of the horizontal cross-compound type, with cylinders 38 and 74 in. in diameter and 52 in. stroke, developing 3,000 I.H.P. normal load at 83 revolutions per minute, and capable of 50 per cent. overload and 100 per cent. momentarily when supplied with steam at 150 lb. pressure and exhausting to a vacuum of 26 in. of mercury. The bearings are each 28″ diameter by 54″ long; the crank shaft is 34″ diameter in the largest part; the flywheel is 20′ 6″ in diameter, 2′ 8″ wide, and weighs 120 tons, 75 tons of which are in the rim; the crank pins are 10″ diameter by 12″ long, pressed into crank discs 6′ 10″

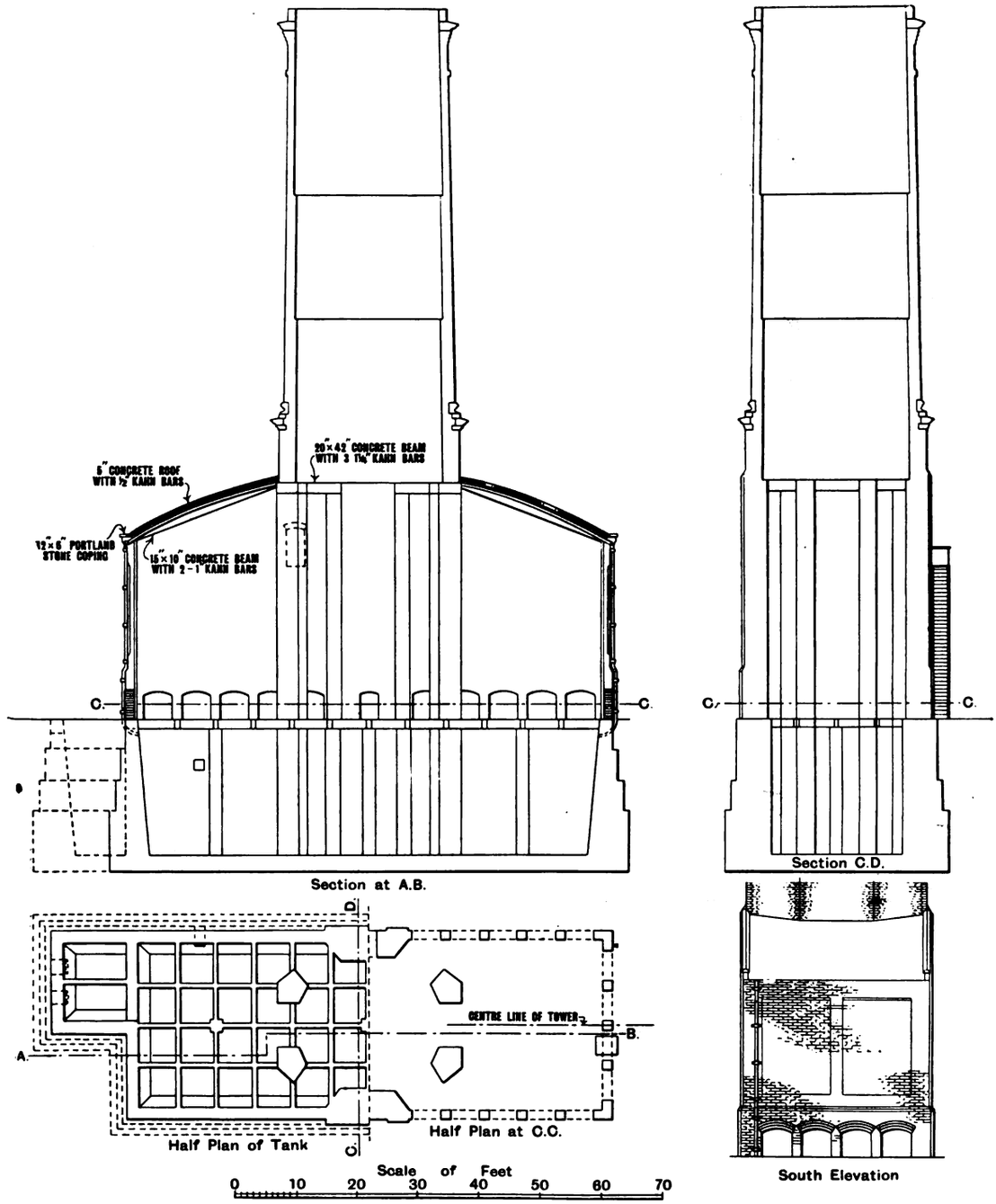


Fig. 4.—Plan, Sections, and Elevations of Cooling Tower.

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diameter by 13½″ wide. The connecting-rod is six times the length of the crank. The total weight of the engine is 320 tons. Drop valves of slightly different design are employed on the two cylinders.

The alternator is a three-phase revolving-field machine, manufactured by the British Thomson-Houston Co., of Rugby, and rated at 2,000 kw. normal, 3,000 kw. for two hours and 4,000 kw. momentarily when running at 83 r.p.m. at 5,000 volts and 25 cycles per second. It is mounted on the engine crank-shaft between the bearings and on the L.P. side of the fly-wheel. The total weight of the alternator is 60 tons.

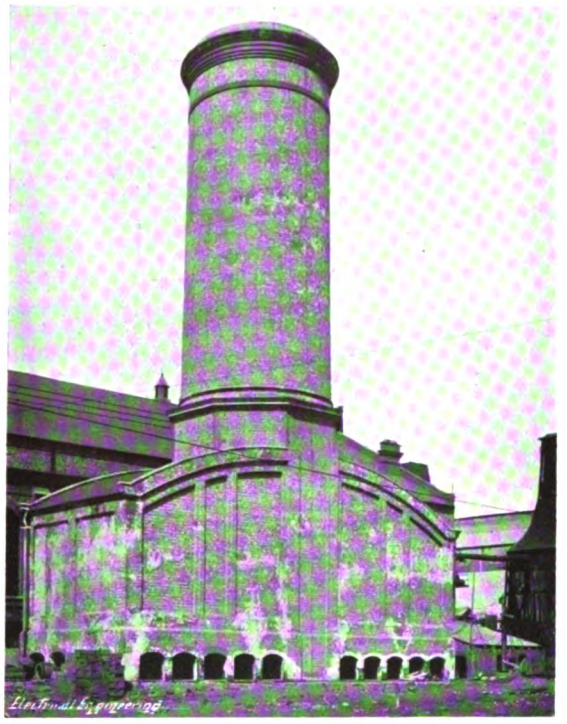


Fig. 4.—Brick Cooling Tower.

The engine exhausts through a 26″ pipe to a barometric condenser placed outside the engine-room, and shown in Fig. 3. This plant was supplied by the Mirrlees-Watson Co., of Glasgow. The condenser is of vertical counter-current design, with a volumetric capacity of 530 cubic feet; it is fitted with a series of trays and baffles for distribution of the cooling water, and so arranged that the water is prevented from entering the exhaust pipe, while ensuring the thorough mingling of steam and water. The air is drawn from the highest point of the condenser and passed through a separator on its way to the air-pump. The water is drained from the condenser by a tail pipe of 15″ diameter leading to a hot well beneath the condenser. An oil separator is inserted in the exhaust pipe immediately in front of the condenser, and the oil from the exhaust is withdrawn by a small steam pump and lifted to a large separating tank.

The cooling water is circulated by means of pumps situated in the basement and driven from the tail rod of the main engine. The water is drawn from the hot well beneath the condenser and delivered through a "Venturi" water meter to a specially designed cooling tower, constructed to deal with 200,000 gallons of water per hour. The tower is shown in Figs. 4 and 5 and is a brick tower of the natural draught type, provided with a chimney 24′ diameter and 115′ high, the building itself being 79′ 3″ long by 30′ 9″ wide, and fitted with an elaborate arrangement of triangular slats. The water enters a main trough at a height of 26′ from the foundation, the trough running centrally the whole length of the building; from this trough the water flows into smaller troughs, branching at right angles and on either side of the main trough. The water leaves these smaller troughs through short lengths of galvanised gas tubes, situated at intervals along the bottom, and falls upon small flat galvanised

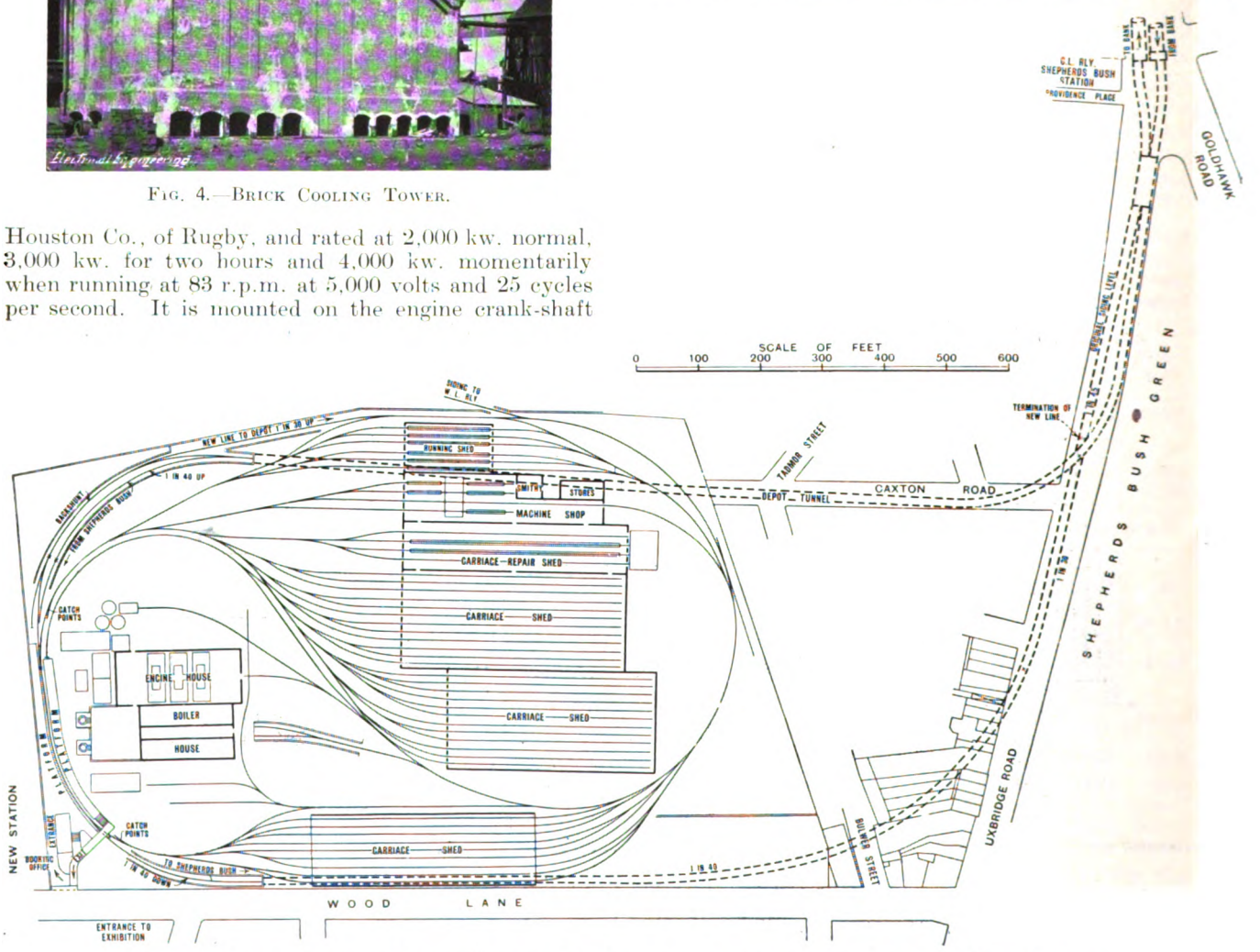


Fig. 6.—Plan of Central London Railway Depôt, showing extensions of Line and New Station.

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steel plates placed directly beneath the tubes. Upon striking the plates the water is divided into spray, after which it falls upon triangular laths, which are staggered and arranged so that each gets its proper share of water. The whole arrangement is such that the water is split up and distributed evenly over the whole of the irrigation area, thus utilising the whole of the cooling surface and obtaining the maximum cooling effect.

No iron parts are used in the construction, all nails being of copper, and the distributing apparatus is supported on a substantial pitch-pine framework. The water falls into a concrete tank forming the base of the cooling tower; the air is admitted through small openings situated at the ground level in the four walls of the tower, the necessary draught being produced by the chimney above referred to.

This tower is the only one of its kind in the country. The whole of the interior fitting was carried out by Messrs. Balcke & Co., and the contractors for the actual brickwork were Messrs. J. Jarvis & Sons, Ltd. Many of the details of the construction and arrangement are due to Mr. Parshall, under whose supervision the designs were prepared.

We have already referred to the special arrangements which the Central London Railway Co. have made to deal with the special traffic in connection with the Franco-British Exhibition. Although there is an entrance to the exhibition in Uxbridge Road, close to the original Central London terminus, it was decided to construct an extension to the line and a new station opposite to the Wood Lane entrance of the exhibition, by the use of which passengers will avoid having to walk through the 900 yards of covered way connecting the Uxbridge Road entrance with the exhibition proper. The extension has been arranged in the form of a loop, through which all the trains will be run, avoiding the shunting, which was formerly necessary. A general plan of the extension is given in Fig. 6. The trains arriving at the old Shepherd's Bush terminus will proceed to the surface by the original tunnel leading into the depôt yard up a gradient of about 1 in 40 to the curve at the extreme end of the company's ground and the new station marked in the plan. From here a new piece of line leads down an incline, also of about 1 in 40, to the new length of tunnel just completed, which, after a slightly stiffer gradient under the Uxbridge Road, leads to the main tunnel towards the Bank. The tunnel is of the usual cast-iron tube construction, and neither it nor the new track equipment call for any particular remark, except that near the point where the new tunnel dips under the original depôt tunnel, a short length of the original siding tunnel was lowered and has now an elliptical section. The station platforms and most of the line from where it leaves the depôt tunnel are directly under the overhead covered way, forming part of the Franco-British Exhibition and connecting the Uxbridge Road and Wood Lane entrances.

In conclusion, we wish to express our thanks to Mr. Parshall for having given us full particulars of the new generating plant, and also to Mr. Basil Mott, under whose direction the extensions of the line were carried out, and to Mr. E. P. Grove, chief engineer to the Central London Railway, for affording facilities to our representative.

NEW 6,000 KW. TURBO-ALTERNATOR AT THE MANCHESTER CORPORATION ELECTRICITY WORKS

We are now able to illustrate the fine new turbo-alternator which, as mentioned in our last issue, was formally started by the Lord Mayor of Manchester at the Stuart Street Electricity Works last week. Although the turbo-alternator is the largest yet built in this country, it cannot be regarded as an experiment. It was mentioned at the dinner which followed the inaugural ceremony, that the alternator is practically a replica of one at the Vienna Electricity Works; it has, however, been built in this country, at the Stafford works of Messrs. Siemens Bros.' Dynamo Works. The turbine, although the largest that Messrs. Willans & Robinson have built, follows the same lines as those previously manufactured with success by the

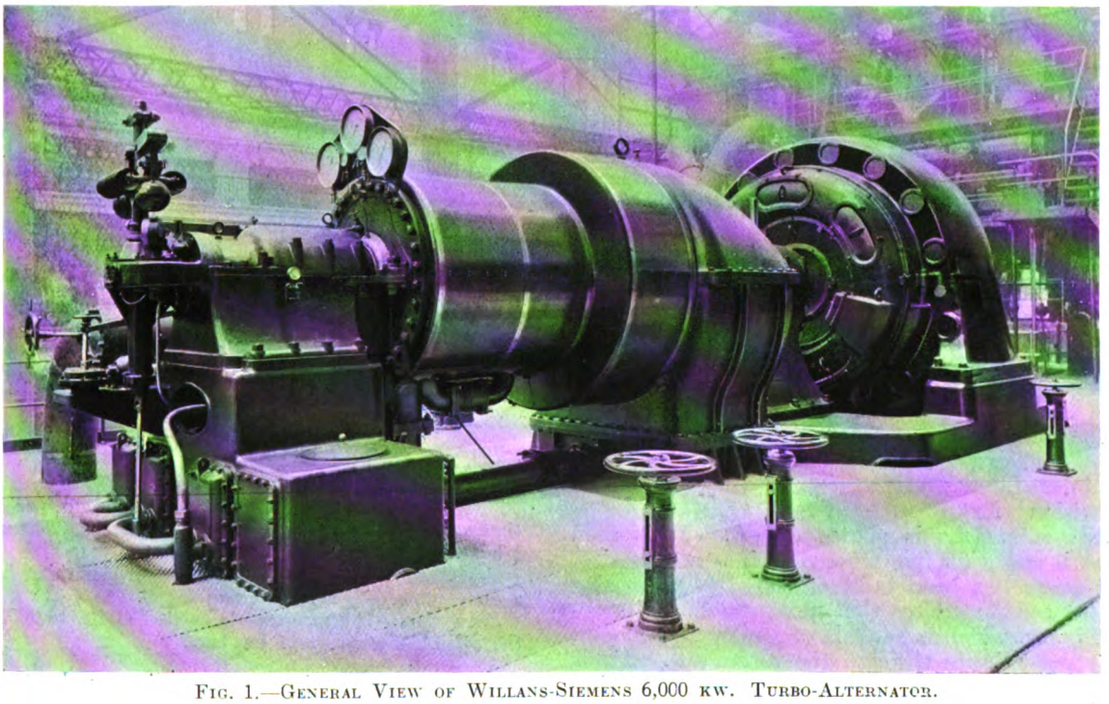


Fig. 1.—General View of Willans-Siemens 6,000 kw. Turbo-Alternator.

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firm for electricity works. Fig. 1 is a general view of the machine taken in the electricity works.

The Willans' shrouded blading is familiar to our readers; a description of it appeared in ELECTRICAL ENGINEERING, Vol. I., p. 961. A similar governor to that of the turbine then described (a 2,000-kw. machine for Sydney) is also employed. It is a ball governor, which can be adjusted from the switch-board gallery. A small motor attached to the machine turns a screw, which varies the tension of a helical controlling spring attached to the governor lever. A feature is the comparatively small length of the machine: its over-all length is only 36 ft., and the overall length of the turbine and alternator is 46 ft. 3 in. The diameter and the high-pressure expansion chamber is 34 in., the intermediate pressure 51 in., and the low pressure 77½ in. The length of the low-pressure blading is 8 in. The diameter of the turbine shaft is 11 in., the weight of the rotor 13 tons, and the total weight of turbine and alternator 158½ tons. The speed is 1,000 revolutions per minute.

A feature of the alternator is the system of forced ventilation. The machine is totally enclosed, and air is forced in to the stator at a pressure of 3 in. of water, passes through the stator and rotor, and out again through the hollow feet of the stator to an exhaust duct which leads outside the engine-room. The general arrangement of the ventilating plant is shown in Fig. 2, in which the present machine is shown in full lines, and the provision for subsequent extensions is shown dotted. It is seen that there is space for five more machines of this size. A small house has been built outside the generating station to accommodate the motor-driven Sirocco-blower (Fig. 3), which is capable of forcing 21,000 cub. ft. of air per minute through the alternator. Air is drawn in to the fan-room through a dust-filter consisting of zigzag screens of woolly cloth mounted on a bamboo frame, supplied by Messrs. K. & T. H. Möller.

The fan is driven by a 23 b.h.p. motor. There is a double door to the room, so that no air can get into it except through the filtering screen. The position of the fan is seen in Fig. 2, and separate fans and filters will be put in for each succeeding machine. To avoid confusion in reading the drawing, we must point out that the two lines in Fig. 2 apparently connecting up the fans do not represent a common shaft, but are merely a line of girders. In Fig. 3 a part of the dust filter is seen on the left, and in front of it is a motor-driven vacuum cleaner which will be employed for removing dust from the filtering material. The two air ducts leading to the machine are seen in Fig. 2. The lower one leads the air to the projecting air inlet at the base of the stator casting seen in Fig. 4, and passes across the stator windings, through the rotor, and out again through the hollow feet of the stator to the exhaust air duct leading to a short exhaust shaft outside. Fig. 6 shows the stator unwound, Fig. 5 the rotor, and Fig. 7 gives two elevations of the alternator. The holes in the stator seen in Figs. 4, 6, and 7, and also in Fig. 1, are fitted with covers which can be removed in the event of any accident to the fan, so that the machine may still be run nearly at its full-load capacity as there will still be a certain amount of ventilation.

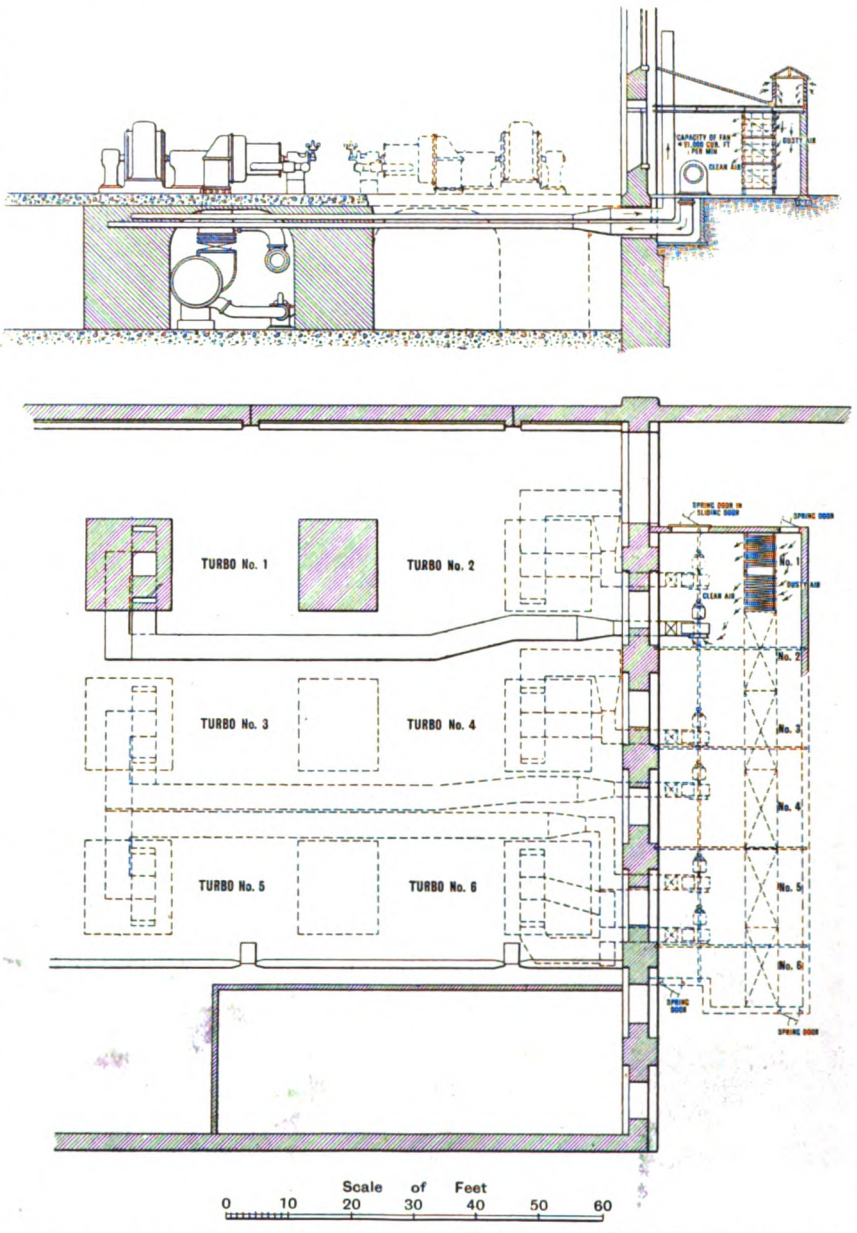


FIG. 2.—GENERAL ARRANGEMENT, SHOWING POSITION OF TURBO-GENERATOR AND VENTILATING PLANT.

The following are the leading specified particulars with regard to the alternator:—

Output. — Normal full load output, 7,060 k.v.a. or 6,000 kw. with a power-factor of 0·85.

Generator supplies three-phase current at a pressure of 6,500 volts between phases, and a frequency of 50 cycles per second, when running at 1,000 r.p.m.

Overload. — The machine is capable of dealing with overloads of 15 per cent. continuously, 25 per cent. for 1½ to 2 hours, and 50 per cent. for ¼ hour.

Temperature Rise.—At normal load the machine is rated for a temperature rise not exceeding 45° C.

Excitation.—The generator is excited at 200 to 225 volts from the station direct-current bus-bars.

The alternator is of the salient pole type, there being six poles of round section, each pole being a separate casting. The field windings are of flat copper, insulated with presspahn between turns, and pressed together with a pressure of 100 tons.

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The efficiency of the alternator, including windage, is stated by the makers to be as follows:—

7,500 K.W.	with power factor of	·85	95·9	per cent.
6,250 ,,	,,	,, ·85	95·2	,,
5,000 ,,	,,	,, ·85	94·9	,,
2,500 ,,	,,	,, ·85	90·9	,,
1,250 ,,	,,	,, ·85	83·7	,,



FIG. 3.—MOTOR-DRIVEN BLOWER, DUST FILTERS, AND VACUUM CLEANER.

The inherent regulation of the machine is such that with full non-inductive load thrown off, the rise in pressure will not exceed 3·5 per cent., and with full inductive load thrown off it will not exceed 13·5 per cent. The stator of the machine consists of open slots with former wound coils, there being four slots per pole and per phase.

A steam pressure of 190 lb. at the stop-valve is employed, and steam is taken from the existing boilers in the station. Additional boilers of the marine type will, however, shortly be erected. The steam is superheated, and, with a temperature of 483·8° F. at the stop-valve, and a 27-in. vacuum, the following steam consumptions per kw.-hour are guaranteed: At $\frac{1}{4}$-load, 21·4 lbs.; at $\frac{1}{2}$-load, 17·67 lbs.; at $\frac{3}{4}$-load,

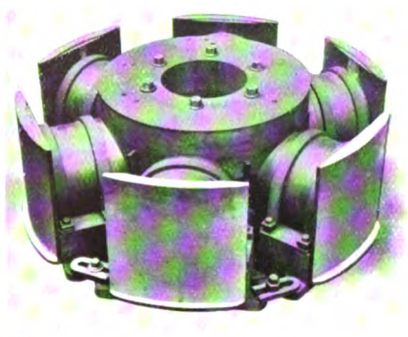


FIG. 5.—ROTOR.

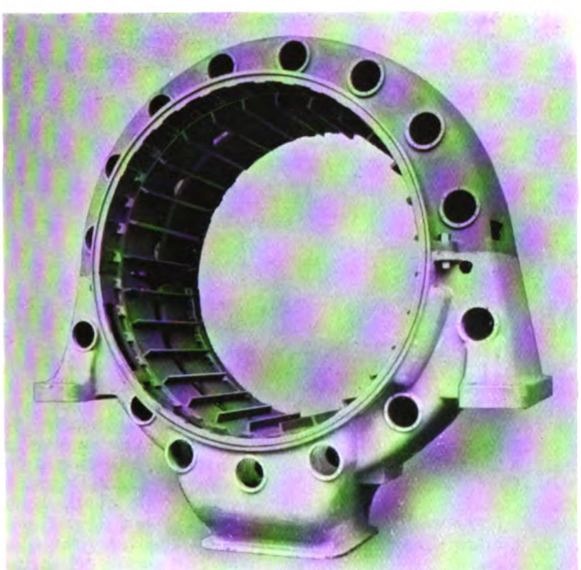


FIG. 4.—STATOR CASTING.

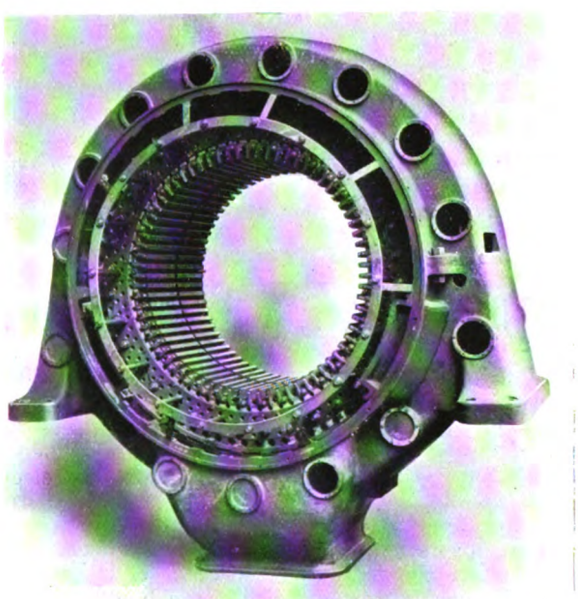


FIG 6.—STATOR UNWOUND.

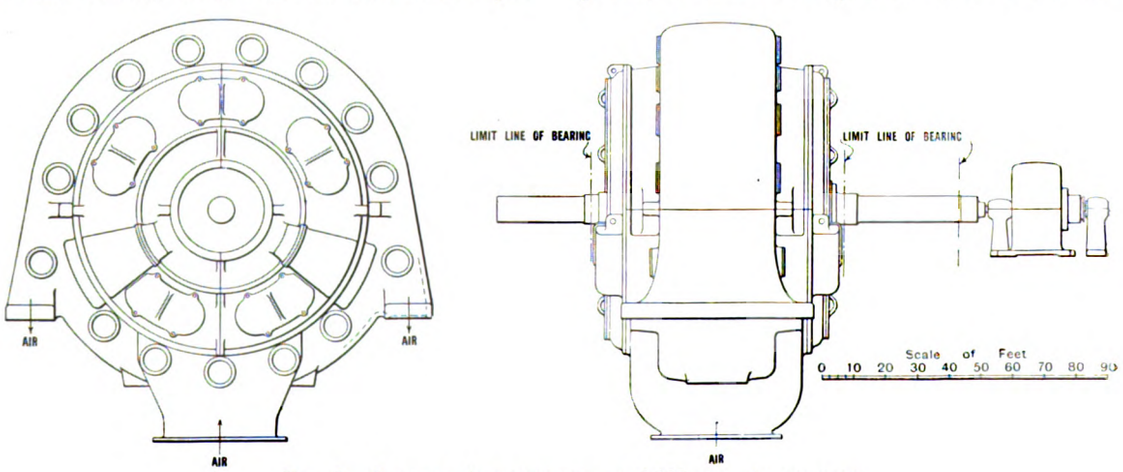


FIG. 7.—GENERAL ARRANGEMENT OF 6,000 KW. ALTERNATOR.

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16·6 lbs.; at 25 per cent. overload, 15·85 lbs.; and at 50 per cent. overload, 16·95 lbs. These figures are based on a rated capacity of 5,000 kw., so that as the machine will normally be run at 6,000 kw., 15·85 lbs. may be taken as practically the full-load steam consumption. For a 26-in. vacuum an increase of 3·3 per cent. in steam consumption is allowable, and a similar percentage decrease if the vacuum is 28 in.

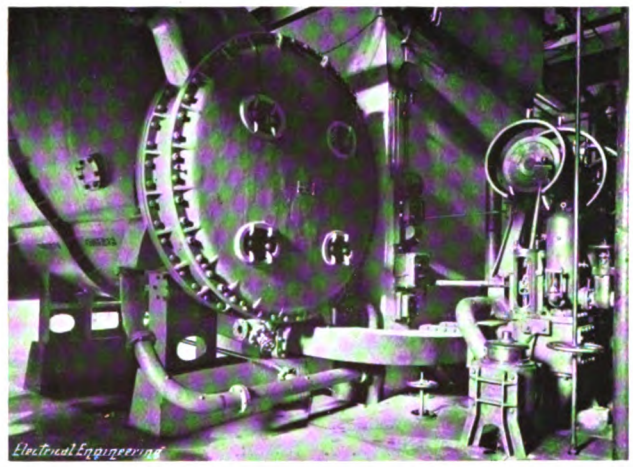


FIG. 8.—CONDENSER AND AIR-PUMP.

The condenser is placed immediately beneath the turbine. It is of Messrs. Richardsons, Westgarth's "Contraflo" type, with a cooling surface of 10,500 sq. ft. Its three-throw Edwards type air-pump is fitted with a 12 h.p. Greenwood & Batley force pump. The air-pump is driven by a 50 h.p. Siemens motor, whose speed of 590 revs. per min. is reduced to 110 revs. per minute by spur gearing. Fig. 8 is a view of the condenser and air-pump. The circulating pump (Fig. 9) is driven by a 250 h.p. Siemens motor. It is a Worthington circulating pump, is directly driven at 600 revs. per min., and supplies 7,700 gals. per min. with a head of 70 ft. These motors are all supplied with continuous current at 400 volts from the works' distributing board. At present the existing cooling towers are used, which are of the fan draught pattern, but two natural draught towers will shortly be supplied by the Blasberg Engineering Co., of Glasgow.

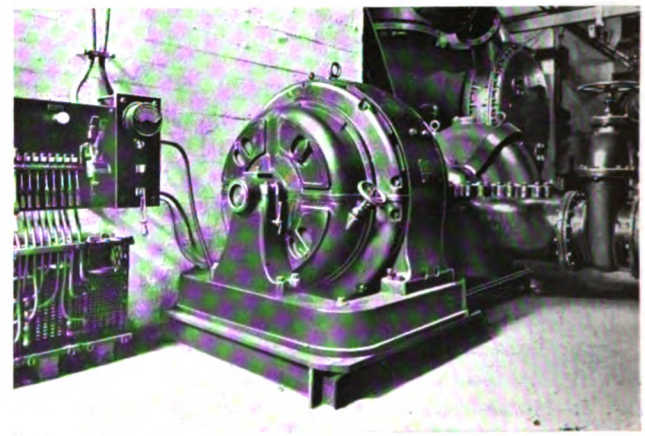


FIG. 9.—CIRCULATING PUMP, DRIVEN BY 250 H.P. MOTOR.

Mr. S. L. Pearce, City Electrical Engineer, and Mr. McKenzie, Resident Engineer at the Stuart Street Station, were kind enough to afford us every facility for inspecting and photographing the plant.

MANUFACTURE OF METALLIC FILAMENTS FOR ELECTRIC LAMPS

Two recent Patents

UP to the present, tantalum has been the only one of the refractory metals used commercially in the manufacture of metallic filaments for electric lamps, which is sufficiently ductile to permit of its being drawn out into a fine wire. Tungsten, under ordinary circumstances, is so brittle that in all the present methods of manufacture the metal, or the oxide of the metal, is first mixed as a powder with some binding solution, or is made into a colloidal solution, as first described by Prof. Kuzel, of Vienna (see ELECTRICAL ENGINEERING, April 2nd, p. 525, and April 16th, p. 589). In connection with the former method the following description of a proposed process of manufacture, abstracted from a Patent Specification (No. 16,530 of 1907) by the British Thomson-Houston Co. (a communication from the General Electric Co. of New York), is of interest.

Tungsten powder of relatively good quality can be readily produced by reduction of tungsten tri-oxide with hydrogen according to well-known chemical methods. The powder so obtained is non-coherent and is exceedingly refractory. In order to consolidate it into a coherent conductor we may proceed as follows:—The tungsten powder is rubbed into a warm and plastic amalgam, consisting of, say, equal parts of cadmium and mercury, forming a homogeneous ductile mixture; the tungsten may be added in the proportion of 30 per cent. or more by weight of the final mixture. The product thus obtained may be squirted warm through a diamond die and may be otherwise manipulated without difficulty. The squirted wires are ductile, and probably consist of a mere mechanical mixture of the tungsten powder with the amalgam. The proportion of mercury and cadmium in the amalgam may be varied through relatively wide limits, and a very suitable mixture consists of 44 parts cadmium to 56 parts mercury. Other binders can be used in place of the cadmium amalgam, as, for instance, cadmium bismuth alloy having 112 parts cadmium to 208 parts bismuth; or an alloy containing mercury cadmium and bismuth in the following proportions:—Mercury 53 parts, cadmium 42 parts, and bismuth 5 parts. It will be noted that all the materials of the binder have relatively low vaporisation points, and can, therefore, be distilled at low temperatures. To remove the vaporisable components above-mentioned, we may bake the ductile wires in an evacuated tube to the temperature at which most of the mercury and part of the cadmium vaporises out; this leaves a relatively strong and somewhat brittle residue, consisting mainly of tungsten and cadmium, and also bismuth, if the latter has been used in the binder. The wires may then be removed from the baking receptacle and suspended in a treating bulb, and there subjected to the heating action of current passed through the wires. A vacuum or inert atmosphere should be maintained about the wires during this treatment. The current distils or vaporises the remaining cadmium or other component of the binding material, and then consolidates the porous residue of tungsten into a homogeneous and relatively compact wire. The tungsten particles seem to sinter together and thus decrease the porosity of the structure. The wire shrinks in length very materially during treatment. The wire is then allowed to cool, and when taken from the treating chamber is found to be strong and firm and somewhat elastic, but without the capability of taking a permanent set and practically devoid of ductility in the sense in which that term is applied to such metals as copper, silver, platinum, &c. Assuming that we desire to coil this coherent body of pure tungsten into a spiral, we may utilise an apparatus consisting of a rotatable mandrel of platinum or other material, supported in a wooden block, and heated by a small gas flame. The mandrel need not be very hot, but may be considerably below a visible red heat. The tungsten wire can be secured to the mandrel in any suitable manner, as by insertion in a slot cut across the end of the mandrel. We find that as soon as the tungsten is heated by the mandrel it becomes soft and ductile and feels pliant like copper-wire. By simply rotating the mandrel between the fingers, the tungsten wire can be wound on the mandrel without danger of fracture, and with

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every evidence of ductility in the metal. The feature of the process, which seems most striking, is that the temperature of manipulation may be below the oxidising temperature of the tungsten, or at least below the temperature at which the tungsten blues or otherwise changes in colour or appearance. After the spiral has been completed, it may be cooled on the mandrel, and then slipped off over the end. The material when cold appears to have returned to its elastic and non-ductile condition, and appears to have been in no wise chemically changed by the heat treatment. As a modified method of treatment, we may keep the tungsten wire hot during its manipulation by the passage of current through it or through the mandrel, or we may utilise a heating coil on the mandrel. If desired, a shallow screw thread may be cut in the mandrel to secure uniformity of pitch in the winding. The elasticity of the finished spiral is sufficient to obviate any difficulty in removing the spiral from the mandrel. As another industrial application of our invention, we may mention the method which consists in winding the tungsten filaments on a spider, similar, for instance, to those used in tantalum lamps, while maintaining the tungsten in a ductile condition by the continuous passage of current through it, or in any other suitable way. We may even secure the desired ductility by merely heating the ends of the supporting spider while the filament is being bent around them. All these manipulations can be carried out while the tungsten is at a temperature lower than that at which it oxidises appreciably in the air.

The principle involved in the above simple manipulations can be applied to rolling or drawing and other complex manipulations, and bars or rods of coherent tungsten can be worked down into filaments without cracks and without flaws, and without appreciable discolouration. Warmed tungsten seems very much softer than many materials which are now successfully drawn through diamond dies. To produce drawn lamp filaments of tungsten, we may first make a well-sintered rod of tungsten, say, one-quarter inch in diameter, by use of the cadmium amalgam or other suitable consolidating process. This rod may then be passed between hot-grooved steel rolls until the diameter has been brought down to one-sixteenth inch, and from then on it may be drawn hot through a series of dies, such as diamond dies. The tungsten piece should be kept up to the temperature at which it is ductile, as by heating the rolls and dies, and also the reels on which the wire is wound; the temperature should, however, be kept lower than that at which tungsten oxidises appreciably in air. The advantages of rolling and drawing tungsten bodies are numerous. The original characteristics of the metal, as its fineness, crystalline conditions, &c., become matters of minor importance, as with sufficient working these characteristics largely disappear. By rolling long lengths of filamentary conductors from a single stick of tungsten, the filaments are of great uniformity, and are obtained without the trouble of individual treatment or handling. The consolidation of the material in the rolls and in the drawing plates no doubt renders the wire stronger than tungsten not so treated, and therefore better adapted to stand shipment and rough handling.

The above method of working the conductors is also employed for connecting lamp filaments with their leading-in-wires, thus avoiding the use of any foreign materials, such as cements and pastes, to form welded joints which might possibly contaminate the filament or spoil the lamp vacuum. To mount coherent filaments of tungsten in a lamp, a central pedestal of glass is provided, carrying a number of copper or nickel wires, bent to form radial arms and having sockets at their outer ends for engagement with twisted wire loops of tantalum. The filaments may be supported by these tantalum loops, and may be symmetrically disposed about the central pedestal. The leading-in conductors at the base of the lamp may be of nickel or platinum, and each provided at its end with a loop or spiral forming a socket for the lower end of the filament. To complete the joint between the filament and the leading-in conductor, we squeeze the joint with a heated body as between the jaws of a pair of heated pliers. We find that the heat of the pliers will soften the tungsten and render it ductile and pliant, and that by squeezing the joint we can distort the filament and can press the platinum or nickel wire into intimate contact therewith. The pliers need not be very hot, and, in fact, should preferably be at about visible redness. At such low temperatures the tungsten filament does not oxidise, and is not injured by the operation. Even if the pliers be hotter and the tungsten be oxidised superficially, the product is still serviceable. As soon as the joint cools, the tungsten resumes its non-ductile and brittle character. It retains permanently its distorted shape, and the joint is entirely free from vaporisable material.

In a simple form of apparatus, suitable for carrying out a modified method of shaping tungsten conductors, two metal plates are arranged in a vertical position and serve as guides for a metal block, movable vertically between the plates, and having a projecting portion cut to form a sinuous curve meshing with a similar curve in the top of one of the plates. These two curved surfaces serve as jaws, between which a tungsten filament can be shaped to correspond with the curve of the block. The movable block may be provided at the top with a handle, and it may rest on a flat spring. This block is preferably made of metal or other good heat-conducting material, and may be heated or warmed electrically or by a gas flame. In carrying out the bending or shaping operation, we lift the block and insert a non-ductile tungsten wire between the curved surfaces of the blocks, and then depress the movable block, thereby bending the wire to conform with the curved surfaces. We find that the heat imparted to the tungsten by the blocks is sufficient to change it over from the non-ductile condition to such ductile condition that the tungsten bends instead of breaking. When the tungsten wire is released from the jaws and cooled, it is found to have taken a permanent set conforming to the shape of the jaws, otherwise it is the same as before treatment. By proper regulation of the heating flame, the tungsten wire will come out without discolouration, or other evidences of oxidation, but for some purposes a little oxidation does no harm and need not be vigorously guarded against.

We have found that the peculiar characteristics of tungsten above mentioned are common to molybdenum, and that the latter, though non-ductile when cold, can be manipulated when warm, and even at a temperature below that at which appreciable oxidation occurs.

The following two claims are appended to the specification:—

(1) In the manipulation of refractory metallic conductors of tungsten, or the like, heating the material in the open air to a temperature below visible redness to render it ductile.

(2) The method of manipulating refractory metallic conductors of tungsten, or the like, which consists in winding the conductor on a heater mandrel, or shaping it between heated metal blocks in the open air, the temperature of the mandrel or blocks being such as to raise the temperature of the material to a point below visible redness or below the point at which the material oxidises.

The long filaments which are necessary for high voltage metallic filament lamps, and the consequent inability of the manufacturer to produce lamps of moderate candle-power for the usual pressures, is due to the high conductivity of the refractory metals used for the filaments. Attempts have been made from time to time to increase the resistance of such metal filaments by the addition of some of the high resistance and refractory oxides, such as oxides of zirconium, thorium, and cerium. These oxides, however, were found to be unsuitable for this purpose, as in time the oxides are decomposed as a result of the high temperature, the vacuum is impaired, and the filaments rapidly fall to pieces. Another objection to the addition of these oxides was that the temperature coefficient of such a filament loses its positive character and becomes negative. As a result of much research in this direction, the Allgemeine Elektricitäts Gesellschaft have found that if oxides of yttrium, ytterbium, and certain other rare metallic earths having high atomic weights and high affinity for oxygen are added to the filament, the resistance is considerably increased, the vacuum is not impaired, and the life of the filament is not decreased. According to the Patent Specification No. 8,841 of 1907 by the above company, ytterbium oxide has been found most suitable for this purpose. The metallic tungsten or the tungsten oxide powder is mixed with about 20 per cent. ytterbium oxide, and the mixture made into a paste with a suitable binder. The filaments made from this paste are heated to a high temperature in a reducing atmosphere, until the tungsten oxide is reduced, the binder vaporised, and the filaments have become hard. When a filament prepared in this way is placed in an evacuated bulb and heated to a very high temperature, the bulb remains quite cold, a proof that gases are not given off by decomposition.

The German Institution of Electrical Engineers.—The yearly conference of this institution, the Verband Deutscher Elektrotechniker, will be held in Erfurt next month. The following are some of the Papers which are to be read and discussed:—"New Developments in Electric Lighting," by Prof. W. Wedding; "The Influence of Pressure Variation on the Life of Metallic Filament Lamps," and "A Comparison of the Working Costs of Small Arc Lamps and Large Osram Lamps," by J. Remané; "The Heating of Electrical Machinery," by Dr. R. Goldschmidt. Five Papers by different authors refer to pressure-rise phenomena and protective devices, and there are others on miscellaneous subjects, making a total of fourteen in all.

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METALLIC FILAMENT LAMPS FOR STREET LIGHTING

IN connection with the figures for life tests and costs of Osram lamps for street lighting, founded on experience at Derby and Harrogate respectively, given on page 703 of our last issue, we have received communications from several engineers of undertakings where metallic filament lamps are in use for street lighting, extracts of some of which will be found of some interest.

Mr. J. B. Morgan, Electrical Engineer to the Horsham Urban District Council, on whose system all the side street lighting is carried out by tantalum lamps, reports some trouble before proper precautions were taken as to pairing the lamps in series, but is now obtaining excellent results. He writes as follows:—

The first experiments were very successful, and the life averaged well over 1,000 hours, some lamps running 2,000 hours, the pressure of supply being five volts below the marked voltage of the lamp. When we adapted the whole of the streets to tantalum lamps, we had very bad luck, and the life results were very poor, and I quite believe that this was due to insufficient care being exercised in grading the lamps for voltage, as I found on testing a batch of 50 lamps all marked for series burning, that the current varied considerably, the lowest reading being 0·295 amps. and the highest being 0·395. This discovery prompted me to test every lamp and pair them. We also found that two 115-volt lamps, burning on 230 volts, only averaged about 600 hours, notwithstanding our pilot-recording voltmeters show a very steady line, and so we use two 120-volt lamps in series on the more important streets, and two 125-volt lamps in series on the more out-of-the-way side streets. The lower candle-power of the three lamps is not noticeable, and we are now obtaining an average life of 1,100 hours. When a lamp does fail we remove its fellow lamp and re-test it for current, and use it again with another partly used lamp in the summer time, when the burning hours are short.

We had many complaints from our consumers owing to very short life, until we adopted this pairing from all the local wiring contractors' lamps. With regard to costs of street lighting compared with gas, it is hard to say how it works out, as our district is growing so fast that we are continually putting new posts up, and the gas lighting was so shockingly poor. The gas lamps were charged on a basis of 5 ft. per hour, flat-flame burners for 1,900 hours per annum, price 4s. 2d. per 1,000 cubic feet; this worked out at 39s. 7d. for gas per annum, plus 13s. for lighting and cleaning, or £2 12s. 7d. per post for a very miserable light, as the pressure was so low as to only allow about 4 ft. of gas to pass, and the candle-power per post was never more than 13. We have two 25-c.p. tantalums, and on our voltage we obtain about 40 c.p. per post, taking 76 watts per hour, or 144 units per post per annum, at 4d. per unit, or £2 8s. for current plus the lamp maintenance, say 8s., or a total of £2 16s., and, as the lighting is all done from the works, there is only the cost of cleaning, so that the comparison is practically £2 12s. 7d. for gas with about 13 c.p. (mantles were tried, but given up), against £2 18s. for electric light with 36-40 c.p.

On the system of the Bray Urban District Council (Ireland), some 50 posts have already been fitted with Osram 35-watt lamps, replacing 60-watt carbon lamps, and Mr. W. J. U. Sowter reports that the consequent increase in the illumination has been very favourably commented on, and has doubtless led to a considerable increase of business. Mr. Sowter has not used a sufficient number of these lamps to obtain a reliable average life figure, but says that many lamps which have been running well over 2,000 hours are still unblackened. With regard to Mr. Wilkinson's remarks last week Mr. Sowter writes as follows:—

I am particularly interested in Mr. Wilkinson's remarks regarding the life of these lamps when enclosed in an outer globe, as my experience is exactly the reverse of his. I find that an Osram lamp protected by an outer globe *lasts very much longer*. I should very much like to have other engineers' opinions as to whether these lamps should, in order to ensure immunity from breakage, be fitted to a rigid lamp-holder, or whether the lamp-holder should be allowed a certain amount of play. I find that many breakages of filaments occur in pillars where the lamp-holder is not rigid, due to movement of the lamps in windy weather, but, on the other hand, other engineers with whom I have discussed the matter inform me that their experience is the reverse of mine in that respect.

Mr. W. A. Walker, Engineer to the Kettering Urban District Council, writes as follows:—

I am afraid I have not much data that I can give you at the present time, but from my experience so far, especially with Osram lamps, this has been very favourable. I have, at the present time, sixty 32-c.p. Osram lamps on street lighting, and most of these have been connected since last July, and all of them were connected by the end of last September, and only two renewals have been required, so that the burning hours in most of these lamps are over 2,000, which I think you will agree is a splendid result. These seem to me very suitable for street lighting, as vibration does not seem to affect them much. As regards consumption, our battery discharge is now only about half what it was a year ago. We were at that time using 32-c.p. carbon filament lamps, and I am now using two 120-volt lamps in series on a 230-volt circuit.

Osram lamps are now being adopted exclusively for street lighting at Sutton Coldfield, but it is not yet possible to give very full particulars as to life and costs. Mr. W. Duesbury (Electrical Engineer to the Corporation) states that, exclusive of the few lamps that have failed in the first few hours and which have been replaced by the makers, the average life has been fully 1,000 hours. With regard to the preliminary experiments and the question of series running, Mr. Duesbury writes as follows:—

We have had about 60 posts fitted with two 30-c.p., 35-watt, 120-volt "Osram" lamps, burning in series on 230 volts for the past six months for a street-lighting test, and as a result of this test we have now decided to use "Osram" lamps throughout for our street lighting, exclusive of arc lamps. The arrangement outlined above will be continued, with the exception of important corners, where the complete extinction of the lamps owing to the failure of one of the two series lamps would be a serious matter, where we are installing two 50-c.p. 240-volt lamps. We are inclined to believe that the success which we have attained has been due to the fact that one series number only is used throughout the street lighting for the series running, and that the lamps are handled by what is to a certain extent skilled labour.

The experience of Mr. A. J. Abraham (Electrical Engineer to the Lanark County Council) at Cambuslang has not been quite as satisfactory as at some other places. Some 500 tantalum lamps are in use, and run two in series on a 250-volt circuit. Mr. Abraham complains that the average life of these lamps during 1907 was considerably lower than in 1906, which he attributes to ill-luck in having met with a batch of lamps not quite up to the standard. Now that the lamps are manufactured in such enormous numbers, a certain amount of variation is, of course, unavoidable, but we are inclined to think that Mr. Abraham's trouble could be avoided to a great extent by precautions as to pairing, to the success of which we have alluded in another case.

Metallic filament lamps have been used for street lighting for about six months at Yarmouth, but actual figures of costs are not yet available. Mr. G. Bryant (Borough Electrical Engineer), however, writes as follows:—

I have, of course, gone into the matter fully in estimates and quoted the Corporation Street Lighting Committee as follows:—To supply cable, posts, fittings, &c., with two lamps of 32 c.p. to each post, to be burning 3,400 hours per annum, at £3 5s. per lamp. This was against previous prices from the local gas companies of about £3 10s. for incandescent gas fittings. I need hardly say that an order for about 100 lamps (most of which were to be changed over from gas) was immediately given, and wherever possible new lamps are to be electrically lighted. The Electricity Committee has decided to pay for all extensions needed for public lighting from surplus revenue rather than raise a special loan for the purpose. The lamps that have been fixed are giving every satisfaction both to the Lighting Committee and the residents of the districts affected.

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THE MANUFACTURE OF ELECTRICAL CONDENSERS FOR TELEGRAPHY AND TELEPHONY

MR. G. F. MANSBRIDGE, in a Paper on the above subject, read before the Institution of Electrical Engineers in London last Thursday, explained that until about 1888 practically the whole of the supplies were for telegraph-work, but since then the situation has been entirely changed by the great development of the telephone service of the world, and particularly of the common-battery system in which condensers play a modest but important *rôle*. The magnitude of the present demand may be gauged from the fact that the aggregate output of condensers in Europe and America during 1907 is estimated at the once-inconceivable capacity of 5 farads.

With manufacture established on this scale, economy in production is imperative, and the skilled hand of the 'nineties, who laboriously assembled or "built" his 1 or 2 microfarads per day, has given place to the machine hand who, with less physical distress, readily turns out one hundred times that quantity per diem. As a result, condensers equal in quality to those produced ten years ago can now be purchased at approximately one-tenth the price, and it now pays to employ condensers for many services from which they were previously shut out by their high cost. Many of the data in the Paper are gleaned from the records of the Post Office factory at Mount Pleasant, Clerkenwell, E.C., and for permission to publish these the author acknowledges his indebtedness to Mr. J. W. Willmot, I.S.O., the Controller of the Factories' Department of the Post Office.

Mica Condensers.—On account of the very high cost of mica sheet suitable for the work, condensers of this form are but little used. Mica condensers, when well made, retain their capacity and insulation better than those made of paper, and they have also a higher dielectric strength for the same thickness, but the cost per microfarad is approximately ten times greater than that of paper condensers. Fortunately, the inductive capacity of mica is high (about twice that of paraffined paper), or the labour cost would be excessive, since the size of the sheets is limited to about 4 in. by 3 in., the cost of larger sheets of uniform thickness being prohibitive. A good working thickness is 0·0015 to 0·002 in., and if the material is carefully selected there is no necessity, for ordinary purposes, to use more than one sheet between consecutive foils. For purposes where mechanical strength in the condenser plate itself is of special advantage mica is very satisfactory, and for standards it is unrivalled.

To obtain constant capacity with efflux of time, it is necessary that the mica and tinfoil sheets be perfectly flat and free from inequalities, so that they will build up under pressure into a solid mass without flexure or mechanical strain; it is also necessary that in assembling the sheets all air-bubbles be excluded. Dr. Alexander Muirhead * discovered that mica sheets have a positive temperature coefficient if coated with shellac, and a negative temperature coefficient if coated with paraffin. By building a condenser in two sections, one treated with shellac and one with paraffin wax, the variation of capacity within ordinary limits of temperature can thus be brought practically to vanishing-point. To obtain high insulation and low absorption, it is necessary to use only selected sheets of the finest clear "ruby" mica, which must be uniform in thickness throughout the sheet, and free from cracks, veins, or flaws; spotted or "speckled" mica is useless for the purpose.† The shellac employed should be the finest button lac dissolved in absolute alcohol and carefully strained until perfectly free from suspended matter. The building up or assembling of the sheets of foil and mica may conveniently be done on a "hot plate," the greatest care being taken to exclude air-bubbles, grit, or excess of paraffin or shellac. The desiccation should be slow but thorough, and the temperature should not exceed 212° Fahr. The finished condenser should be carefully and not excessively pressed, and should be allowed to cool under pressure in the ordinary way.

Glass Condensers.—The requirements of wireless telegraphy and X-ray work have latterly increased the importance of apparatus of this character. As is well known to wireless workers, Leyden jars, like other condensers, are prone to fail in use if at any point there is imperfect contact between the conductor and the dielectric, and to avoid this difficulty the best plan is to silverplate the glass. This may be done by precipitating metallic silver on to the glass in the form of a bright continuous film by the well-known method employed for silvering galvanometer mirrors, &c. The solution generally used is nitrate of silver which has been treated with ammonia until the precipitate first formed has been completely re-dissolved. The surface of the glass must be cleaned with the most scrupulous care before plating is attempted, or an imperfect coating will result. The silver coating should then be mechanically strengthened by a protecting layer of varnish, or it may be over-plated with copper. An important development of this silver-plated Leyden jar is to be found in the Moscicki high-tension condenser recently placed on the market.* In the author's opinion this condenser represents the most satisfactory and practical high-tension condenser for commercial work which has been introduced up to the present. Excessive strains are avoided at the point of high dielectric stress (the edges) by suitably thickening the dielectric at this point, and the effects of local heating are minimised by water-cooling. In view of the large number of stations working with a power factor ranging about 0·75, and of the advantages to be gained by improving this power factor, the author suggested that the question of installing a battery of modern glass condensers at such stations is worthy of more than passing consideration.

Condensers with Paper or other Fibrous Dielectrics.—The standard practice up to the last decade was to use separate sheets of tissue paper and separate sheets of thin metallic foil, and the method employed was to dry the paper by heat, then to transfer it to a bath of hot paraffin wax, and after due soaking to build up the condenser on a "hot plate," the paper being taken sheet by sheet from the bath of hot wax. At least two sheets of paper were used between consecutive foils, the alternate foils being bunched into two books in the well-known way. A good working thickness of paper was 0·001 in. The metal foil was usually of tin, the thickness being about 0·0003 in. This method of building condenser plates was slow and expensive, and it had the further disadvantage that as the workmen who handled the material were exposed to a high temperature, the risk of contamination of the wax by emanations from the body was great; indeed, the difficulty was such a serious one that in London it often became necessary to cease manufacture during the summer months. Even in cooler weather it was necessary to select workmen who were not prone to perspire freely, as only such men could be depended upon to produce condensers with satisfactory and permanent insulation. In consequence of this difficulty, the author found it of advantage to build up the condenser plates "dry" in a separate room and to desiccate and impregnate the condensers as a subsequent operation. The slow process of assembling the sheets one by one and of handling about 250 separate pieces to make up a 1-microfarad plate had, however, still to be reckoned with, and the percentage of failures through short circuit or low insulation was considerable, so that the labour cost remained an important factor.

The next step was in the direction of bringing down this high labour cost by reducing the number of pieces to be handled. The method adopted was to wind up into the form of a roll long strips of metal foil, two strips of paper being interposed between each foil—that is, six strips in all. This method, which was introduced to the Post Office by Sir John Gavey in 1899, had, however, difficulties of its own. Pure tin foil of the requisite thinness could not at that time be obtained in strips longer than a few feet, and the alternatives were: (1) to feed between the rolls of paper a series of strips of pure tin foil some 4 ft. long, each strip overlapping its predecessor by an inch or two so as to maintain continuity; or (2) to use an alloy of lead and tin which could be obtained in continuous lengths. The former was an awkward and unmechanical arrangement, and the latter had the disadvantage of producing a heavy and bulky condenser. Both methods also involved a considerable proportion—rarely less than 10 or 15 per cent.—of short circuits in the finished plates brought about by grit in the foil or by defects in the paper. In endeavouring to overcome these difficulties, the author hit upon the idea of using metallised or "foiled" paper of the same character as that sometimes employed for wrapping up packages of tea, &c. Experiments showed that commercial "tin-foiled paper" as then made was not sufficiently reliable as an electrical conductor for the purpose, but after careful investigation, the difficulties in the way of producing a thoroughly reliable conducting surface on such paper were found to be insurmountable.† For assistance in carrying this part of the work to a successful issue, the author expresses his indebtedness to Messrs. Olive & Partington, Ltd., of Upper Thames Street, London, who were the first to produce foiled paper for electrical purposes on a commercial scale. As soon as supplies of good electrical foiled paper became available the manufacture of condensers on this principle was taken up by the Post Office, and subsequently by various commercial firms, under licence from the patentee.

* U.K. Patent 15337, 1891, A. Muirhead.

† An interesting memorandum on mica has recently been published by the United States Department of the Interior.

* See *Electrical Engineering*, Vol. I, p. 565, and Vol. II, p. 57.

† U.K. Patent 19451, 1900, G. F. Mansbridge.

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The ingot tin—previously granulated or "feathered"—is dissolved in nitrohydrochloric acid, and after all scum and insoluble matter have been removed, the solution is diluted and the tin is carefully precipitated by metallic zinc, or by the action of a weak electric current. For the best results the most minute subdivision of the tin is essential, since only the thinnest layer of metal is desired, and unless this layer is uniform metal will be wasted or imperfect continuity will result. After precipitation the powder is repeatedly washed to free it from all traces of acid, and is sifted through sieves of the most minute mesh so as to eliminate all large particles of tin or any grit. A suitable adhesive such as size is added, and the tin mud is then passed to the coating machines. These are provided with mechanical stirrers to prevent the metal settling, and with rotating brushes and spreaders to distribute the metal evenly over the surface of the paper as the latter passes through the machine. In some machines the paper is passed over heated cylinders so as to dry the coated surface quickly, but as this is liable to reduce the efficiency of the adhesive it is preferable that paper for electrical purposes should be dried more slowly—for instance, by exposure to currents of warm air. The paper then passes to the burnishing rolls which consist of heated heavy steel calenders or friction rollers between which the paper is fed. These friction rollers compress the dull magma of tin powder into a coherent thin film having the lustre of the polished metal. During this process any comparatively large crystals of tin or particles of grit which may have escaped untrapped will be driven partly or wholly through the paper, but the effect of this is eliminated by the subsequent electrical treatment. The paper is now passed to the slitting machines where it is trimmed and cut to any desired width.

It is interesting to note that prior to the calendering process referred to, the film of tin powder is non-conducting, but in properly calendered foiled paper, with a fairly heavy coating, the conductivity of the coating may be as much as 50 per cent. of that of a continuous strip of pure tin of equivalent weight. On the foiled paper as usually made for condensers, the quantity of tin averages 25 grains to the square foot, and the conductivity is about 25 per cent. of that of pure tin, the resistance of a strip 1 ft. wide averaging 0·3 ohm per foot run, that is, 0·3 ohm per foot square or per metre square. This density of coating gives a surface of 280 sq. ft. to the pound of tin, or say, 57 sq. metres per kilogramme of tin. The average thickness of the tin film is therefore as nearly as possible 0·0001 of an inch, or say, 0·0025 millimetre. Seeing that the material is semi-transparent, the current-carrying capacity of this film is surprisingly high, the fusing current in air being rather more than 1 ampere per inch of width for the standard coating of 25 grains per square foot; this is assuming that the paper has not been creased. Bending the paper round even a very small radius does not affect the continuity, but if the paper be very closely folded back on itself so as to put the film sharply in tension or compression, the fusing current is correspondingly lower. By using a greater density of coating, say, 40 grains per square foot, the effect of creasing is greatly diminished, but there is no necessity for this higher density in condenser work since the creases in the rolled condenser even at the centre of the roll are not very sharp.

Continuous reels of electrically-conducting foiled paper being available, all that is necessary is to roll up together two strips of foiled paper, interleaved with two strips of plain paper.

The foiled papers may be placed with their metallic sides facing each other, but separated by the two plain papers, in which case the two body papers form the dielectric on the opposite side, or, alternatively, the papers may be arranged so that the dielectric on each side is made up of one body paper and one plain paper. The latter plan is preferable, as it gives a more even distribution of the dielectric strain. Interleaving paper is invariably used for telegraph or telephone condensers, since the insulation, otherwise obtainable, is but a few megohms. The machine usually employed for the rolling operation accommodates two reels of plain and two reels of foiled paper, and is provided with a set of interchangeable winding mandrels of various diameters. The winding of the strips on to the mandrel is usually done by hand if the number of turns per condenser is small, but in some instances more than a hundred turns have to be wound on, and the mandrel may then be power driven with advantage, but in this case a mechanical counter becomes essential. The placing of the strips in position and the starting must be done by hand, and this also applies to the insertion of the connecting lugs, which should be strips of annealed copper foil, about 0·001 in. thick and $\frac{3}{8}$ or $\frac{1}{2}$ in. wide. These strips are simply slipped into place between the foiled surface and the interleaving paper, and are so light that they readily retain their position; they should make contact with the foiled surface over practically its full width and should protrude about 1 in., so as to serve subsequently as a soldering point for the wire connection. The two lugs should be placed at the middle of the foiled strips rather than at the beginning or end, so as to avoid interposing any appreciable resistance into the condenser circuit. This plan has the additional advantage that thereby the innermost layers, which possibly may have been rather sharply creased, are not called upon to transmit any considerable current on charge or discharge.

From first principles it would be expected that the capacity would be directly proportional to the area of the electrodes, but in practice it is found that, within limits, plates of high capacity require appreciably less area per microfarad than those of low capacity. This is particularly the case where the thickness of the plate is small in comparison with its length and breadth. There is therefore a saving in material as well as in labour by building the plates in as large units as possible. Further, it is found that plates built with narrow foiled paper require less material per microfarad than those built with wide paper. This effect is doubtless due to the wider paper offering greater facilities for trapping the paraffin instead of allowing it to be pressed out. The two effects taken together indicate that a condenser in the form of a cube would require less material than one in any other shape. The cube is, however, not the most suitable shape for manufacture, and as the conditions of service are often such as to demand the adoption of thin, flat plates, the usual compromise has resulted. The capacity most in demand for telephone work is 2 microfarads, and as plates of this size form a convenient manufacturing unit, they are usually taken as the basis on which to frame standard data for manufacturing purposes. Condensers of larger capacity are almost invariably built up by assembling standard units. The usual sizes of paper at present in use are: for interleaving paper, $7\frac{1}{8}$ or 4 in. wide by $\frac{1}{2}$ mil thick giving about 400 sq. ft. to the pound; for foiled paper, $6\frac{3}{8}$ or $3\frac{1}{2}$ in. wide by $1\frac{1}{4}$ mils. thick, giving 100 sq. ft. of conducting surface to the pound, and consisting of 35 per cent. tin and 65 per cent. paper.

At one time an unfoiled margin was left on each side of the foiled strip, but since the introduction of the "breakdown process" subsequently referred to, this has been found unnecessary. With $1\frac{1}{4}$-mil foiled paper and $\frac{1}{2}$-mil interleaving paper, the area required for a 2-microfarad plate is about $12\frac{1}{2}$ sq. ft. for each electrode. The volume of the plate after waxing and pressing is approximately $7\frac{1}{2}$ cub. in., and the weight 7 oz. The insulation between the electrodes taken at 60° Fahr. with 400 volts after one minute's electrification, usually lies between 1,000 and 2,000 megohms per microfarad.* Any lower insulation than 1,000 megohms per microfarad is an indication of imperfect desiccation, excessive pressure, or faulty material.

It should be noted that the specific insulation of foiled paper is lower than that of plain paper, the difference being due chiefly to the fact that the former is heavily sized. When condensers of extremely high insulation are demanded for special purposes, it is possible to obtain an insulation of nearly 20,000 megohms per microfarad (400 volts, 60° Fahr., 60 seconds). Such condensers are invariably built up of sheets rather than by the rolling process, and metallic foil may be used in preference to foiled paper. Three sheets of paper are usually interleaved between consecutive foils. Increasing the number of interleaving papers, while increasing the actual insulation of the plate, does not increase the "megohms per microfarad" since the capacity falls in proportion to the rise of insulation.

For certain purposes, such as absorbing the spark across the break of sparking coils, leaky condensers, that is, condensers with specially low insulation, are of advantage. The low insulation necessary may conveniently be obtained by rolling up foiled paper without any interleaving paper, the plate being in other respects treated in the ordinary way. An important detail in the manufacture of condensers for spark suppression is that there must be no appreciable resistance in the condenser circuit, that is, in the electrodes or thin connections. The insertion of even 1 ohm in series with the condenser of a high-frequency spark coil markedly increases the sparking at the primary contacts.

Even with foiled paper, although the quantity of metal per unit area is extremely small, the conductance of the electrodes is in excess of the actual requirements, whilst if solid foil is employed, it is necessary to use fully ten times the weight and volume of metal that would suffice if only the conductance had to be considered. The necessity arises from the fact that metal foil cannot be rolled in continuous lengths to give a greater covering surface than about 90 sq. ft. per pound (about $18\frac{1}{2}$ sq. metres per kilogramme), and even with this thickness the foil is extremely tender and requires delicate handling, as, if made of pure tin, it is only 0·0003 in. thick. The metal foil is in addition expensive, and is by far the most costly item in the construction of a condenser. Further, when metallic foil is used, short circuits are very apt to develop both during manufacture and in subsequent use. The short circuits are due to grit in the foil, or to pinholes or other defects in the interleaving paper, or are consequent upon disruptive discharges caused by the application of a voltage in excess of the dielectric strength.

Now with respect to these short circuits or disruptive discharges, however produced, condensers made of foiled paper have the peculiar advantage of possessing to an almost perfect degree the property which in a pneumatic tyre is called self-sealing, and consequently they are practically proof against short circuit, and can be subjected to much higher voltages than is permissible with those made from metallic foil. Owing to the extreme thinness of the conducting film, the small quantity

* The expression "megohms per microfarad," though incorrect, is so generally employed that the custom has been followed throughout this paper; the phrase should, however, invariably be interpreted as "megohm-microfarads."

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of heat generated at the point of short circuit by the sudden discharge of the condenser through that point is sufficient to cause the film of metal immediately surrounding the point of breakdown to be fused into minute globules. The segregation of these globules from each other and from the surrounding metallised surfaces effectually isolates the point of breakdown, and the defect is instantaneously sealed up. So rapid, indeed, is this effect, that if a pin is stuck into an insulated charged condenser so as to produce short circuits between the foiled papers, the short circuits seal up without fully discharging the condenser, and a dozen or more of such short circuits may be created one after the other before the condenser becomes fully discharged. Consequent upon the observation of such an effect as this, the author conceived the idea of electrically treating the foiled paper before making it up into condensers in such a way as practically to eliminate all pinholes or defective places by subjecting them momentarily to currents of such strength as to produce a minute non-conducting ring round each defect, thereby isolating it from the surrounding surface.* All that is necessary is to pass the paper, foiled side uppermost, over a conducting roller, and to maintain a suitable potential difference between the roller and the foiled surface. When any pinhole or weak place in the paper reaches the roller a short circuit occurs, and the effect of the spark is to isolate the defect by volatilising or fusing the film of metal immediately around it. In this way all the weak places in the dielectric are detected and isolated before the paper is brought into use, and in consequence it is possible to use thinner paper, both foiled and plain, than would otherwise be safe. If current from lighting mains is employed a series resistance is necessary to limit the short-circuit current. With 100 volts this resistance should be about 15 ohms, and with 200 volts about 150 ohms. Experience shows that the searching effect of the voltage is increased by connecting a condenser of considerable capacity, say 20 microfarads, across the potential terminals, but a series resistance of about 50 ohms in the condenser circuit is needed to tone down the suddenness of the condenser discharge. The values given above for voltage, capacity, and resistance are in no sense "critical," and they may be varied considerably; the result desired is the production of a small uncharred hole surrounded by a minute ring of

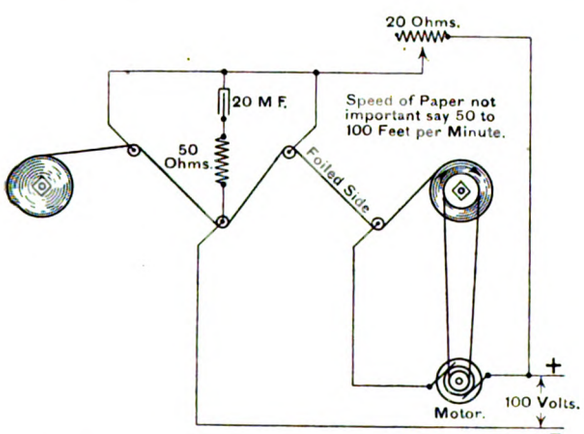


Fig. 1.—Device for Treating Tinfoil Paper.

perfectly clean white paper. The author's experience is, however, that the majority of defects are shown up and removed by a comparatively low voltage, and that there is little to be gained by using more than 200 volts for this process if the condensers are for telephone or telegraph work. As regards the direction of the current there appears to be little to choose; if anything the preference may be given to connecting the positive pole to the plain side of the paper, but the device works quite satisfactorily with alternating current. When the breakdown device is driven by an electric motor it is of advantage to have two rollers making contact with the foiled side of the paper at separate points, preferably not less than 2 ft. apart; the current driving the motor may then be led along this strip of foiled paper between the two rollers, so that should there be any break in continuity in the foiled surface the current driving the motor would be broken when the fault passed the first roller, and the stopping of the machine would call attention to the want of continuity. Fig. 1 shows the connections of the breakdown rollers as arranged for motor driving. If the apparatus is mechanically driven, a suitable relay may be connected between the second and fourth rollers so that a local circuit is completed and a bell rung whenever there is any break of continuity between the two rollers.

Joints in the paper may have to be made from time to time.

* U. K. Patent 22139, 1905, G. F. Mansbridge.

A simple way of making them electrically continuous is, after the ends have been joined by lapping and pasting in the ordinary way, to paste on to the foiled surface a 6-in. strip of foiled paper placed face downwards, so that part of the foiled surface of the strip makes contact with one side of the break and part with the other. It is not desirable to paste the whole of the surface of the strip since the continuity of the film may thereby be destroyed; the usual plan is to paste merely the edges on each side leaving the middle portion clean. Good flour paste is found to give satisfactory results.

The condenser plates having been wound then pass to the drying oven, and subsequently to the vacuum pans and screw-presses. Ovens heated by gas, steam, and electricity are in use for desiccations prior to waxing. Electrical ovens are preferable owing to the ease with which the temperature can be controlled, and the facility with which the heat can be kept to its legitimate purpose instead of being dissipated throughout the shop. For an oven of about 25 cub. ft. capacity which will accommodate five hundred 2-microfarad plates, a power consumption of 2 kw. suffices. The temperature permissible is limited by the necessity to avoid scorching the paper, since cellulose suffers adverse physical changes if heated much above 212° Fahr. for any considerable time. Consequently the practice at one time was to dry the condensers at a temperature of 212-220° Fahr., but this involved from three to four days stoving unless the plates were composed of only a very few sheets or layers, and were disposed in such a way that the heat could readily permeate, and the moisture readily leave, the innermost layers. This in commercial work is impracticable since some condensers of ordinary size have over 100 convolutions, that is 800 layers of paper in the flat roll, and a great many have to be accommodated in the oven at the same time. To expedite the drying process, the author tried the plan of utilising the resistance of the strip of foiled paper to generate heat in the interior of the condenser when a current of suitable strength was passed along it. It was found in this way, that with an oven temperature of 212° Fahr., and an additional expenditure of 4 watts per 2-microfarad plate, thorough desiccation could be effected in 8 to 12 hours, without any scorching of the paper, although the temperature inside the rolled condenser reached 270° Fahr. Although fairly simple in manipulation, this method did not lend itself very readily to commercial manufacture on the large scale, but it eventually led to the use of a simple process which has been found most satisfactory and efficient, namely, the vigorous churning of the heated air inside the oven by means of a fan. The use of a fan in this way permits of temperatures as high as 290° or 300° Fahr. being employed without scorching the paper. It will be understood that the fan does not create a circulation of air from outside, but merely churns the hot air in the oven, and although after a time this air becomes more or less moisture-laden, the high temperature enables it to absorb an enormous weight of water before reaching saturation point. By running up the temperature in this way satisfactory desiccation can be obtained in as short a time as 8 hours.

One point calling for attention as regards the drying of condensers is the shrinkage in length which takes place with many papers during desiccation. In the case of plain paper newly come from the mill, this may amount to ½ per cent. after 24 hours' drying at 212° Fahr., and there is a further shrinkage on waxing. In the case of foiled paper, the shrinkage on drying is much less, and the whole of this occurs prior to waxing. If perfectly fresh and undried interleaving paper is wound up tightly with foiled paper and the compound roll is then dried and waxed, there will be a tendency for the great shrinkage of the interleaving paper to cause the foiled paper to crinkle or crease when pressed. To guard against this, the plain paper should either be matured for a few months in stock, by which time it will have shrunk considerably, or it should be oven-dried for some hours before use.

After being effectively desiccated the plates have to be impregnated with paraffin wax. The function of the paraffin is not only to increase the inductive capacity of the dielectric, and to prevent moisture from again reaching the highly hygroscopic paper, but also to retain the condenser in the closely compacted form into which it is compressed while the wax is hot. The inductive capacity of the layers of paper and air which separate the electrodes before the plate is impregnated is approximately 1·2, and on the air being replaced by paraffin this increases to approximately 3·2. Obviously the more thoroughly the air is replaced by the paraffin the greater will be the gain, and to facilitate this it is advantageous to impregnate the condensers *in vacuo*. As the result of tests of some batches aggregating a thousand plates, it was found that the gain in capacity due to impregnation under vacuum averaged 11 per cent. This means that 11 per cent. less material is required for a given capacity, while in addition the condenser produced is more reliable, since every isolated air-bubble tends to reduce the dielectric strength by causing unequal distribution of strain, and also tends, by expansion and contraction, to cause, in time, a drop in capacity by separating the layers, and a drop in insulation by affording an opportunity for moisture to enter the interior of the plate. An obvious way of impregnating *in vacuo* is to exhaust the air from the pan containing the condensers, and then after complete

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evacuation to run in the not paraffin; but equally good results can be obtained by plunging the plates into a pan of hot wax, fastening the lid, and then maintaining a vacuum in the upper portion of the pan. The advantage of the latter plan is as follows:—In order to facilitate the exhaustion it is necessary to heat the paper; this heat can most conveniently be conveyed into the inside layers of paper by means of the hot wax. If the exhaustion is carried out with the paper dry there is no vehicle to carry the heat into the interior of the condensers, and only radiated heat from the sides of the pan is effective since the air has been withdrawn; for other reasons also the plan of evacuating over the wax is found to have the balance of advantage. An illustration of a gas-heated vacuum pan was shown which would accommodate 150 2-microfarad plates per charge. To prevent deterioration of the paraffin by scorching, the bottom of the pan is made exceptionally thick, and several rows of

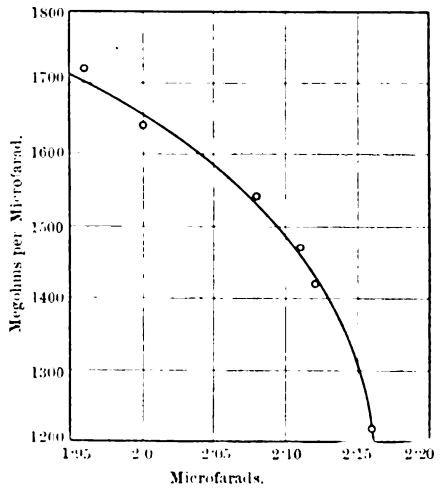


Fig. 2. Foiled Paper Condensers. Relation between Capacity and Insulation of similar Condensers, subjected to differing Degrees of Mechanical Pressure.

minute gas jets are provided so as to distribute the heat uniformly over the bottom. To facilitate the circulation of the hot wax the plates are not allowed to rest upon the pan itself, but are laid upon a loose metal grid which stands up an inch or so from the bottom of the pan. Two hours' impregnation at 212° Fahr. is sufficient if a thoroughly good vacuum is obtained. After full impregnation the vacuum is broken and the condensers are left subjected to atmospheric pressure for ten minutes, and are then removed from the hot wax and at once pressed. No advantage can be traced from the employment of more than atmospheric pressure in the pan after evacuation is complete.

The method of pressing and the manipulation at this stage are of considerable importance. In the first place it will be obvious that the greater the pressure, the greater, within limits, will be the capacity obtained, and with this object it is the practice in certain factories to employ hydraulic machinery and to compress the plates to the utmost limit. The objections to this course are, however, considerable. First, there is a great tendency to drive the paraffin out of the pores of the paper. Secondly, the enormous pressure greatly increases the liability to short circuits. Thirdly, the excessive pressure results in lowering the insulation to an extent which is out of proportion to the increased capacity. This effect, which is shown graphically in Fig. 2, necessarily follows from the reduction in the proportion of paraffin to paper, since the wax has much the higher specific insulation. A further objection to hydraulic pressing is that for commercial reasons it involves the simultaneous pressing of a vertical pile of plates, and this procedure is to be deprecated since the cooling of such a pile is necessarily slow, and the wax continues to drain out of the inner condensers to such an extent that when cold there is comparatively little left in them. As the result of experience, it can be said that for a condenser which is required to maintain its insulation and capacity for many years it is of first importance that a good body of wax be left in the plate. For this reason the pressing of even two plates one above the other is not permitted at the Post Office factory. The same objections do not apply to the pressing of a number of plates laid flat, and placed side by side on a water-cooled plate. This is the current practice, and it is found to give satisfactory results; the presses are water-cooled both on the top and on the bottom. With cooling water at a temperature not exceeding 60° Fahr., five minutes' cooling in the press suffices for a condenser ¼ in. thick; for plates of greater thickness a correspondingly longer time is necessary. Contrary to what might be expected, experience shows that more uniform results can be obtained with screw-presses than with levers and dead weights, and the latter form has consequently been altogether abandoned at the Post Office factory. Even the use of gauge-blocks for the screw-presses, by means of which the condensers are pressed to a certain definite thickness, seems to give less uniform results than can be obtained by a careful workman with a little practice, without any guide other than the "feel" of the press, and an occasional capacity test of the plates as they come from the presses. One objection to the gauge-blocks is that they do not allow for the small commercial variations which are constantly met with in condenser manufacture, and another is that they tend to reduce the operation of pressing, which is one that really requires some little skill and care, to the mere manipulation of a machine.

As soon as the plates are fairly cold they should be placed aside to settle down in temperature before being tested, and in the meantime they should be protected from atmospheric moisture; paraffin, contrary to the opinion of the layman, is markedly hygroscopic.

In addition to or in substitution of paraffin, various waxes and mixtures have from time to time been proposed for condenser work. Beeswax, resin, shellac, ceresine, stearine, lead stearate, &c., have all been suggested, but the author has been unable to find that any one of these substitutes possesses the all-round advantages of good paraffin. For condenser work a high quality of wax is necessary, but this does not necessarily imply a high price. For use in tropical countries paraffin of a specially high melting-point is desirable, but for use in the temperate zones wax with a melting-point of about 130° Fahr. answers most requirements. For condenser work the wax cannot be considered satisfactory unless it is chemically neutral and free from unsaturated hydrocarbons. Its suitability in this respect can readily be ascertained by the usual chemical tests. Before being run into the vacuum pan the wax should be strained through sieves of the finest mesh (a few thicknesses of muslin will answer very well) to remove mechanical impurities.

In all stages of condenser manufacture handling by the workmen should be restricted to a minimum, and no operative who is inclined to perspire freely should on any account be permitted to handle the plates prior to boxing. The ideal method of manufacture is to place the dried plates in metallic cases, to plunge the whole into the hot wax, then to exhaust the air, and finally to take out the condenser complete in its case so that the plate, after impregnation, suffers no handling whatever. The objections to this plan are that there is so little control over the capacity, and that there is such great waste of material, since the pressure which can be brought to bear is so small; the method can, however, be recommended where long life is of more importance than first cost.

Reference has already been made to the question of dielectric strength. As a rough approximation, it may be said that with ordinary paraffined paper at 60° Fahr. the breakdown-point is

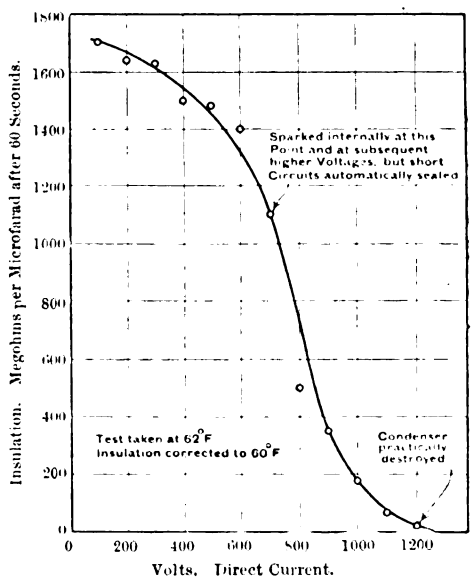


Fig. 3.—Foiled Paper Condensers. Curve showing Relation between Testing Voltage and Observed Insulation.

approached when the pressure reaches the equivalent of 150,000 volts per centimetre. With foiled paper, however, the result of the automatic sealing is practically to double the effective dielectric strength.

Fig. 3 shows graphically the results obtained on subjecting an ordinary telephone condenser, made from foiled paper, to steadily

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increasing pressure. As the voltage rose above the normal point of dielectric strength the paper broke down, possibly at several places, but each short circuit sealed up as fast as it was formed, and not until the pressure reached 1,200 volts was the condenser rendered useless.

For telegraph condensers, which are generally required to be adjustable, an outer wooden case carrying a plug-switch is provided; the internal construction is as follows:—Separate condensers of suitable capacity are selected, and after a preliminary test are assembled between a pair of sheet-iron plates, which are then bolted together. The object of these clamping plates is two-fold; first, to build up the separate condensers into a substantial mechanical structure; and, secondly, to keep upon them a certain degree of pressure so as to counteract the natural tendency towards a drop in capacity. The batch of plates so assembled is built up into a solid mass with plastic paraffin, and is then hermetically sealed in a tinned-iron case, the opening where the wires are brought out being sealed with a non-contracting mixture of gutta-percha, resin, stearine pitch, and Stockholm tar.*

This compound does not flow at high temperatures, does not get brittle when frozen, adheres firmly to metal surfaces, and contracts very little on cooling. The same mixture is used for sealing the top of the tin cases of telephone condensers, the metal cap which is subsequently soldered in position being merely a mechanical protection. On the Continent *papier-mâché* cases have been adopted to some extent, but their use cannot be recommended, since *papier-mâché* readily absorbs moisture.

In speaking of the insulation resistance of a condenser it is necessary to be most precise as to exactly what is meant. The insulation is usually expressed either in terms of the percentage loss of charge after the charged condenser has been insulated for a certain time or as so many megohms per microfarad. The "percentage-loss-of-charge" method is used chiefly for standards and for submarine cable condensers; for ordinary telegraph and telephone condensers the insulation is more often reckoned as "megohms-per-microfarad." Neither expression is a precise specification of the insulation value unless certain datum lines are assumed or stated. The first of these necessary data is the temperature at which the test is taken, the second is the value of the voltage applied, and the third is the time which is allowed to elapse between the first application of the voltage and the moment at which the leakage is measured. For the loss-of-charge method the periods of charge and of insulation have to be stipulated. The latter period is commonly taken as one minute, but the period of charge is not so well standardised, 15 seconds being taken by some observers and 60 seconds by others. The pressure often employed for this test is 100 volts. Of the scanty literature on this subject the most noteworthy seems to be that contained in an article† by Messrs. Dearlove and Sayers, who have given the results of some interesting experiments made by them on tinfoil and paper condensers as made for submarine telegraph work.

With respect to temperature, 60° Fahr. is in this country the standard generally accepted for tests made by both methods.

The voltage adopted for the "direct deflection" or megohms-per-microfarad method varies according to the nature of the duty demanded of the condenser. The period of application of the pressure in this case is usually two minutes; the leakage is measured at the 60th second after the moment of application, and the insulation is calculated on the basis of that moment's reading. During the whole period of the test the leakage should steadily decrease; and as a measure of this absorption or "electrification," it is usual to take the difference between the readings at the end of the 60th and the 120th second respectively, and to express this difference as a percentage of the reading at the 60th second. With a good condenser this percentage will usually fall between 25 and 35 if the test is taken at 60° Fahr. The degree of electrification falls markedly with a rise in temperature. The behaviour of a condenser in respect to electrification is an important indication of its quality, as incipient defects give the first indication of their existence by producing unsteady or "negative" electrification.

The correcting temperature coefficient for foiled-paper condensers is as nearly as possible 3·50 per cent. per degree Fahr., or $Y_{60} = Y_t\ 1{\cdot}035^{t-60}$, where Y_t and Y_{60} are respectively the observed insulation resistence at $t°$ Fahr. and the corrected insulation resistance at the standard temperature of 60° Fahr. This assumes that the insulation is measured after 60 seconds' application of a pressure of several hundred volts. It is not suggested that this formula has an accuracy which is comparable with that of a copper-resistance temperature coefficient, since the difficulties of measurement are so much greater in the former case, but it is thought that the formula will be found generally to give, over a considerable range of temperature on both sides of 60° Fahr., results sufficiently accurate for commercial purposes.

* The mixture consists of:—

Gutta-percha scrap	...	...	...	20	parts
Resin ...	...	...	...	14	,,
Stearine pitch	...	...	...	6	,,
Stockholm tar	...	...	...	14	,,

Commercial stearine pitch varies considerably in hardness, and if the mixture so made proves too hard it may be tempered by the addition of a little boiled linseed oil.

† *Electrical Engineering*, March 21, 1907, "Relative Dielectric Resistance at various Temperatures of Paraffined Paper Condensers."

From general considerations one may state the relation—

$$\Omega = \alpha \frac{s}{vt}$$

where—

Ω = megohms per microfarad.
s = seconds after application of voltage.
t = temperature in degrees Fahr.
v = applied voltage.

Analysis of a number of insulation and electrification curves shows that this expression may be thrown into a simple numerical form, and for foiled-paper condensers the following approximate empirical formula is obtained:—

$$\Omega = 400 \frac{s^{\cdot 5}}{v^{\cdot 1} \times 1{\cdot}035^{t-60}}$$

For metallic-foil condensers the expression becomes—

$$\Omega = 4{,}000 \frac{s^{\cdot 5}}{v^{\cdot 1} \times 1{\cdot}035^{t-60}}$$

These empirical formulæ are, of course, only applicable to thoroughly desiccated condensers properly constructed of good material.

Electrolytic Cells.—These have not been received with much favour in this country, but they were at one time used to a considerable extent in Germany for common battery telephone work. They have, however, been almost entirely discarded in favour of paraffined-paper condensers. The only advantage which these "polarisation cells" possess over condensers is with respect to size, a cell, or a set of cells capable of stemming back a direct current at 25 volts having a volume of only about 5 cub. in. On the other hand, the cost of such a set of cells is from three to four times that of a condenser of equal effectiveness. The cells used appear to be of three classes, viz.: "Acid cells," consisting of two small electrodes of platinum dipping into an acid solution; "sodium cells" (Natronzellen), in which the electrolyte is a solution of a sodium salt; and aluminium cells, in which the electrodes consist of aluminium, and the electrolyte is some kind of basic solution. The acid cells have a damming effect of about 1·8 volt each, the sodium cells about 2·7 volts, and the aluminium cells as much as 30 or more volts. It is probable that the polarisation cell would never have been developed as a practical device if the modern condenser had been available at a reasonable price in the early stages of telephone development. The disadvantage of the polarisation cell is that it is more or less leaky, both electrically and mechanically. The permanent polarisation current passing through each cell is small, but on a system of many thousand subscribers the aggregate leakage becomes considerable. The mechanical difficulty is, however, the more serious one. If the cells are hermetically sealed they are liable to burst owing to the gradual accumulation of gas, which has been known to cause pressures up to 20 atmospheres. To avoid this difficulty some forms are provided with a simple release valve. This is particularly necessary with aluminium cells, as these are of larger size and evolve a greater quantity of gas. It is, however, almost impracticable to prevent some leakage of the solution, and in all the circumstances it is not surprising that the chemical cell has been ousted by the static condenser.

An appendix to the Paper contains a set of specifications for condensers.

In Post Office wooden-cased condensers for telegraph purposes, the plates are to be secured between substantial iron clamps, and to be boxed up solid and air-tight with an approved insulating compound, the clamp being secured to the side of the case by means of suitable lugs and screws. The capacity of each section is to be not more than 5 per cent. higher or lower than the nominal value in the case of plates of 1 microfarad and above, and not more than 10 per cent. higher or lower in the case of capacities of less than 1 microfarad, and, in the case of signalling condensers, the difference between the two halves of the condenser is to be not more than 0·25 microfarad. The capacity of each section is to be measured by taking the instantaneous discharge after the section has been charged for a period of 10 seconds with an electromotive force of 50 volts. The tests for insulation and electrification are taken on the condenser as a whole, and not on the separate sections, and the tests are made with an E.M.F. of 400 volts as follows:—The condenser being at a temperature of approximately 60° Fahr., apply the battery for a period of two minutes. The deflection shown after one minute must indicate such an insulation resistance in megohms that when multiplied by the capacity in microfarads the products shall be not less than 1,000. The deflection shall steadily decrease during the second minute, and the difference between the readings at the beginning and end of the second minute shall be not less than 20 per cent. of the first minute reading for 1 microfarad and the larger sized condensers, and 10 per cent. of the first minute reading for condensers less than 1 microfarad.

The overall dimensions and weight of a complete metal-cased condenser for telephone purposes, including the outside soldering

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tags, is specified by the Post Office not to exceed the following, viz. :—

	Dimensions.	Weight.
For condensers 0·5 mfd.	$4\frac{3}{4}$ in. × $2\frac{5}{8}$ in. × $\frac{5}{8}$ in.	4 oz.
,, 1·0 ,, ...	$4\frac{3}{4}$ in. × $4\frac{3}{4}$ in. × $\frac{5}{8}$ in.	8 oz.
,, 2·0 ,, ...	$4\frac{3}{4}$ in. × $4\frac{3}{4}$ in. × $\frac{5}{8}$ in.	12 oz.
,, 2·0 ,, ...	$4\frac{3}{4}$ in. × $1\frac{3}{8}$ in. × $1\frac{3}{8}$ in.	10 oz.
,, 4·0 ,, ...	$4\frac{3}{4}$ in. × $4\frac{3}{4}$ in. × $1\frac{1}{8}$ in.	20 oz.
,, 10·0 ,, ...	$4\frac{3}{4}$ in. × $4\frac{3}{4}$ in. × $2\frac{1}{16}$ in.	46 oz.

The actual capacity, measured in the same way as the telegraph condensers, is to be not more than 10 per cent. higher or lower than the marked value.

The insulation tests are made with an E.M.F. of 300 volts instead of 400 volts, and the megohms per microfarad, after one minute's electrification, must be not less than 300. The difference between the readings at the beginning and the end of the second minute must be not less than 20 per cent. of the first minute reading. The insulation resistance between either of the outside soldering tags and the metal case must be not less than 300 megohms. The condenser plates are to be tightly fitted in the metal case, and the top is to be hermetically sealed before the metal top is put on. The sealing composition must not be brittle or so soft that it will flow at a temperature of 75° Fahr., and it must adhere firmly to the tinned iron case.

The technical details in the National Telephone Company's specification for condensers are as follows :—

1. The capacity to be not less than 1·8 nor more than 2·2 microfarads when tested with direct current at 4 to 5 volts, and with an alternating current (sinusoidal wave at 4 to 5 volts and 800 periods per second.

2. The insulation resistance to be not less than 100 megohms between the two plates and between the plates and the case when tested with an E.M.F. of 100 to 200 volts.

3. The condensers to withstand an E.M.F. of 400 volts maximum (not R.M.S. value), alternating at 20 to 25 cycles per second applied at the terminals for a period of half a minute.

FOILED PAPER CONDENSERS.

Temperature Coefficients for Correcting Insulation Resistance to Standard Temperature (60° *Fahr.*).

(400 Volts, 60 Seconds.)

Testing Temperature. Deg. Fahr.	To Correct to 60°, Multiply by	Testing Temperature. Deg. Fahr.	To Correct to 60°, Multiply by
50	0·710	71	1·457
51	0·734	72	1·508
52	0·759	73	1·561
53	0·785	74	1 616
54	0·812	75	1·673
55	0·840	76	1·732
56	0·870	77	1·793
57	0·901	78	1·855
58	0·933	79	1 919
59	0·966	80	1·986
60	1·000	81	2·055
61	1·035	82	2·127
62	1·071	83	2·202
63	1·109	84	2·279
64	1·148	85	2·358
65	1·188	86	2·440
66	1·229	87	2 525
67	1·272	88	2·613
68	1·316	89	2·704
69	1·361	90	2·799
70	1·408		

Owing to pressure on our space, we are obliged to hold over our report of the discussion until our next issue.

ELECTROCHEMISTRY AND ELECTROMETALLURGY

AT the meeting of the Faraday Society of Tuesday, there were two Papers on the agenda. The first was by L. O'Dowd and Dr. F. Mollwo Perkin upon the "Determination of the Boiling Points of Very Small Quantities of Liquids." The authors pointed out that in dealing with very small quantities of liquids, the ordinary method of distillation was not satisfactory owing to the loss of material which took place in the apparatus, and to the time required to bring the thermometer to the correct temperature, practically all the liquid being distilled off before this ensued. They therefore devised the following method, by means of which it is possible to determine the boiling point of such small quantities of liquids as ¼ c.c. The apparatus is shown in Fig. 1. It consists of a wide-mouthed flask, capable of holding about 100 c.c. of liquid. This is used to receive the liquid which is to serve as heating material. The liquid the boiling point of which is to be determined is placed in the small test-tube (*A*), which is slightly inclined so that the end of it comes exactly against the thermometer bulb. A stirrer (*B*) is passed through a rather wide glass tube inserted through the cork, which serves as an outlet for the air as it expands. The tube (*A*) also passes through a glass tube, and is therefore slightly widened at the top edge to prevent it slipping down right into the liquid. A capillary tube (*C*), about 1 c.c. long, closed at one end, is placed in the liquid, and the flask heated, the outer liquid being stirred meanwhile. Shortly before the b.p. of the liquid in the tube is arrived at, bubbles are seen to be given off from the bottom of the capillary tube. As soon as the stream becomes rapid, and the bubbles rise in continuous succession, the heating is stopped and the temperature allowed to slightly fall, the outside liquid being continually stirred. The speed of the bubbles coming off from the small tube rapidly slackens until finally they stop altogether. At this point the thermometer is read and gives the correct b.p., because it is at this point that the pressure of the vapour is equal to the atmospheric pressure, and that, of course, is the b.p. of the liquid. The authors have determined the b.p. of a considerable number of substances, varying from ether, b.p. 36°, to safrol, 232°, and in all cases, either with low boiling substances or high boiling substances, accurate results have been obtained. In research work it is very often of the greatest importance to be able to determine the boiling point of very small quantities of liquid, because it frequently happens that the amounts of liquid which one has to deal with are of the minutest. Of course, in dealing with mixtures, this process would only give the common b.p. of the mixture, and it would be necessary to separate the mixture in the usual manner.

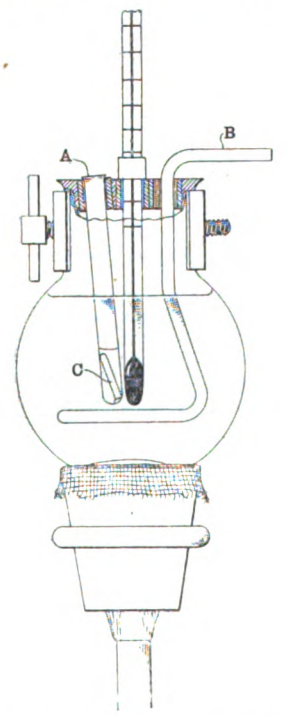


FIG. 1.—APPARATUS FOR DETERMINING THE BOILING-POINT OF SMALL QUANTITIES OF LIQUIDS.

The second Paper was by Dr. F. M. Perkin, upon "The Industrial Uses of Ozone, Particularly in Connection with the Purification of Water." The author commenced with a brief historical survey of the various methods employed for the purification of potable water. These may be mechanical, that is, methods of filtration through beds of sand, such as is usually employed in this country; purely chemical, by the employment of various oxidising agents, such as the addition of chlorine, bromine, permanganates, and the like; electrolytic, in which the electrodes produce both a chemical and mechanical purification, but which, although frequently tried, has never been found practicable upon a large scale; and, lastly, chemical and mechanical methods combined, as employed in the ozonising processes. This might, however, be better designated as electrical, mechanical, and chemical combined, because in the first place electrical energy is employed for converting the oxygen of the air into the active chemical product which causes the sterilisation of the water—ozone. The mechanical part of the process is the previous filtration, which is frequently of advantage. In dealing with large volumes of water which is employed for domestic purposes, there are two considerations of prime importance. In the first place it is essential that the water, when delivered to the consumers, shall be in such a state of purity that when used by the population it shall be incapable of propagating any form of disease or illness. The second consideration is, how can this be brought about satisfactorily and cheaply? The method employed for purification will naturally depend largely upon the source of the supply. Filter beds of sand are fairly cheap, and, given ordinary conditions, usually fairly efficient. But with sand filters it must be remembered that the purifying action is partly bacteriological. The surface of the sand becomes coated with a form of slime which consists largely of bacteria, which are able to destroy noxious bacterial substances originally in the water. The water, therefore, filters first through this bacterial filter, and then passes through the sand. If the amount of water which passes through is of so great a volume that the action of the bed is not sufficiently rapid, then disease may be propagated. Another objection to

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the sand-bed method is the large area of land which is necessary if the town or city to be supplied be of large dimensions. Now ozone is one of the most powerful bacteria-destroying agents, but it has been found that not only does it sterilise by destroying bacteria, but it is also able to eliminate iron, even when that iron is united with humic acid, which is frequently met with in sewage contaminated water. In this country very little appears to have been done in connection with sterilising of potable water, but in Germany the firm of Siemens & Halske have installed plant for dealing with the water supply of Wiesbaden and Paderborn. The construction of the ozoniser is illustrated in Fig. 2. The discharge space is bounded by concentric pipes fitted into one another, an outer glass cylinder *E* surrounded by a conducting liquid and an inner metal cylinder *D*, which is cooled by means of a current of water circulating through it. The dried air to be ozonised enters the apparatus at the lower pipe *T*, and passes up between *D* and *E*, where it meets with the silent electric discharge, becoming ozonised, and finally passes out at the upper pipe *T*. The whole apparatus consists of a cast-iron box divided up into three spaces; a lower compartment for receiving and conveying the air to the pipes, an upper ozone collecting chamber, and an hermetically sealed middle chamber, into which the ozone pipes are inserted by means of a stuffing box. In the middle air chamber, in which the pipes are contained, cold water is circulated, and, being in contact with the other high-tension pole, conducts the current to the glass cylinder *E*. As the iron box which constitutes the one pole is upon the ground, and the other pole is very carefully insulated and is contained in a closed pipe, the apparatus can be handled and interchanged without any danger and without stopping the plant. The iron box has a plate-glass window, so that the blue light in the discharge chamber can be viewed in order to ascertain whether the apparatus is working satisfactorily. The

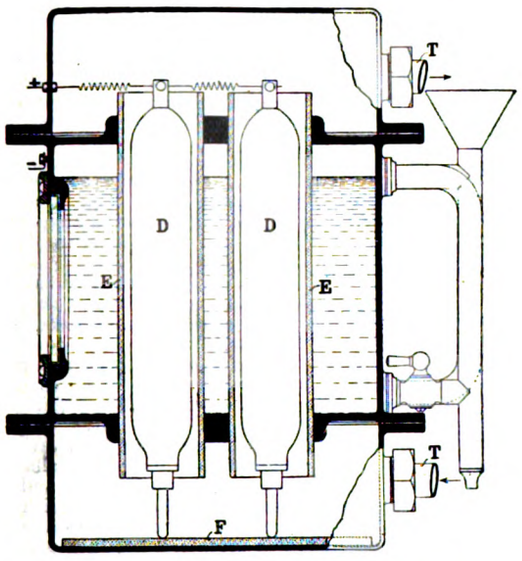


FIG. 2.—SIEMENS AND HALSKE OZONISER.

room in which the plant is working is usually kept dark, so that the attendant on entering can see at a glance whether the apparatus is working properly. An ozoniser such as described takes current at a potential of about 8,000 volts, and requires for its operation 1 h.p., and yields 13·5 to 27 grams ozone per hour, according to the volume of air which is passed through it, and also to the degree to which moisture has been removed. In Paderborn and Wiesbaden the average consumption of ozone per cubic metre of water is 1·3 gram. Consequently with water of this quality one ozoniser can sterilise sufficient water for a town of from 2,400 to 4,800 inhabitants, reckoning the consumption of water at 100 litres per head (about 22 gallons per head; in this country we require more like 30 gallons per head). At Paderborn the sterilisation towers are about 4 metres (13 ft.) high, and are constructed of concrete, their action being similar to the scrubbing towers used in chemical works. The water trickles through a layer of pebbles of about the size of pigeons' eggs; it is thus broken up into numerous little streams, and consequently a very large absorbing surface is presented to the current of ozone, which is forced by means of a slight pressure from the bottom to the top of the tower. The construction of the tower is made clear by Fig. 3, which shows the vertical section. Every tower is divided into three parts: (1) the reservoir for water which is to be treated, *H*; (2) the sterilisation space; (3) the collector for the sterilised water. The interior of a tower is divided by two partitions into four independent shafts, all of which obtain their water from a common supply pipe fitted with a valve *C*. Every single tower is in turn divided by an iron grating into an upper sterilisation space, which is filled with a layer of pebbles two metres deep, and a lower part for collecting the water after treatment. Each tower has a cross-section of one square metre, and about 15 to 20 cubic metres of air is passed up, and meets 15 to 20 cubic metres of water in one hour. After collecting at the bottom of the tower, the water at Paderborn flows out in cascade form as represented in

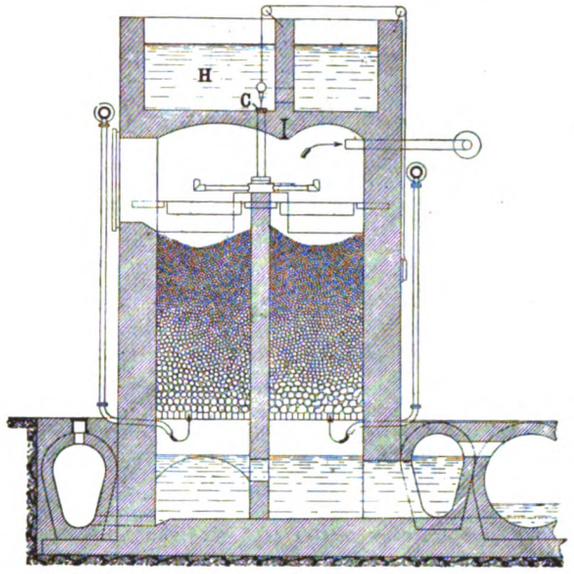


FIG. 3.—STERILISATION TOWER.

Fig. 4. It thus loses any excess of dissolved ozone which it may contain. In case of interruption of the electric current or accident to the blowers, the supply of water to the sterilisation towers is automatically shut off, thus preventing any flow of unsterilised water into the town supply. If, for example, the current in one of the ozonisers is interrupted, thus stopping the ozone formation, the lever of an electro-magnet drops and closes an independent circuit, and this in turn causes a floating conical rubber valve to drop and shut off the water supply to the four towers. On the other hand, should the blower fail, an aluminium disc, which is inserted into the main air-pipe and under normal conditions is kept raised by the air current, falls, and likewise by electromagnetic action, shuts off the water supply to the towers. In either case an indicator at the switchboard points out which set of apparatus and in which tower the trouble has arisen, and at the same time an alarm signal rings continuously until the defect is remedied. Consequently it is impossible for unsterilised water to flow into the water mains. The plant at Wiesbaden is worked upon similar lines, and is constructed to treat 250 cubic metres of water per hour. Although ozonising of water may be called a chemical process, yet nothing is ultimately left in which was not already there, because, should a certain quantity of ozone remain after the water leaves the sterilising towers, this is removed when the water flows over a cascade into the final reservoir. On the other hand, bacteria are practically non-existent after the water has been ozonised. The cost of the process is also extremely low; thus, with a steam plant capable of dealing with 2,000 cubic metres per hour, the cost, including 4 per cent. interest on the capital and a 4 per cent. sinking fund, works out to about three-fifths of a penny per cubic metre of water treated (35·3 cubic feet). Other apparatus for ozone production was also mentioned, and a laboratory apparatus in working was also

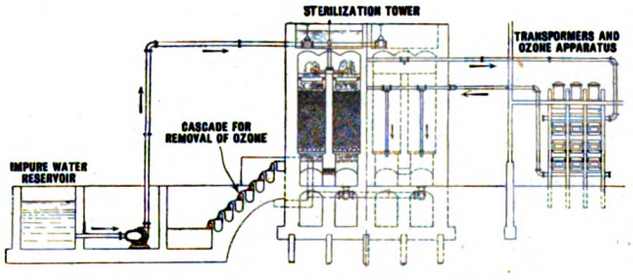


FIG. 4.—PADERBORN WATER STERILISING PLANT.

shown. Dr. Perkin also referred to the use of ozone for the production of artificial vanallin, for the bleaching of flour, and other purposes.

Martin Gruber, in the German Patent 197,510, describes a new

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solder which can be employed in soldering aluminium and its alloys. It consists of 10 parts of copper, two parts aluminium, 25 parts zinc, 60 parts tin, and three parts cadmium. This alloy has a low melting point, and therefore can be used for soldering together very thin sheets of metal. The alloys which have been used up to the present have always had a very high melting point; consequently it was always necessary to heat to a very high temperature the parts which had to be united, and as a consequence it was difficult in dealing with very thin sheets, and was apt to spoil the character of the metal.

ELECTRICAL SCIENCE

British and American

Theory of Graded Cables.—At the Physical Society meeting last Friday, C. S. Whitehead read a Paper which examines the formulæ given by O'Gorman and by Russell for the "grading" of cables, that is to say, for the due adjusting of the electrical constants of the different layers so that the electric intensity radial to the axis may be constant throughout the covering. The object of the Paper was, in fact, to corroborate the formulæ arrived at by approximate methods by the authors named, by the rigorous use of Maxwell's general equations. The result is to confirm the approximate formulæ, provided that the electrical waves propagated along the cable are not short waves. If λ is the specific inductive capacity of the dielectric at distance r rom the axis of the conductor, and σ the specific resistance of the dielectric at the same point, the rule for alternating current is make the product λr constant; and for continuous currents the rule is make σ/r constant. In the more general case, however, the author shows that a more accurate rule would be to make the product $r\sqrt{\lambda}$ constant for alternating currents, and to make $\sqrt{\sigma}/r$ constant for continuous currents.

A Theory of Gravitation and of Electrons.—At the same meeting of the Physical Society, C. V. Burton read a Paper which endeavours to adapt the ether of electromagnetic theory so as to account for gravitation. Hicks and other writers have supposed that ordinary matter is a modified portion of ether possessing as one of its properties a perpetual pulsatory motion in respect of its volume. It is well known that any such pulsatory objects, placed in a fluid, will exhibit attractions towards one another. The chief outstanding difficulty has lain in providing for that agreement in phase which must be assumed to subsist among the centres of pulsatory disturbance. This difficulty is avoided by the author by supposing the pulsations all caused by primary waves of compressional-rarefactional type propagated through the ether with a velocity enormously transcending that of light. These primary waves may be travelling in directions indifferently distributed, or predominantly in one direction; but an essential point is that all effective wave-lengths should be very great, measured even by astronomical standards. Taking Lodge's estimates for the density of the ether (10^{12} grams per c.c.), and for the constitutive energy of the ether (10^{33} ergs per c.c.), the author finds as mathematically reasonable figures the following:—Velocity of the compressional waves of the ether = $7{\cdot}3\times10^{16}$ times the velocity of light; wave length = $1{\cdot}5\times10^{17}$ cm.; rate at which energy is being propagated through each square cm of surface taken parallel to the wave fronts = $3{\cdot}4\times10^{11}$ kilowatts.

Continuous Oscillations.—At the meeting of the Roentgen Society on May 7th, Dr. Horace Manders read a Paper on "Continuous Oscillations of Electricity, and their Application." After dealing with mechanical oscillations and electrical oscillations in a general way, he described his experiments with arcs between different metals in air in a Duddell circuit with a view to the simple production of sustained oscillations. He had been largely assisted by Mr. Sharman in this work, and had been able to obtain successful results in aerial telephonic transmission by means of these currents. He found that the combination of zinc and aluminium for the poles of the arc, with the zinc rod positive, give satisfactory results, and he demonstrated to the audience the production of sustained oscillations by this method. Frequencies much higher than those of the singing arc could thus be obtained, and the lecturer proceeded to consider the applications of high frequency currents produced in this way. They might be useful for telegraphic, telephonic, or medical purposes. The lecture closed with a demonstration of aerial telephony by use of the method. In the discussion which followed, the President (Mr. Duddell) mentioned that he had made many experiments with arcs between metallic electrodes, but that he had found that a general characteristic of such arcs in Duddell circuits was that they could only be maintained with small currents; indeed, for some combinations of metals the arc could only be sustained when the currents were of the order of a few milliamperes.

Leeds University.—The Marquis of Ripon, Chancellor of Leeds University, has received an intimation that the King has consented to open the new university buildings in July. The Queen will accompany the King on his visit.

Continental

High-Frequency Oscillations from Direct-Current Dynamo.—A new method of producing high-frequency continuous oscillations is described by R. C. Galletti in *L'Elettricista* for April 15th. A direct-current Thury dynamo giving 25,000 volts and 114 amperes, is connected with a triangular oscillating circuit *MNO*. One lead goes to *M*, and the other to *N* and *O*. Between *M* and *N* there is a capacity and an inductive resistance. Between *M* and *O* there is a similar capacity in parallel with a spark-gap *B*, and also an inductive resistance. Between *N* and *O* there is a third capacity in parallel with a spark-gap *A*, and (towards *O*) a fourth capacity. The arrangement of the four capacities has the effect that a spark across *A* produces a virtual reduction of the spark-gap *B*, and *vice versâ*. The circuit *MNO* is syntonised with the circuit *NOD* (*D* being one pole of the dynamo), so that a spark at *A* produces undamped oscillations in *MNO*, and *vice versa*. At all events, when the dynamo is worked at a certain load, a series of practically undamped high-tension and high-frequency oscillations is obtained from the two syntonised circuits. The experiments are to be repeated at Lyons with a dynamo giving 40,000 volts.

Electrolysis of Hydrochloric Acid.—A novel view concerning the migration of chlorine ions is advanced by E. Dcumer in the *Comptes Rendus* for April 27th. If the transport factors of H and Cl ions are calculated on taking account of the fact that only a part of the current serves for the electrolysis of HCl, and the rest for that of water, the results obtained are very different from those yielded by Hittorf's hypothesis. To decide between the rival hypotheses, it is necessary to measure the impoverishment at *both* poles. On Hittorf's hypothesis, the impoverishment will be very different at the two poles. But if the migration velocities of the H and Cl ions are nearly the same, there will be an equality of density of acid at both poles. To obtain correct results, it is necessary to avoid the disengagement of chlorine, and the production of hypochlorous acid. This is accomplished by operating with dilute solutions of 1 to 5 per cent., and currents not exceeding 20 milliamperes. When this is done, the impoverishment is the same at both poles, and the author concludes that H and Cl ions are transported with the same speeds, instead of the H ions moving five times faster. If the HO ions also moved with the same speed, a simple process would result, but the author has not been able to determine this.

Contact Rectifiers.—It is known that some contacts between carbon or silicon and certain metals may be used as detectors in wireless telegraphy. This was attributed to some thermo-electric effect, but that explanation does not seem to cover the ground. Most of the action is due to a rectifying action of the contact, a current being transmitted more easily across it in one direction than in the other. L. W. Austin goes into this question in the *Physikalische Zeitschrift* for April 15th. The most regular effects are obtained with combinations of carbon and steel; tellurium and aluminium; and silicon with almost any metal. The silicon is embedded in a bar of solder, and a steel or brass point is pressed against it by a spring. With a continuous current at 2·5 volts, and a galvanometer of 280 ohms resistance, the author obtained a current of 6 milliamperes in the direction silicon-steel, and 25 milliamperes in the opposite direction. The resistance fell on reversal from 420 to 100 ohms. An alternating current of 60 periods per second at 2 volts was rectified to 8·1 milliamperes in the direction steel-silicon. With a combination of an arc carbon and a steel needle the author obtained 5 milliamperes with 0·4 volt alternate. In a tellurium-aluminium combination, the current passed into the aluminium at the junction, which is opposite to the thermoelectric effect on heating that junction.

Small E.M.F.'s of Prescribed Form.—A universal method for obtaining E.M.F.'s of any desired curve-shape on a small scale is described in the *Physikalische Zeitschrift* for April 15th by L. Baumgardt. The conductors which serve as terminals are two wire curves, one of them a circle and the other a cardioid or other curve, traced in accordance with a proper formula. These two curves are mounted in the same plane, and a conducting bar moves in the same plane in contact with them. A magnetic field is provided, whose lines of force are at right angles to the plane. The E.M.F. in the circuit, which includes that portion of the bar which bridges the wire curves is at any time proportional to the rate at which the bar by its motion adds or subtracts lines of force from the area of the circuit. In one of the simplest contrivances of this kind the centre of the circle is also the pivot of the bar, and the origin of the polar curve $r=\sqrt{\phi}$. This gives a zigzag E.M.F. The equation $r=\sqrt{1-\cos\phi}$ would give a sine E.M.F. accurately. Two other arrangements are also suggested. In one of them, there are two bars in opposite directions, and only a single wire curve. The terminals are the insulated concentric pivots. In another there are two separate wire curves, and two bars with a right angle between them, and concentric pivots.

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"ELECTRICAL ENGINEERING" PATENT RECORD

(This Patent Record is compiled by our own Editorial Staff and is Strictly Copyright.)

Specifications Published May 7th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

8,623A. S. STONE AND L. W. MIGOTTI. In the "multiple unit" control system for electrically-driven trains, all the motor coaches are of equal power, and when a train enters a curve, owing to the greater tractive resistance offered to the leading coach, there is a tendency for the leading and middle coaches to be forced out of line by the trailing coaches; the effect of which is excessive rail and flange wear, and undue strains and stresses on the truck frames and axles. This invention provides a means of control whereby the leading coach always has the maximum tractive effort, and pulls the remaining coaches to a certain degree. The traction motors are controlled by means of a pilot motor on each motor coach, the pilot motors being governed by a master controller. One claim, three figures.

16,530, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). A method of manufacturing tungsten filaments for glow lamps, and means for rendering the filaments ductile during the process of bending and attachment to the supporting and leading-in wires. These processes are fully described on page 738 of this issue. Two claims, eleven figures.

16,736. C. O. BASTIAN, G. CALVERT, & J. H. SANDERS. The chief difficulties to be contended with, when cheaper metals are substituted for platinum for the leading-in wires of electric glow lamps, are: (1) the different coefficients of expansion, (2) the occlusion of gases by the metal, and (3) the oxidisation of the metal. According to the present invention these difficulties are overcome by making the conductor of a very thin ribbon (0 004 in. thick) of pure copper. This ribbon is provided with a surrounding tube of enamel, glass, or soft white "platinum flux" glass, which is fused round that portion of the conductor which is to be fused into the glass of the bulb. The tube is quickly fused on to the ribbon by the action of two oppositely directed blow-pipe flames. Not only are all gases excluded from the film between the copper and the soft glass covering, but oxidisation of the metal is prevented, and a gas-tight seal is obtained. Six claims, eight figures.

18,515. BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). In a lightning arrester of the electrolytic type, a number of cells with aluminium electrodes immersed in a suitable electrolyte are connected in series. The current leaking to earth is limited by the thin film of aluminium oxide which forms on the surface of the electrodes, and which, with the rise of pressure, is broken down, thus permitting the current to flow until the pressure is reduced. It has been found that the voltage across some cells is liable to become greater than that across others, thus causing the former cells to overheat, and eventually to break down. According to this invention, this local rise in voltage is prevented by connecting each cell as a shunt across an equal number of turns of the winding of an auto-transformer. If the pressure across any one cell tends to increase, the auto-transformer immediately effects a balance, and the pressure is again equally distributed. Two or more auto-transformers in series can be used instead of one. A resistance shunted across each cell may be substituted for the windings of the auto-transformer. The separate resistances are connected in series. The resistances are cheaper than an auto-transformer, but the leakage current is increased. Five claims, four figures.

21,476, A. G. BLOXAM (*Siemens & Halske Akt.-Ges.*). The manufacture of metallic filament lamps of various candle-powers may be facilitated by the employment of two or more filaments twisted together to form one filament of lower resistance and higher candle-power. Standard bulbs and supporting frames may be used for lamps of various candle-powers. A twisted filament has more surface than a single filament of equal section, and is thus shorter for a given candle-power. The twisted filament may be embedded in a ductile metal, and drawn out, if necessary, the outer metal being afterwards removed chemically or by fusion. With thick filaments, excessive heating of the supporting hooks is liable to occur. With twisted filaments, however, this can be avoided, as only one strand of the twisted filament need be passed over the hook. Five claims.

27,401, J. J. RAWLINGS & R. T. SMITH. Fuses for electric circuits when made of either thin hard wire or thick soft wire are liable to become reduced in section at the points where they are gripped by the screw or terminal. The fuse wire often breaks due to this, and also tends to fuse first at these points, instead of at the middle, as is desirable. According to the present invention, copper or other suitable metal is electrolytically deposited on the ends of the wire, thus ensuring good contacts with the terminals. The fuse will also blow at its centre. To cause the fuse to blow simultaneously in several parts of the same fuse wire, and thus distribute the arc, copper can be deposited on all parts of the wire, except where it is to fuse. One claim.

1908 Patent

401, THOMAS A. EDISON. In alkaline secondary batteries of the Edison type, the difficulties have been largely confined to the depolarising electrode in connection with which nickel hydroxide is used. The storage capacity of the nickel element has been less than that of the iron element, and the capacity of the nickel element cannot be maintained for so long a period as that of the iron electrode. The nickel hydroxide is also seriously affected by the presence of dissolved iron in the electrolyte. These defects are partially remedied by the addition to the alkaline electrolyte of about 2 per cent. by weight of lithium hydroxide. The alkaline electrolyte may be a solution of sodium or potassium hydrate. The increase in the capacity of an Edison cell in which lithium hydroxide is used is about 10 per cent., while the increase in the time over which the capacity is maintained is very much more. One claim.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1907 Patents

1,292, RUHMER. Converting direct into alternating currents by means of the electric arc.
8,742, OPPERMANN. Electrical controllers.
8,951, DAVY. Distribution of electricity.
9,576, THURSFIELD. Motor starting apparatus.
11,165, HIGHFIELD. Electrical distribution.
12,139, PLANCHON. Electric lamp filaments.
12,535, HAAR. Apparatus for telegraphing type printed messages.
12,712, MILLER. Means for obtaining unidirectional electric current from spark coils.
13,891, TATE. Apparatus for treating liquids electrolytically.
14,162, PLUMSTEAD, & NEWTON & LAWRENCE, LTD. Apparatus for igniting gas electrically.
14,368, LAKE (*Charles M. Thompson Co.*). Automatic telephone switches.
15,171, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Methods of insulating sheet metal.
16,166, HIGHFIELD. Supplying current to electric motors in series systems.
16,531, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Supports for the filaments of electric lamps.
17,046, NEWMAN & LODGE. Application of electricity for stimulating vegetable growth.
18,101, WUNNER'SCHE BITUMEN-WERKE GES. Process for the manufacture of electric insulating materials.
19,477, GAIFFE. Rotary mercury interrupters.
21,077, ALLISON (*Behan*). Electro-motors.
21,827, LATOUR. Single-phase series alternating-current commutator motors.
22,085, SCHWARZWALDER. Electric batteries.
23,199, TIMAR & VON DREGER. Arc lamps.
26,920, SIEMENS BROS. & CO. (*Siemens & Halske Akt.-Ges.*). Electrical locking apparatus for railway signals.
26,937, EVANS. Coin-operated apparatus for controlling the supply of electricity.
27,783, DENNY (*Eastgate & Horn*). Means for making electrical connections.

1908 Patent

898, ROBERT BOSCH. Electromagnetic sparking machines.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patents

1,253, GERARD. Apparatus for producing electrical effluvia.
4,947, NOODT. Insulating bodies.
5,859, TAYLOR. Alternating-current relays.
8,414, ALLGEMEINE ELEKTRICITÄTS-GES. Alternating-current commutator motors.
8,522, BERG. Turbo-electric generator systems.
8,547, RUTHARDT. Field magnets for magnetic inductors.
8,713, HENRIQUE. Electrical ignition apparatus.

Expiring Patents

No patents of electrical interest expire during the current week.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ltd.	10	7	7%	10⅜—11⅜	
Do. 4½% Cum. Pref.	10	4½	4½%	10—10½	
Do. 6% Cum. Second Pref.	10	6	6%	10¼—11	
Do. 4½% Debenture, Red.	Stock	4½	4½%	102—105	
Bromley (Kent) E.L.& Power Co.,Ltd.	5	5½	5½%	4½—5	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	94—97 xd	
Brompton & Kensington E. S. Co.,Ltd.	5	10	10%	7—8	
Do. 7% Cum. Pref.	5	7	7%	6¾—7¾	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4*	98—101	
Ch. Cross, W. E. & City E. S. Co.	5	5	5%	3¼—3¼	−⅛
Do. 4½% Cum. Pref.	5	4½	2¼%	4¼—4⅝	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	3¾—4¼	
Chelsea Electric Supply Co., Ltd.	5	4½	4½%	3—3½	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9¼—10¼	−¼
Do. 6% Cum. Pref.	10	6	6%	12—13	
Do. 5% Deb. Red	Stock	5	5%	124—127	+1
Do. 4½ 2nd Deb. Red	Stock	4½	4½%	102—105	+1
City of Durham E. P. Dis. Co.	5	4	2%	3—3⅜	
Do. 5% Pref.	5	5	5%	4¼—4¾	
County of London Elect. Sup. Co. Ltd.	10	5	5%	7¾—8¼	
Do. 6% Cum. Pref	10	6	6%	10½—11½	
Do. 4½% Deb. Red	Stock	4½	4½%	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	96—99 xd	
Edmunson's Electricity Corp., Ltd.	5	4	1.6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	⅜—1	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	55—60	
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4¾—5¼	
Do. 5% Cum. Pref.	5	5	5%	⅜—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co. Ltd.	5	9	8½%	6¼—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	90—93 xd	
Kensington & Knightsbridge E.L.Co.	5	10	10%	7½—8½	−¼
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens & N'tng Hill E.L. Cos. Db.Rd.	Stock	4	4%	97—101	
London Electric Supply Corporation	3	4	2½%	1—1½	
Do. 6% Pref.	5	6	6%	4¾—4⅞	−⅛
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd	5	8	6¼%	4¼—4⅜	−½
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5	−¼
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D.	100 & 500	4½	4½%	96—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	9¼—10¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	8	5¾—6	−⅛
Do. £2 Pm.	5	8	8	5¾—6	−⅛
Do. 5% Pref. (fully paid)	5	5	5%	5¼—5⅜	
Do. 10/- Pm	5	5	5%	5¼—5⅜	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7%	5¼—6¼	
Do. 4% Deb. Red	Stock	4	4%	94—98	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7¼—8¼	
Do. 7% Non-Cum. Pref.	5	7	7%	6¼—7	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	¼—¾	−¼
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4%	2⅜—2⅞	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅜—⅝	
Do. 7% Cum. Pref.	1	7	7%	1⅛—1⅜	−1/16
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5%	1—2	
Do. 5% Cum. Pref.	5	5	5%	1⅝—2¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¼—8	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5¼	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	88—91	
Central London	Stock	4	3%	74—77	
Do. 4% Preferred	Stock	4	4%	87—89	+3
Do. Deferred	Stock	4	2%	54—57	
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pr. Db.	Stock	4	4%	81—84	
City and South London Cons.	Stock	2¼	4¼%	39—41	
Do. 4% Perp. Deb	Stock	4	4%	99—102 xd	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1895	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11½d.	¾—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4%	6—7	
Do. 4% Perp. Deb.	Stock	4	4%	87—90	
Mersey Cons.	Stock	nil	—	1—3	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	½%	42—43	
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	75—78	
Do. 3½% Convertible Pref.	Stock	3½	3½%	73—76	
Metropolitan District	Stock	nil	—	11¼—12½	
Do. 6% Perp. Deb.	Stock	6	6%	105—110	−3
Do. 4% Deb.	Stock	4	4%	no price	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	36—40	
Whitechapel and Bow 4% Deb.	Stock	4	4%	103—106	−1
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅝—¾	
Do. 5% Cum. Pref.	1	5	5%	1/16—1/8	
Do. 4½% Deb. Red.	Stock	4½	4½%	86—91	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1¾	
Do. 6% Cum. Pref.	10	6	6%*	3⅜—4⅛	−⅛
Do. 5% Perp. Deb.	Stock	5	5%	88—92	−1/2
Do. 4½% 2nd Deb.	Stock	4½	4½%	67—71 xd	
City of Birmingham Trs. Co., Cm. Pf.	5	5	5%	4¼—4¾ xd	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	97—100	

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%	%		
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	94—97	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅜—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	1⅝—1⅞	
London United Trs., Ld., Cm. Pf.	10	5	5%	6⅜—7⅜	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—85	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	1¼—1⅜	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	94—97	
National Elec. Construction Co. Ltd.	1	10	2/-	⅞—⅞	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	½—1	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	¼—⅜	
Do 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	9.2d*	¼—½	
Do. 5% Cum. Pref.	1	5	5%	¼—⅜	
Do. 4½% Deb. Red	Stock	4½	4½%	93—96	
Provincial Tramways Co. Ltd.	10	3½	4%	4⅜—5⅛	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Lig. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6%	¾—1	
Do. 4% Deb. Red.	Stock	—	4%	76—80	−2
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1¼	
Do. 6% Cum. Pref.	5	nil	—	3¼—3½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	55—58	
Do. 6% Pref. Ord.	Stock	6	30/-*	98½—99½	−½
Do. Def. Ord.	Stock	1¾	1%	14¼—14¾	+⅛
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3½—3¾	
Do. 10% Cum. Pref.	5	10	10%	8—9	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4¼	4/-*	13⅞—14	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	99¼—101½	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	99—101	
Do. do. (Mauritius Sub.)	25	4	4%	98½—100¼ xd	
Eastern Ext. Australasia & China	10	7	7/6	13—13¼	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	100—102	
Eastern Telegraph Co.	Stock	5¾	7%	131—136	
Do. 3½% Pref.	Stock	3½	3½%	84—87	
Do. 4% Mort. Deb.	Stock	4	4%	100—102 xd	
G. N. Tel. Co. (Copenhagen)	10	20	20%	29—31	
Indo-European Telegraph Co. Ltd.	25	13	65/-	53—56	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅜—½	
National Telephone Co., Ltd., Pref.	Stock	6	6%	107½—109½	+½
Do. Deferred	Stock	5¼	6%	109—111	+½
Do. 6% Cum. 1st Pref.	10	6	6%*	10½—12½	
Do. 6% Cum. 2nd Pref.	10	6	6%	10½—12½	
Do. 5% 3rd Pref.	5	5	5%	5⅛—5⅜	
Do. 3½% Deb. Red	Stock	3½	3½%	98—100	
Do. 4% Deb. Red.	Stock	4	4%	101½—103½	
Western Telegraph Co., Ltd.	10	7	7%	13¼—13⅜	
Do. 4% Deb.	Stock	4	4%	100—102	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	6%	1⅛—1⅜	
Babcock & Wilcox, Ord.	1	20	1/7½*	3½—3¾	−⅛
Do. 6% Pref.	1	6	7½d	1/16—1/8 xd	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	6⅛—6⅜	
Do. 6% Cum. Pref.	5	6	6%	5⅝—6⅛	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	93—98	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—⅜	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brest. Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	1/16—⅛	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	70—75	−4
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	55—60	−4
Callender's Cable and Const. Co., Ltd.	5	15	15/-	10¼—11¼	−½
Do. 5% Cum. Pref.	5	5	5%	5⅛—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106½—108½	
Consolidated Electrical Co., Ltd.	1	3	3½%	⅜—½	
Crompton & Co., Ltd.	3	5	5%	1⅜—1⅝	−⅛
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1⅝—1⅞	
Do. 6% Cum. Pref.	1	6	6%	1—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
Edison & Swan United "A" £3 paid	5	4½	2/6	¾—1	
Do. do. (fully paid)	5	4½	4/2	1½—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	¼—½	
Do. 7% Cum. Pref.	2	7	—	1¼—1¾	
Do. 4% 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7¾—8¼	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10½—11½	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5⅛	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	30—32	
Do. 4% Deb. Bds. Red.	100	4	4%	100—103	
Willans & Robinson, Ord. Shres.	1	nil	5%	¾—1¼	−⅛
Do. 6% Cum. Pref.	5	nil	6%	3¼—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

ASTON: *Tramways.*—The negotiations between Aston Manor, Handsworth, and the British Electric Traction Co. have been concluded, and Handsworth has entered into an agreement to purchase and electrify the Villa Road tramway, and arrangements were made for through running from Perry Barr to Birmingham.

BATH: *The Sale of the Electricity Undertaking.*—An alternative arrangement to that originally proposed whereby a syndicate connected with Mr. Schenk was to purchase the electricity undertaking from the Bath Corporation, has been put forward by the Electric Lighting Committee. The syndicate originally agreed to pay £162,000, the total capital expended by the Corporation, and £20,000 bonus, but was unable to raise the necessary capital immediately. It was subsequently arranged that instead of the bonuses the Corporation was to receive annually a supply of £1,000 worth of electricity per annum free. According to the proposed new terms, the payment of the £152,000 is to be spread over 50 years, and certain recommendations for public lighting are to be made.

BELFAST: *Electricity and Tramway Statistics.*—At the weekly meeting of the Tramways and Electrical Committee on Monday, Mr. Eloxam, the Electrical Engineer, read his report on the working of the year ending March 31st last, from which it appeared that the total output was 10,885,658 units, or an increase of 12·7 per cent., the total revenue £57,094, or an increase of 11·5 per cent., and, owing to the rise in coals, the cost of production has risen from 0·654d. per unit to 0·755d. per unit. The net profit on the year's working was £8,198 16s. 4d. He recommended the allocation of various sums, amounting to about £6,500 for various purposes. The report was adopted. From the financial statement, afterwards submitted, it appeared that the tramway revenue amounted to £195,815 1s. 4d., and the expenditure was £119,823 1s. 4d., leaving a gross profit of £75,990.

BLACKBURN: *Light Railway Inquiry.*—On May 8th an inquiry was held by the Light Railway Commissioners as to the expediency of granting an application by the Blackburn, Whalley and Padiham Light Railway Co., for a revival and extension of time for the proposed construction of a light railway in those districts. The inquiry lasted eight hours. The sitting Commissioners were the Hon. H. E. Gathorne-Hardy (chairman), Col. G. F. O. Boughey, R.E., C.S.I., and Mr. Henry Allen, steward. The Chairman said the arguments of counsel had not succeeded in establishing that it would be *ultra vires* to consider the matter as presented. The Commissioners were satisfied no substantial inconvenience had arisen from the course followed by the promoters. It was clear this scheme could not have been carried out in the hands of the original promoters, but having heard the evidence of Mr. Cownie and Mr. Mountain, they thought if those gentlemen were constituted the directors of the company, there was a probability of the scheme being duly proceeded with. The Commissioners consequently granted the application, but, having heard all the objections of the Blackburn Corporation, the Lancashire County Council, and the Padiham District Council, they would insert clauses in the Order for their protection before submitting to the Board of Trade. They could not insist on a width of 27ft. as a minimum for all roads, as asked for.

BRAY: *Electricity Supply.*—In a recent report presented to the Electric Light Committee, the Engineer refers to the great disadvantages under which the undertaking is worked. It is pointed out that the Bray works were among the first electricity works opened for public supply; that the site and buildings are entirely unsuited for electricity works, and the system of supply (single-phase alternating) is not a very suitable system for a small town. Mr. Sowter draws attention to the fact that the coal consumption is unduly high, the cause being chiefly due to the uneconomical loads at which the plant is run for many hours per day. In order to economise under this head, he recommends the Council to instal a 50 b.h.p. gas engine and suction gas plant, which will be run during the hours of light load, and the steam plant entirely shut down at such times. The Engineer also recommends that the mains be extended and supplemented where necessary in order to obtain more consumers. The introduction of the Osram lamp is favourably referred to, and Mr. Sowter proposes to introduce a free wiring scheme, whereby small consumers, who only require two or three lights, and whom it would not be financially possible to supply at a profit by meter, may be charged at a fixed rate per lamp per annum, such rate to include supply of current and hire of wiring. The Engineer's report was discussed and adopted at a recent meeting of the Electric Light Committee, and the Council is recommended to apply to the Local Government Board for sanction to borrow £4,800 to carry out the recommendations embodied therein.

CARSHALTON: *Tramways.*—The Urban District Council has received from the Board of Trade a copy of the report of Colonel von Donop on a visit he paid to Carshalton to investigate complaints concerning the noise of the trams. He found that the noise was only slight, but the representatives of the Council contended that there was usually much more noise. The day was hot, and the rails were perfectly dry, except for lubrication, which the tramways company said they put down always twice a day. On that day the lubricant was put down a little later than usual. Colonel von Donop reported the promise of the company to take greater care in the future and provide for more frequent lubrications. It appeared to him that if care was taken to lubricate the rails, the noise could be reduced to within reasonable limits.

CITY OF LONDON: *Lighting of Markets.*—The annual report of the Clerk and Superintendent of the London City Central Markets (Mr. H. W. G. Millman), which has just been issued, states that the new "Orionamme" arc lamps have greatly improved the lighting of the fruit and vegetable section of the market, and that the introduction of similar lighting in the other sections would prove advantageous. The illumination from the arc lamps around the market, installed and lit during the past year, is giving general satisfaction.

COLCHESTER: *Electricity Supply.*—The report of Mr. A. R. Sillar gives some figures showing the increase in supply since last year. During March, 1908, 142,800 units have been generated against 123,916 for the corresponding month of last year. The total number of consumers is now 1,306, and the connections represent 47,370 8-cp. lamps. Some complaints regarding variation of pressure have been received during the year, but the report attributes these in some cases to the running during unexpected hours of some large motors, and to difficulties in obtaining a satisfactory balance of the three-wire system.

DARWEN: *Tramways.*—Figures relating to Darwen's electric tramways were placed before the Council last week. The gross receipts for the main line were £12,215 11s. 4½d., and working expenses, including £500 for depreciation, have been £8,145 6s. 4d., showing gross profit of £4,058 4s. 9½d., reduced after necessary reductions of the value of £242 10s. 9½d., compared with a net profit of £477 16s. 7½d., for 1907, or a reduced profit of £235 5s. The working expenses were an increase on the previous year, the gross receipts being £85 19s. 11d. less than the previous year. The total mileage was 213,699, compared with 208,935 for 1907, an increase of 3,765 miles. Last year power expenses were £2,308 15s. 10d. In 1907 they were only £2,280 17s. 5d., a saving of £27 18s. 7d. On the Hoddesdon section the gross receipts were £1,685 19s. 7½d., and the working expenses were £1,474 4s. 1d., leaving a gross profit of £211 15s. 6½d. After provisions amounting to £817, there was a net loss for the year of £605 9s. 1½d., compared with a net loss for the previous year of £594 6s. 1d., or an increased loss of £11 3s. 0½d. The total mileage on this section was 31,895, against 30,955 last year, an increase of 938 miles. Power expenses were only £449 14s. 5d., against £471 8s. 3d. the previous year.

In the electricity department there had been 10 per cent. increase in the consumption of electricity for lighting, but a decrease in the units supplied to the trams due to the introduction of demi-cars. The net profits on the electricity works this year was £104, as against £65 last year. Certain improvements were being introduced, by which it was hoped the cost of production would be reduced.

DUDLEY: *Electricity Accounts.*—The units sold during the year ended March 31st, 1908, numbered 2,022,207, an increase of 211,195 over the previous year's total. The costs have slightly increased, but the income has shown an increase of £1,087, so that the net profit has increased from £68 to £344. During the year £200 has been spent in converting boilers from hand to mechanical stoking.

DUMBARTON: *Tramways.*—The Board of Trade inspection of the new tramways between Dumbarton and Alexandria was made by Col. Yorke on Thursday last, and the line was subsequently opened for traffic. It is expected that the whole system will be completed early next month.

EAST BARNET: *Public Lighting.*—The District Council, at its last meeting, considered the question of a proposed agreement with the North Metropolitan Tramways Co. in regard to the fixing of lamp brackets on poles carrying electric wires. It was held that the company had no power to call upon the Council to sign the agreement, and that, on the sanction of the Herts County Council, the local Council could fix the brackets on the poles. The Council declined to enter into any agreement with the company with regard to the standards.

ERDINGTON: *Tramways and Electricity Accounts.*—The receipts of the Electric Light and Tramways Department for the year ended March 31st were £5,254, and the expenditure was £4,294. £600 has been placed to reserve.

ERITH: *Assessment of Supply Undertaking.*—At the last meeting of the Urban District Council, the Clerk reported that he had given notice of appeal against an assessment of the electric supply undertaking for income tax, amounting to £1,142. The question in dispute was the allowance which should be made for depreciation of the machinery and plant, and the Surveyor of Taxes stated that he felt this would be best determined by the Income Tax Commissioners. The Clerk was instructed to appear before the Commissioners in support of the

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appeal, and a rating surveyor is to give evidence on behalf of the Council.

GLASGOW: *Power Signalling.*—The large new installation of electro-pneumatic signalling gear at the central station, which has been carried out by the McKenzie, Holland and Westinghouse Power Signal Co., was inaugurated last week. The main frame contains 340 levers. Shortly after the opening, however, a main fuse blew, and the whole traffic was stopped for a few minutes.

HAMPTON WICK: *Tramways.*—At the last meeting of the District Council it was reported that the Surveyor had examined the tramway track, and had found that from Normansfield Avenue to Kingston Bridge practically no repairs had been done, the track being in the same bad condition as mentioned in a police report. Although some repairs had been done in Hampton Court Road, the setts were generally in a bad condition. The Surveyor has been instructed to prepare a detailed report, which is to be sent to the tramways company, together with a request for the remedying of the defects.

HARTLEPOOL: *Street Lighting.*—The cost of street lighting for the last quarter has shown a decrease of £42, as against the corresponding quarter of last year.

LONDON: *London County Council: Metropolitan Electric Tramways Bill.*—The Highways Committee recommend that no opposition be offered to the Metropolitan Electric Tramways Bill, 1908, subject to the insertion therein of clauses providing (1) that the powers with respect to the proposed tramway extension along Harrow Road to Edgware Road shall not be exercised unless and until the Council gives its consent; (2) that in the event of the Council promoting a Bill hereafter for the construction of tramways along the same route, the company shall not oppose the proposal, except on details; and (3) for the protection of the Council's property and interests.

Tramways in the Metropolitan Area.—The Metropolitan Association of Electric Tramway Managers are suggesting to various Metropolitan Councils that representations should be made to Parliament with a view to securing a provision that contribution should be paid by motor-omnibus proprietors towards road maintenance in each local area in which such conveyances run, and that the tramways undertakings, failing such contribution being made, should not be responsible for making good repairs necessitated by the running of the vehicles. The association are of opinion that, under existing conditions, the greater part of the repairs necessitated by the running of motor-omnibuses falls upon tramways undertakings under the provisions of the Tramways Act, 1870, and considers it manifestly unjust that tramways should be held liable to construct, maintain, and repair roads damaged by competing vehicles which, in most instances, are not even rated in the district. The association is also requesting the support of the Metropolitan Councils to the effort being made to revise Metropolitan Public Carriage Act, 1869, in order to obviate the present unnecessary expense and inconvenience to the tramways undertakings in connection with the licensing of tramcars, motormen, and conductors.

Camberwell.—The Borough Council has been informed by the Board of Trade that the Board have consented to the electrification of the London County Council tramways (partly situated within the borough) from Brixton Road, via Gresham Road and Coldharbour Lane, to Denmark Hill, and have approved the rail, paving, and substructure proposed to be adopted in the re-construction.

Westminster: Supply to the City Council.—The contracts of the Metropolitan Electric Supply Corporation, the St. James's & Pall Mall Electric Light Co., Ltd., the London Electric Supply Corporation, and the Charing Cross, West End & City Electricity Supply Co., Ltd., to supply current to the premises in the occupation of the City Council at 2½d. per unit for lighting and 2d. per unit for all other purposes, expires on June 24th. The Westminster Electric Supply Corporation, whose contract expired last January, reduced their charge for power heating and cooking to 1d. per unit, as from January 1st, 1906. The other companies are to be asked at what reduced price they will be prepared to enter into fresh contracts for one or three years. In consequence of the inconvenience which results from the Post Office Telegraph Department carrying out work during the season, the Works Committee state that they will advise the Council to refuse their consent in future to any telegraph works proposed to be laid through an important main thoroughfare, unless the work be done at a period of the year when the execution of same will cause the least amount of inconvenience to the public.

MANCHESTER: *Hire Purchase Wiring Scheme Abandoned.*—On Wednesday last week the Electricity Committee asked the Council for leave to borrow £130,500. As stated in our last issue, the original sum was about £500 in excess of this, but, owing to opposition to the proposed "assisted" wiring scheme, this scheme has been abandoned, and the sum allocated for this purpose will therefore not be borrowed. The money is required for extensions at the Stuart Street and Dickinson Street works. Included in the estimates was a sum of £13,500 for "bore-holes, complete, with electrically-driven pumps, softening plant, cabling, and pipe work." At present the water supply at Stuart Street is taken from the town's mains, and it is proposed to sink an artesian well at a point half a mile distant from the station, which it is hoped will supply sufficient water both for make-up feed and the make-up of the circulating water for the condensers (circulating condensers with cooling towers are used). The committee estimate that they could save £2,000 a year by this expenditure, as the daily water consumption at Stuart Street amounts to 400,000 gallons, and costs the Electricity Committee about £3,400 a year. It is estimated that the well should be capable of delivering 1,200,000 gallons per day of eighteen hours, and thus be sufficient for the requirements of the station for the next few years. Mr. Bowie and Mr. Heggs argued that the money would be wasted, as the water was already there, and it was only a question of taking money from one department and putting it into another. Mr. Hynes said that he would oppose the application for the loan at the Local Government Board inquiry. He complained that the capital of the electricity works was £2,385,495, and that as there were 7,000 consumers, this represented a cost of £341 per consumer. Mr. Jackson pointed out that at present the water was not brought from Thirlmere for nothing, and Sir Bosdin Leech, the Chairman of the Waterworks Committee, expressed his approval of the new scheme. Mr. Hargreaves suggested that the river Medlock should be utilised. Mr. Kay, Deputy-Chairman of the Electricity Committee, replied to all the objections, and also pointed to the risk they would run if they were dependent on one source of supply only for their water. The proposal was then adopted.

NELSON: *Electricity Accounts.*—The net profit of the Electricity Department for the year has been £591. A steady increase is being maintained in the load the units sold during the year amounting to 872,534. There has been a small profit on the tramways of £22, instead of an estimated deficit of £159. The receipts per car mile have averaged 8·63d.

SUTTON COLDFIELD: *Electricity Accounts.*—During the year ended March 31st, the units sold have been 347,820, an increase of 24,919 since the previous year. The maximum load has decreased from 931 to 908 kw. A slight increase in the working costs is reported, due mainly to the rise in the price of coal and increased cost of repairs. Last year's deficiency of £99 has been turned into a profit of £100. The total capital expenditure stands at £41,308, including £1,204 spent during the year.

TORQUAY: *Supply to the Tramways.*—Attention was called at a recent meeting of the Town Council to the incorrectness of a statement, that at the end of five years the tramway company would be able to withdraw from their present arrangement with the Corporation and put down their own generating plant. This was not so, as under their act they were bound to take current for an unlimited period from the Corporation unless they failed to supply. The profit on the electricity undertaking during the past year had been over £2,000, and the whole amount required in connection with the proposed removal of the generating station could be met without approaching the Local Government Board for a loan.

WATFORD: *Appointment of New Engineer.*—The Urban District Council has received no fewer than 210 applications for the post of Electrical Engineer. Before the final selection is made, the Electric Lighting Committee is to visit some six electric lighting undertakings, where some of the candidates are engaged, in order to see the actual nature of their work, and obtain other information.

WEST HAM: *Tramways.*—The Tramways Committee of the Council has consented to variation of agreements with the Leyton Council, with a view to extension of the through-running arrangements. In addition to the through services between Bow Bridge, "Green Man," Leytonstone, and "Rising Sun," and between Stratford and the "Bakers' Arms," it is suggested that, during the summer, direct facilities should be given from the south of the borough to Epping Forest, and it is intended to experiment with certain other services, such as a circular route—Stratford, Romford Road, Wanstead Flats, Cann Hall Road, Leytonstone Road, and The Grove, and, possibly, Clapton, "Bakers' Arms," Cann Hall Road, Forest Gate, and Green Street. The East Ham Corporation, having come to an arrangement with the North Metropolitan Tramways Co. for the purchase of the tramways line between Green Street and High Street, East Ham (the electrification of which is to be proceeded with at once), the committee has decided to carry out the overhead equipment of 336 yards of the northern line belonging to West Ham. The Tramways Manager has been in conference with the managers of East Ham and Ilford, so that through-running may commence as soon as the electrification is carried out, and, having regard to the three interests involved, and the varying earning capacity of the route in the different areas, the committee has approved of the proposed appointment of Mr. J. B. Hamilton, Tramways Manager of Leeds, and ex-President of the Municipal Tramways Association, to act as arbitrator to settle the through-running basis, conditionally that the other two authorities agree to abide by his award for a period of seven years. The Tramways Manager reports that during the past year the consumption of current per car mile shows an increase, and no bonus was earned during the quarter ended March 31st, in connection with the scheme providing for a payment to the traffic staff on decrease of current used. It is

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proposed that the Chairman of the Electric Lighting and Tramways Committee and the Tramways Manager represent the Borough Council at a conference of tramways authorities on "Mutual Insurance against Third-Party Risks," to be held in London this month. West Ham's experience has shown, says the Tramways Manager, that the risk in question may be borne by the undertaking at a cost below the premiums demanded by insurance companies, and there are other advantages derived from this matter not being placed in the hands of an outside company. A mutual scheme under which the individual risks of different tramways were carefully graded would, in the opinion of the Tramways Manager, prove useful in minimising undue risks in connection with claims amounting to, say, over £250.

TENDERS INVITED AND PROSPECTIVE BUSINESS

BEDFORD.—Tenders are invited for the supply of about 6,500 tons of Derbyshire and Nottinghamshire coal for the electricity works. Particulars from the Town Clerk, to whom tenders by May 15th.

BELGIUM.—Tenders are invited by the Société Nationale des Chemins de Fer Vicinaux, Rue de la Science 14, Brussels, for the supply and laying down of underground electric traction cables. Tenders to the Director General by May 27th.

CHRISTCHURCH.—A report is to be prepared as to the best method of lighting the workhouse and cottage homes.

CORK.—The Cork Joint Hospital Board have received permission from the Local Government Board for the erection of a sanatorium on a site at Stream Hill, near Doneraile, for which a loan of £12,000 had been asked. The plans for the erection of the sanatorium, which will be electrically lighted, are being drawn by Mr. W. H. Hill, architect, Cork.

DARTFORD.—The Engineer has been instructed to obtain tenders for condensing plant.

Tenders are invited for a supply of meters, house service cable, jointing material, and accessories for the electric lighting department. Full particulars from the Clerk to the Council, to whom tenders by June 9th.

DOVER.—The Corporation invite tenders for the supply of large and small Welsh coal, and 3,000 tons of North Country and Midland or small coal, for the electricity works. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by May 18th.

EAST HAM.—The Board of Trade have sanctioned the borrowing of £8,000 for the purchase of the North Metropolitan tramway track in Romford Road. Application has been made for sanction to the following loans:—£1,000 for roof coverings to tramcars, £1,620 for cooling plant for the electricity station, £2,000 for extension of mains.

EDINBURGH.—Tenders are invited for an electrical installation for lighting, heating, and power, at the College of Art, Edinburgh. Full particulars may be obtained from Mr. F. A. Newington, the Borough Electrical Engineer, and tenders to the Town Clerk by May 14th.

ELLAND.—An application is to be made to the Local Government Board for sanction to borrow £3,000 for extensions to the electricity works, in connection with the company which it is proposed to form to construct tramways in the district.

GRIMSBY.—Sanction has been given to the negotiation of a loan of £3,519 in connection with extensions of the plant at the electricity works.

HAMPSTEAD.—The Borough Council Finance Committee has passed an estimate, amounting to £278, for work on the low-tension network in order to improve the efficiency of the electric supply.

HANLEY.—The Corporation invite tenders for the supply and delivery of lamp columns and arc lamps. Particulars from the Borough Electrical Engineer.

HASLINGDEN.—The Local Government Board have approved plans for the erection of a new infirmary at a cost of over £32,000. The Guardians have instructed their architect (Mr. Ross, of Accrington) to prepare specifications.

ILFORD.—A Local Government Board inquiry was held last week into an application by the Council to borrow £27,000 for the purpose of the electric lighting undertaking.

LONDON: *Bermondsey.*—Tenders are invited for a boiler, steam dynamo, condenser and cooling tower. Particulars from the Borough Electrical Engineer (fee, £2 2s., returnable), and tenders to the Town Clerk by May 18th.

St. Marylebone.—The Finance Committee of the London County Council, in a report upon an application by the St. Marylebone Borough Council for a loan of £44,002 in connection with the Council's electric lighting undertaking, point out that it has been previously agreed to grant the application to the extent of £31,306. With regard to the balance of £12,696, this is made up as follows:—Engineering works consequent upon change of pressure, £5,963; and architectural works, £6,733. The committee recommend that sanction be granted to the reduced amount of £12,301, repayable as follows:—Buildings, £3,320, 50 years; change of pressure (miscellaneous items), £5,963; station lighting, £2,133; furniture, £885, 15 years.

London County Council.—The Highways Committee, in a report upon the tramways from Loughborough Junction to Norwood, recommend that these be converted to the overhead trolley system at a total cost of £45,335, made up as follows:—Track work, &c., excluding rails, £35,400; overhead equipment, £6,490; cable ducts and feeder pillars, £3,200; sub-station equipment, £240.

NEWCASTLE (STAFFS.).—Application is to be made to the Local Government Board for a loan of £700 for mains extensions.

NORWAY.—Tenders are invited by the 16th inst., by the Norwegian State Railways, for the erection of an electric lighting station at Kongsvenger Railway Station.

ROTHERHAM.—Application is to be made to the Local Government Board for sanction to borrow £5,300 for the erection of a turbo-generator condensing plant, switchboard, &c., at the generating station.

SOUTHEND.—The Corporation invite tenders for the supply and delivery of traction poles, brackets, overhead line material, and bonds in connection with the construction of 1,500 yards of single tramway track with loops, the rails and setts being supplied by the Corporation. Particulars from the Borough Electrical Engineer (fee £1 1s., returnable), and tenders to the Town Clerk by May 28th.

STOCKPORT.—A Local Government Board inquiry was held last week into an application by the Corporation for sanction to borrow £10,500 in connection with the electricity undertaking. It is proposed to put in an additional generator and to extend the mains.

WALSALL.—The Electric Lighting Committee invite tenders for the supply and erection of condensing plant, including surface condenser, air pumps, cooling tower, and water purifier. Specifications from the Borough Electrical Engineer (fee one guinea, returnable), and tenders to the Town Clerk by May 29th.

WEDNESBURY.—The Local Government Board have approved of a loan of £7,107 for new generating plant. The question of extension of supply in the King's Hill district has been held over, pending a decision as to the use of overhead wires by the Board of Trade.

WEST HAM.—The Local Government Board has sanctioned the borrowing of amounts totalling £64,317 in respect of the electricity undertaking, including the following items:—Additional plant, £17,076; extensions to Silvertown district, £17,212; prospective expenditure on mains, £14,300; prospective expenditure on transformers, £6,000; prospective expenditure on meters, £3,000; excess expenditure, Abbey Mills Station, £1,442; excess expenditure, Canning Town Station, £5,287. The Electric Lighting Committee has decided that the Electrical Engineer proceed with the erection of two of the five chain-grate stokers at the generating station included in his estimate of £51,600, for which an application for sanction to a loan has been authorised, at an estimated cost of £700.

TENDERS RECEIVED AND ACCEPTED

BRAY.—The following tenders have been accepted for electrical stores during the current year:—Fittings and accessories, General Electric Co. and British Insulated Helsby Cable Co.; carbons, Messrs. Johnson & Phillips; carbon lamps, the Cryselco Lamp Co.; Osram lamps, General Electric Co.; engine room stores, Messrs. Tuck & Co., Messrs. Tomey & Son, and General Electric Co.; cylinder oil, Vacuum Oil Co.; crank chamber oil, Wakefield Oil Co.

BRISTOL.—The following tenders have been accepted: a 150,000 gallon soft water storage tank at Avonmouth, Messrs. W. Cowlin & Son, £645; for the supply of coal to the Avonmouth Electricity Works, the Bedminster Collieries, Ltd., at an estimated value of £12,078.

DARLINGTON.—The tender of Messrs. Callender's Cable & Construction Co., Ltd., at £1,642 has been accepted for the erection of a sub-station with mains.

DERBY.—The tenders of Messrs. Johnson & Phillips, for L.T. cable, and of the British Insulated & Helsby Cables, Ltd., for high-tension cable have been accepted.

DURBAN.—The Corporation have placed an order with Messrs. Willans & Robinson for a condenser capable of dealing with 30,000 lb. of steam per hour.

GLASGOW.—Messrs. Willans and Robinson are supplying two condensers for dealing with 4,000 kw. each, to the Corporation.

JOHANNESBURG.—A condenser for dealing with 12,000 lbs. of steam per hour is being supplied by Messrs. Willans & Robinson for a mine near Johannesburg.

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LEEK.—The tender of Messrs. Mather & Platt, Ltd., for a supply of a generating set at £2,650 has been accepted.

LONDON: *London County Council.*—In connection with the construction of the new tramways from Hammersmith to Harlesden, it is decided to construct a siding at the Franco-British Exhibition in Wood Lane at a cost of about £1,950. It is recommended that the contract already entered into with Hadfields Steel Foundry, Ltd., be extended to include the special track work required for this siding.

Battersea.—Mains are to be extended to the Châlet in Battersea Park Road at a cost of £32 11s., and in other roads at a cost of £54 19s. In order to obviate vibration in steam pipes, which is set up when the turbo-generator set is running, an additional anchor is to be fixed at the centre of the main steam range at £9 12s. Callender's Cable & Construction Co., Ltd., have agreed to purchase old scrap iron at the Central Station for 44s. per ton.

City of London Union.—The tender of Messrs. Rinchin & Walton for repairs to the lighting installation at the Poplar Infirmary; Mr. Adrian Collins is the consulting engineer.

Hornsey. The Education Committee has decided that electric light be installed in the hall and classrooms at the North Harringay School, at an estimated cost of £154 6s. (Tantalum lamps will be used).

Islington.—The Council has placed an order with Messrs. Willans & Robinson for a condenser to deal with a 1,500 kw. turbine.

Hammersmith.—The Borough Council has received the following tenders for the supply of main switchgear:—Johnson & Phillips: (*a*) switchboard, £1,401 5s.; (*b*) cubicle work, No. 1½ in. slates; (*c*) select switch in oil, £50; (*d*) total without feeders, £1,451 5s.; (*e*) 20 feeder panels, £500; (*f*) complete contract, £1,951 5s. Johnson & Phillips, alternative tender: (*a*) £1,401 5s.; (*b*) £29; (*c*) £50; (*d*) £1,480 5s.; (*e*) £500; (*f*) £1,980 5s. Switchgear, Ltd. (provisionally accepted): (*a*) £1,344 10s.; (*b*) £150; (*c*) £70; (*d*) £1,544 10s.; (*e*) £470; (*f*) £2,014 10s. Spagnoletti, Ltd.: (*a*) £1,330; (*b*) £70; (*c*) £100; (*d*) £1,500; (*e*) £560; (*f*) £2,060. British Westinghouse Co.: (*a*) £1,344 10s.; (*b*) included in total; (*c*) included in total; (*d*) £1,534; (*e*) £574; (*f*) £2,108. Cowan's, Ltd.: (*a*) £1,575; (*b*) £120; (*c*) £118; (*d*) £1,813; (*e*) £515; (*f*) £2,129. Ferranti, Ltd.: (*a*) £1,519; (*b*) £562; (*c*) £200; (*d*) £2,281; (*e*) £700; (*f*) £2,981. The Electricity and Lighting Committee, reporting on the tenders, stated that a letter received from Messrs. Johnson & Phillips, in effect, materially increased the total amount of their tender, and, although the company had since virtually agreed to adhere to their original tender, the committee did not think the Council would be justified in further considering their tender. A letter had also been received from Messrs Spagnoletti, Ltd., reducing the amount of their tender to £1,969 5s., but as this was not received until after a recommendation to the Council setting out particulars of the various tenders received, the committee decided that permission could not be given for the amending of the tender. The provisional acceptance of the tender of Messrs. Switchgear's, Ltd., is subject to their undertaking to deliver the plant not later than July 31st.

The following tenders have been received for the supply of steam piping required in connection with the scheme for the extension of electricity department plant: John Spencer, Ltd. (provisionally accepted), £230 (welded-on flanges); Aiton & Co., £247 (welded-on branches); John Spencer, Ltd. (alternative), £255 10s. (rivetted-on flanges); Rosser & Russell, £261 (rivetted-on flanges); Aiton & Co. (alternative), £263 (rivetted-on branches); Stewarts & Lloyds, £289 15s. (welded-on flanges); Edward Le Bas & Co., £303 (rivetted-on flanges); Babcock & Wilcox, £320 (weldless mild steel).

The following tenders have been received for battery boosters and switchboards:—Premier Accumulator Co. (provisionally accepted): (*a*) battery with lead-lined cells, £650; (*b*) hand reversing booster at 500 revs., £155 10s.; (*c*) milking booster, £18 15s.; (*d*) switchboards, £115; (*e*) totals, £959 5s. Electrical Power Storage: (*a*) £622; (*b*) £163 5s. 6d.; (*c*) £51 10s.; (*d*) £140; (*e*) £976 15s. 6d. Tudor Accumulator Co.: (*a*) £896; (*b*) £163; (*c*) £52; (*d*) £63; (*e*) £979. Electrical Power Power Storage: (*a*) £622; (*b*) £198 10s.; (*c*) £65 10s.; (*d*) £98 14s.; (*e*) £984 14s. D.P. Battery Co.: (*a*) £560; (*b*) £198; (*c*) £65; (*d*) £80 15s.; (*e*) £1,003 15s. Chloride Electric Storage: (*a*) £692; (*b*) £172; (*c*) £52 16s.; (*d*) £95 10s.; (*e*) £1,012 6s. Hart Accumulator Co.: (*a*) £809 10s.; (*b*) £180, appx.; (*c*) £56 7s.; (*d*) pp. £156; (*e*) £1,192 17s. Pritchetts & Gold: (*a*) £783. Accumulator Industries: (*a*) £946 10s. Haven Accumulator Works: (*a*) £1,010. W. C. Rooper & Co.: (*a*) £1,421 12s.

Marylebone.—The Borough Council has accepted the following tenders for the annual supply of stores, materials, and tools for the Electricity Department: W. H. Wilcox & Co., Ltd., vaseline, 2s. 3d. per 5 lb.; best white rags, 35s. per cwt. Naylor Bros., Ltd., orange shellac varnish, 7s. 6d. per gal.; enamel: white, black, blue, P.O. red, black anti-sulphuric, 10s. each per gal. respectively. Pryke & Palmer, common resin, 11s. 9d. per cwt.; white resin, 14s. 9d. per cwt.; Dexine manhole gaskets, 3s. 10d. per lb. F. Bird & Co., spirits of salt, 10½d. per gal.; asphalte cutters, 3d. per lb.; 5 in. pipe cutters, 35s. each; side cutting pliers, 4 in., 6 in., 8 in., 10d., 1s., and 1s. 6d. per pair respectively; clasp knives (heavy), 1s. each; picks, 18s. 6d. per cwt.; pick shafts, 3 ft. hickory, 5s. per doz.; London shovels, No. 2 strap, 17s. per doz.; shovel handles, 5s. 6d. per doz.; steel road wedges, 16s. 6d. per cwt.; enamel iron saucepans, 4s. each; tinned copper wires, 14, 16, 18, 20, 22, 24, 26, 30, 36, S.W.G., 10d., 10½d., 10¾d., 11d., 11¼d., 1s. 0½d., 1s. 1d., 1s. 3d. per lb. respectively; tinned copper sheet, 24 S.W.G., 1s. per lb. Witty & Wyatt, ⅜ in. and ½ in. asbestos tubing, 1s. per lb. J. F. & G. Harris, meter boards, 18 in. by 15 in. by 1 in., 18s. and 15s. per doz.; 18 in. by 15 in. by ¾ in., 17s. and 14s. per doz.; 11 in. by 15 in. by ¾ in., 11s. and 9s. per doz.; banjo boards, 21s. and 18s. per doz.; battens, 11 in. by 3 in. by 1 in., 10d. per doz. H. W. Gilbart, creosoted troughing, 4 in. by 4 in., 24s. 6d. per 100 ft.; saddles for same, 5s. per doz.; brackets, 11s. per doz. Wm. McGeoch & Co., Ltd., black adhesive tape, 1s. per lb. St. Helen's Cable Co., Ltd., rubber gloves, 6s. 3d. per pair; 2 ft. by 2 ft. by 1.15 in. rubber mats, 11d. per lb. British Insulated & Helsby Cable Co., Ltd., pure tin fuse wires, 14, 16, 18, 20, 22, 24, 26, 30, 36, S.W.G., 2s., 2s., 2s. 1d., 2s. 2d., 2s. 4d., 2s. 7d., 3s., 3s. 3d., and 6s. per lb. respectively. Tulley & Straker, mica, 6 in. by 5 in., 4s. 2d. per lb.; 5 in. by 4 in., 2s. 11d. per lb.; 4 in. by 3 in., 1s. 11d. per lb. Baxter & Caunter, ceiling roses, 2s. 3d. per doz. Pope Electric Lamp Co., radiator lamps, 120 v., 24s. per doz.; 240 v., 26s. per doz. General Electric Co., steel conduit, 45 per cent. discount off list.

Metropolitan Asylums Board.—The offer of the Magneta Co. to install 30 clock dials, synchronised by electricity, at the Head Office, at an annual cost of £19, has been accepted.

NEWCASTLE (STAFFS.).—The tender of Messrs. Baggaley & Wood for laying 1,000 yards of three-wire mains, at £579, has been accepted.

SLEAFORD.—Messrs. Pattinson's tender for coal at 16s. per ton has been accepted.

SOUTHAMPTON.—Messrs. Willans & Robinson have been given an order for a condenser capable of dealing with a 15,000 kw. turbine.

The tender of West's Gas Improvement Co., Ltd., Manchester, for the supply and erection at the Westshore Electricity Works of a coal conveyor at £558, has been accepted.

SYDNEY.—A condenser for dealing with 2,000 lb. of steam per hour is being supplied to the University by Messrs. Willans & Robinson.

WEST HAM.—The Town Council has provisionally accepted the following tenders for annual supplies for the Electricity Department:—India-rubber covered wires: Liverpool Electric Cable Co., Ltd.; Plutte, Scheele & Co.; Armorduct Manufacturing Co., Ltd. (flexible wires, single vulcanised). Electrical fittings: Evered & Co.; Electrical Co., Ltd.; Armorduct Manufacturing Co., Ltd.; G. Straus & Co., Ltd.; G. Braulik; British Insulated & Helsby Cables, Ltd.; Verity's, Ltd.; General Electric Co., Ltd. Engine-room stores: Geo. Angus & Co., Ltd.; James Gibb & Co., Ltd.; H. Edmunds & Co.; Manufacturers' Agency Co., Ltd.; Fredk. Bird & Co.; Middleton Bros.; Pryke & Palmer; Wiggins & Rihll. Chemicals: Only one tender was received for chemicals, and this is not to be accepted, but the various articles are to be obtained at the following agreed prices:—F. W. Berk & Co., Ltd., sulphate of alumina, £4 5s. per ton; Middleton Bros., carbonate of soda, £5 5s. per ton; caustic potash, £1 8s. per ton; glycerine, 6s. 9d. per gallon; calcium chloride, 10s. per cwt.

APPOINTMENTS AND PERSONAL NOTES

The salary of the Works Superintendent at the Derby electricity works has been increased from £180 to £200 per annum, and that of the Chief Clerk from £2 10s. per week to £140 per annum, with a further increase to £150 per annum next year.

The West Ham Electric Lighting and Tramways Committee has decided to increase the salary of Mr. G. Lloyd Jones, Resident Engineer, from £260 to £280 per annum, rising to £300 per annum at the expiration of twelve months, and the salary of Mr. W. McKenzie, station foreman, from £3 10s. to £3 15s. per week.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Gilpot Lane, London, E.C., inform us that the price of electrolytic wire-bars, net c.i.f port of arrival, quoted on Tuesday night, was £58 5s. to £58 15s. per ton. (Last week £59 to £59 10s. per ton.)

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—The P.P.B. Syndicate is to be wound up voluntarily.

A meeting of the South Western Electrical Co., Ltd., will be held at the offices of Messrs. Elles, Salaman & Co., 1 Oxford Court, Cannon Street, London, E.C., on June 15th, at 12 noon, for the purpose of hearing the liquidator's account of the winding up.

A meeting of the Pioneer Gas, Electric Light & Power Co., of South Africa, Ltd., will be held at 35 New Broad Street, London, E.C., on June 12th, at 12 noon, to hear the liquidator's account of the winding-up.

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PARLIAMENTARY INTELLIGENCE

LONDON POWER BILLS.—A full report of the proceedings in the House of Lords Committee appears on pp. 721 to 750.

BRISTOL TRAMWAYS.—All opposition to this Bill has now been withdrawn, and it has been referred to the Unopposed Committee of the House of Lords.

ELECTRICAL FIRMS AND RATES OF WAGES.—In the House of Commons on Monday, Mr. Tyson Wilson asked the Postmaster-General whether he was aware that the India Rubber, Gutta Percha & Telegraph Works Co., of Silvertown, and the Western Electric Co., of North Woolwich, who contract for work and supply articles to the Post Office, paid many of their workmen less than the standard rate of wage, the amount in some instances being 8s. per week less than the recognised rate of the district; and whether he would take steps to induce these firms to comply with the fair wages clause. Mr. Sydney Buxton, in reply, asked the particular class or classes of workmen referred to, giving the rate of wages received by them. He would then have full inquiry made.

Another question on the same subject was addressed by Mr. Tyson Wilson to the First Lord of the Admiralty; whether he was aware that the firms of Messrs. W. T. Henley's Telegraph Works Co., the Western Electric Co., of North Woolwich, the India Rubber, Gutta Percha, and Telegraph Works Co., of Silvertown, and Messrs. Johnson & Phillips, of Charlton, who contract for and supply goods to the Admiralty, pay from 2s. to 8s. per week less than the standard rate of wage to many of the workmen in their employ; and whether, seeing that this was unfair both to the workmen and to firms that compete with them who did pay the standard rate of wage, he would take steps to induce those firms to pay the standard rate, or otherwise strike them off the list of firms that are allowed to contract for Admiralty work. Mr. M'Kenna replied that the Admiralty was not aware that the firms in question were paying wages below the current rate of the district. All contracts with those firms contained the usual clause as to the payment of the current rate, and no complaint of any breach of that clause had reached the Admiralty. If specific details of any cases of underpayment were furnished in respect of Admiralty contracts, full inquiry into the matter would be made and suitable action taken according to the result of any such inquiry.

ELECTRIC LIGHTING PROVISIONAL ORDER CONFIRMATION BILLS.—The Electric Lighting Provisional Order Confirmation Bill No. 1 confirms Provisional Orders by the Board of Trade under the Electric Lighting Acts for Bispham-with-Norbreck, Caldy Manor (Caldy Manor Estate, Ltd.), Carnarvon (J. B. Saunders & Co.), Fleetwood, Halesowen (G. Balfour), Heswall, Lowestoft, Portsmouth (amendment), Lymington (extension), Southampton (amendment), Woking (extension).

No. 2 confirms Orders granted by the Board of Trade under the Electric Lighting Acts to Barrhead (Strathclyde Electric Supply Co.), Clyde Bank (Clyde Valley Electrical Power Co.), Dundee (extension), Rutherglen.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY.—All opposition to this Bill has now been withdrawn, and it has been referred to the Unopposed Committee of the House of Lords.

HIGHGATE HILL TRAMWAYS.—The promoters of this Bill have intimated their intention not to proceed with it. This decision has been come to as a result of the agreement by which the London County Council will purchase the undertaking.

POTTERIES FEDERATION.—The Local Government Provision Order Confirmation Bill No. 3 confirms Provisional Order of the Local Government Board, consolidated various townships in the Potteries district of Burslem, Hanley, Longton, Stoke-upon-Trent, and Fenton and Tunstall. Article xvi. stipulates that the several electric lighting undertakings of the districts in question shall be carried on by the new Corporation as one undertaking, and a schedule to the Order gives the following list of Electric Lighting Orders which will be so absorbed into one undertaking:—Burslem Electric Lighting Orders of 1898-99, and the one authorising the Council to supply in Tunstall, granted in 1905; the Hanley Order of 1891; Longton, 1899; Stoke-upon-Trent, 1898 and 1907; and Fenton, 1907.

PROGRESS OF ELECTRICAL BILLS.—The Rochdale Corporation Bill was read a second time in the House of Lords on Wednesday last week.

The Edinburgh Corporation Tramways Order Confirmation Bill was read a third time in the House of Commons on Monday.

The King's College (London) Transfer Bill was read a third time in the House of Lords on Monday.

TRAMWAYS PROVISIONAL ORDER CONFIRMATION BILL (No. 2).—This Bill confirms provision orders made by the Board of Trade under the Tramways Acts, authorising the Liverpool Corporation to construct some short lengths of line. It also confirms an order authorising the Potteries Electric Traction Co. and the North Staffordshire Tramways Co. to double the existing tramways in Burslem, Hanley, Longton, Newcastle-under-Lyme, Stoke-on-Trent, Fenton, and Wolstanton.

MISCELLANEOUS CITY NOTES

BUENOS AYRES TRAMWAYS.—The directors of the Buenos Ayres New Tramways Co., Ltd., have convened a meeting of the holders of the four per cent. debentures for £250,000 for to-morrow, for the purpose of considering the following resolutions:—(1) That the company be authorised to increase the amount of the conversion debenture stock from £500,000 to £400,000, with power to further increase the amount by the creation of such an amount as may be necessary for redeeming the £50,000 six per cent. prior lien bonds. Provided that the further £100,000 of stock shall only be issued for raising the money required for the electrification and extension of the company's line, and for the other purposes of the agreement of November 27th, 1902, and that the provisions contained in the agreement as to the proportions which the issues of conversion debenture stock by this company and the Buenos Ayres Grand National Tramways Co., Ltd., are to bear to one another shall continue to apply; and (2) that the terms of issue of the five per cent. conversion debenture stock be varied so that, in the event of voluntary liquidation for the purpose of reconstruction or amalgamation, such stock shall be repayable at 105 per cent. instead of at par. The directors of the Buenos Ayres Grand National Tramways Co., Ltd., have also, says the *Financial Times*, convened a meeting of shareholders to-morrow to consider resolutions to increase the amount of the five per cent. conversion debenture stock to £900,000 by the issue of an additional £200,000 of the stock ranking *pari passu* with the stock at present authorised, and to further increase the conversion debenture stock beyond £900,000 by such amount as may be necessary for the purpose of raising the money required for the redemption of the £150,000 five and a half per cent. preference debentures at present ranking in priority thereto or any part thereof. It is also proposed to make certain variations in the terms of issue of the five per cent. conversion debenture stock, and of the six per cent. debentures, which, so far as the conversion debenture stock is concerned, are required by the Stock Exchange authorities as a condition of granting an official quotation for the stock. The directors, in the course of a circular, state that the proposed increase of the conversion debenture stock by £200,000 is required for the purpose of raising the further money necessary to complete the electrification of and to extend the company's system. The further increase of the conversion debenture stock will only become operative if and when it be decided to redeem the existing £150,000 preference debentures.

Institution of Electrical Engineers.—The following is the result of the ballot for new members at the meeting on Thursday:—*Associate Members:* S. K. Broadfoot, W. Golding, C. W. Inggs, W. E. Kidner, M. B. Logan, A. R. Macdonald, Dr. M. de A. Ramos, H. Robertson, L. A. Smart. *Associate:* T. Pearson. *Students:* R. G. Barton, H. N. Cunliffe, P. Furness, A. E. D. Kennard, D. J. Leacock, F. Parkinson, A. Schmidt, W. A. Stephens.

Obituary.—We regret to have to record the death of Mr. Benjamin Hawarth Thwaite, which took place at Egham on May 2nd. Mr. Thwaite was born in the year 1854, the son of a quarry owner. In his young days Mr. Thwaite was engaged in municipal engineering, and later as pupil and assistant to the late Sir William Siemens in South Wales. Subsequently he opened an office in Liverpool, and later came to London, practising in furnace work, metallurgy, and gas plant. He will, however, be best remembered as a pioneer in the use of blast-furnace gas for motive power purposes, though he never reaped any substantial reward from his work in this direction. Years ago he advocated the electrical transmission of energy from the coalfields to London, and two years ago gave his cordial assistance to a revised scheme with gas as motive power. Lately he has carried on experiments in the electrical forcing of plant growth. Other matters which claimed his attention were cement burning, mine-dust removal, and safety appliances. For the last year or two he had associated himself in business with Mr. T. E. Thorpe, who, with Mr. Alwyn Thwaite, have carried on the business at 29 Great George Street, S.W., and will continue the same.

Telegraph Traffic.—By reason of the break of communication between Chio and Tenedos, a cable belonging to the Eastern Telegraph Co., messages for Turkey are subject to delay, as they have to be sent via Syra-Chiotchesme. The Ottoman have, in consequence of the delay occasioned by this change, requested that they be sent by other routes. But telegrams are still being directed by this route. The Via Fao route has again been broken between Bagdad and Bassorah, but the trouble did not last long. We are able to announce that the cable between Mole St. Nicholas and Cape Haiti, in the Island of Haiti, was repaired on the 8th instant. This cable was interrupted on the 15th ultimo, so that the break lasted twenty-five days. Simultaneously with the above repair, we find that the cable between Cayenne and Salinas gave out, so that messages for Brazil cannot be accepted "via Hayti." This does not end the misfortunes of the Compagnie Française des Cables Telegraphiques, for on the 9th instant their cable between Martinique and Guadeloupe became interrupted. This, however, being a branch cable, will not affect through communication to the Guianas.

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Institution of Electrical Engineers: Council for 1908-9.—As no alternative nominations have been received, the gentlemen nominated to fill the vacancies on the Council of the Institution of Electrical Engineers have been duly elected. The Council will therefore be as follows:—*President:* W. M. Mordey. *Vice-Presidents:* Colonel H. C. L. Holden, F.R.S., Dr. G. Kapp, C. P. Sparks, and F. Gill. *Ordinary Members of Council:* S. Evershed, H. E. Harrison, Dr. E. Hopkinson, J. W. Jacomb-Hood, J. E. Kingsbury, M. O'Gorman, G. W. Partridge, W. H. Patchell, W. Rutherford, A. A. C. Swinton, T. Mather, F.R.S., Major W. A. J. O'Meara, C.M.G., Prof. Alfred Schwartz, J. F. C. Snell, and G. G. Stoney. *Associate Members of Council:* J. Hunter Gray, H. Human, and J. E. Taylor. *Honorary Treasurer:* Robert Hammond. *Chairmen of Local Sections:* Miles Walker (Manchester), W. W. Lackie (Glasgow), H. E. Yerbury (Leeds). The new Chairmen at the Newcastle, Dublin, Cape Town, and Calcutta Local Sections have not yet been announced. Dr. Kapp, who has been elected for a second year as Chairman of the Birmingham Local Section, is a Vice-President.

Birmingham Local Section of the Institution of Electrical Engineers.—The annual general meeting was held at the Grand Hotel, Birmingham, on May 6th. The chairman, Prof. Kapp, in moving the adoption of the committee's report, briefly reviewed the work of the session. He said that the new scheme of dealing with the Institution Papers was working very satisfactorily. Owing to the sad death of the President of the Institution, they had had to postpone the annual dinner of the Birmingham Local Section. It was hoped, however, that this function would be held next session sometime in November. There was a gratifying increase in the attendance at their meetings, the average attendance being 40 per cent. greater than the average of last session. Also their total membership had increased by 14 per cent. There was a proposal to include in the Birmingham Section the districts of Derby and Leicester, as well as Birmingham. He then made an appeal to members in connection with the Corps of Electrical Engineers now being raised in Birmingham in connection with the Territorial Army. The Institution of Electrical Engineers had taken this matter up, and he hoped that many members of the Local Section would offer their services in connection with the Birmingham companies. Mr. Jackson, in seconding the report, said that in looking at the attendance figures it was clear that Papers dealing with practical subjects were most popular.

COMPANIES' MEETINGS AND REPORTS

EASTERN TELEGRAPH.—At the half-yearly meeting on Tuesday, the report and accounts given in our last issue were adopted. Sir John Wolfe Barry, K.C.B., who presided, stated that the receipts from South Africa continued to decline, whilst those of India showed a slight improvement, but there was a steady increase in the traffic from South America. On the whole the revenue showed an increase of about £5,000 over that of the previous half-year. In view of the continued depression in South Africa, which was adversely affecting the company's receipts, the directors had decided to transfer the sum of £70,000 to the general reserve fund, which now amounts to £1,144,750. Very important renewals had been completed on one of their cables in the Indian Ocean, and the steamer "Duplex" had undergone extensive repairs in England.

KALGOORLIE ELECTRIC TRAMWAYS.—At the annual general meeting on Wednesday last week, the report and accounts given in our issue for April 30th were adopted. Mr. H. H. P. Stoneham, the chairman, who presided, said that the progress of the company was such that it was evident that the town had entered upon a period of commercial and economical prosperity.

NATIONAL ELECTRIC CONSTRUCTION.—Mr. L. B. Schlesinger presided at the meeting last Monday, and said that considering the general financial depression, the Board considered the year's results satisfactory. Although it was advisable to pass the dividend this year, there was a prospect of an interim dividend being declared later on. The result of the Musselburgh undertaking had been poor, but they looked for an increase in the value of the 20,000 ordinary shares, which they held, when certain extensions were completed. The receipts at Torquay had been excellent, averaging 12·18d. per car mile, but the weather had been against them. On the Mexborough and Swinton line there had been a great deal of trouble with the Dolter surface contact system, but the replacement of this by the overhead trolley system was in hand, and a portion of the reconstructed system would probably be ready at Whitsuntide. In spite of delays due to arbitration cases, &c., the large Rhondda system should be completed in about three months. He also referred to the Bill which had been obtained for the reconstruction of the Oxford tramway system, and the construction of the Dewsbury and Osset line, which was now in hand. In dealing with the accounts, he spoke of the difficulty in raising capital for schemes upon which they had to depend for earning dividends. The report and accounts were adopted.

POTTERIES ELECTRIC TRACTION.—Mr. G. F. M. Cornwallis West presided at the annual meeting in London, when the report and accounts given in our last issue were adopted. During the speech the chairman mentioned that the question of third party risk is now done entirely by a committee of the British Electrical Federation. With regard to the Federation of the majority of the towns and villages in the Potteries district, he stated that at present it was not known how far this would affect the company.

SOUTH METROPOLITAN ELECTRIC TRAMWAYS AND LIGHTING.—At the meeting on Monday, the report given on page 713 of our last issue was adopted. Mr. Tegetmeier, who presided, commented on the figures already given, and said that during the year nearly seven million passengers had been carried on their tramways.

UNDERGROUND ELECTRIC RAILWAYS OF LONDON.—At the meeting called on Monday, to consider the readjustment scheme prepared by the London Waterhouse Committee, Sir Edgar Speyer profoundly regretted the disappointing result of their labours, which he attributed mainly to the unfavourable state of the investment market, delays in completion, opposition from local authorities, and competition of motor-omnibuses and the rate-aided tramways of the London County Council. He also considered the scale on which the rates and taxes of the company had been assessed was unwarrantably severe, and this matter was further aggravated by the fact that their most serious competitors got off practically free in this respect. He considered their experts had been too sanguine in estimating the differences between English and American conditions. He spoke strongly in favour of the appointment of a Traffic Board on the lines recommended by the Royal Commission. The increases in the tube traffics were, however, satisfactory. The receipts for the first 12 weeks of 1908 on the Great Northern, Piccadilly, and Brompton Railway amounted to £584 per route mile per week, being an increase of about 37½ per cent. on £425, the figure for the corresponding weeks in 1907. Similarly, the Baker Street and Waterloo Railway showed traffic receipts of £728 per route mile per week in 1908, against £645 in the same weeks of 1907, or an increase of about 13 per cent. The Charing Cross, Euston and Hampstead Railway started with earnings at the rate of £335 per mile per week, and has already over £400 per mile per week. Sir Edgar Speyer then outlined the feature of the new scheme. The eighteen millions which had sufficed for their capital expenditure, &c., up to November last, has been raised as follows:—Share capital, £5,000,000, sale of notes, £7,000,000, sale of Tube and District debentures and shares, £3,000,000; sale of power house debentures, £800,000, and a loan of £1,000,000. In November last it became necessary to provide for the December coupon, and his own firm had advanced £175,000 for this purpose, and £300,000 of the issue of short notes. The new scheme provides for the issue of £1,000,000 of five per cent. prior lien bonds, due November 1st, 1920, which have been underwritten at 93 per cent. There are also created £3,000,000 four and a half per cent. bonds, due January 1st, 1933, and £5,200,000 six per cent. income bonds, due January 1st, 1948. The holders of the profit-sharing secured notes will be asked to exchange their notes as on the 1st December last, as to 40 per cent. of their nominal value into four and a half per cent. bonds at par, and as to 70 per cent. of their nominal value into income bonds at par. The shareholders would in future share the control with the note-holders, as the income bonds were given a vote. The future was not without promise, and he had no hesitation in recommending the acceptance of the scheme. Lord George Hamilton seconded the adoption of the scheme, which was carried.

CAPE TOWN TRAMWAYS.—The report for 1907 states that the company was formed to take over, and has taken over, the undertaking of the late Cape Town Consolidated Tramways and Land Company, Ltd., on the following basis:—The shareholders of the old company, in exchange for the 450,000 ordinary shares of £1 each held by them, have received 300,000 ordinary shares of £1 each in the new company credited as paid with 17s. 6d. per share, and with a liability of 2s. 6d. per share, which has since been called up and paid to the company in cash with the exception of £9 18s. still outstanding at the date of this report. The £400,000 five per cent. mortgage debentures of the old company have been exchanged for £400,000 five per cent. mortgage debentures of the new company in the same form as those of the old company, except that for the period ended June 30th, 1910, interest is only to be payable out of the profits of each year, so far as the same (if any) will extend. A further issue has been made of £50,000 debentures which were taken up at par by Messrs. Erlanger and Company, and Messrs. Wernher Beit and Company, making a total debenture issue of £450,000 redeemable at 105 per cent. in annual drawings commencing July 1st, 1911. The profit and loss account shows a debit balance of £711, which has been carried forward. The estate companies and the Camps Bay Tramway Company have declared no dividends since the reconstruction of this company. The Camps Bay Tramway Company, Ltd., has felt most severely the effects of the serious depression in Cape Colony, and their accounts show a loss of £2,954. During the past year the Parliament of the Cape Colony passed a Bill,

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granting to the Camps Bay Tramway Company relief from operating the Kloof Nek route to Camps Bay during the winter months, from May 1st to September 30th, except on certain stated public holidays.

EDMUNDSON'S ELECTRICITY CORPORATION.—A meeting of the debenture holders was held on Thursday to discuss the trust deed in connection with the raising of new capital as prior lien stock. Mr. Tuckett, K.C., one of the directors, deplored the necessity which had compelled them to resort to the creation of prior lien debenture stock, but this was an expedient which offered the only practicable and satisfactory solution of a difficult position in which the company now was. There was no question of the interests of the debenture holders being sacrificed, and although the new issue was by no means a satisfactory method of procedure from the point of view of the debenture holders, he was himself satisfied that not only would their interest be safeguarded, but their position would be improved. New capital was not required for any new policy of expansion, but solely for the development of their undertaking in order to bring them to a profitable stage. The new stock proposed was £200,000 five per cent. prior lien debenture stock, and £50,000 to be provided out of revenue. The issue, of course, would take place gradually, and would not be all met at once. An amendment was moved limiting the new capital to £100,000, to be raised in two amounts of £50,000 each, but eventually the directors agreed to adjourn the meeting.

KALGOORLIE ELECTRIC POWER AND LIGHTING.—At the annual meeting in London on Thursday, the report and accounts given in our issue for April 13th were adopted. Mr. R. W. Wallace, K.C., who presided, called attention to the fact that reconstruction of the company had resulted in an increase of the amount of capital given to the shareholders, and not a reduction. The trading account for 1907 had been a record one. The company claimed that their load factor upon the works was better than that of any electric supply company in the world.

SOUTH STAFFORDSHIRE TRAMWAYS (LESSEE).—The report for the year ended December 31st, 1907, states that the total revenue, including a dividend at the rate of 3 per cent. on the preference shares of the South Staffordshire Tramways Company, amounted to £49,786, against £43,741 for the preceding year. The expenditure (including rental of lines and other payments to local authorities, repairs and maintenance of track, and interest on loans) amounted to £45,562. The profit for the year amounts to £4,223, add amount brought forward £611—£4,835. Deducting debenture interest £1,668, and amount placed to renewals account £500, there is a balance available for distribution of £2,667. The directors propose to place £700 to sinking fund, and recommend a dividend of 6 per cent. on the cumulative preference shares for the six months ended January 15, 1905; and to carry forward £467. The capital expenditure in respect of the reconstruction of the tramways in Tipton, Darlaston, and Wednesbury amounted to £34,088, of which £18,392 has been recovered from the South Staffordshire Tramways Company in accordance with the agreement of May 25th, 1905. The Birmingham and Midland Tramways advanced on loan against security a total amount of £32,000, which was expended in payment of the balance on reconstruction, in repaying the loan of £9,000 to the South Staffordshire Tramways, and reducing the bank overdraft and sundry creditors by £11,345. The amount advanced by the Birmingham and Midland Tramways has been reduced by £2,083 since the close of the year. There is an amount of £6,271 8s. 2d. to be received from the Dudley Corporation in respect of the cost of reconstruction and electrical equipment of the portion of tramway in Dudley, as mentioned in the last report, which will be credited to capital account when received. All the old steam tramways have now been reconstructed and are working by electric traction, except a small section of about a quarter of a mile in Wednesbury which is not worked. The expenditure includes an increase of over £1,700 for interest on loans from the Birmingham and Midland and South Staffordshire Tramways Companies, and arrangements will be made as soon as possible with the Birmingham and Midland Company for the conversion of the existing loan into debenture stock.

SUBMARINE CABLES TRUST.—The revenue for the year ended April 15th, 1908, amounted to £2,394, and the expenditure to £1,157. To the balance is added £453 brought forward, making a total of £23,237. The payment of coupons required £18,378, the sum of £4,810 has been transferred to redemption fund, and the balance of £49,000 carried forward. During the year 41 certificates have been redeemed by purchase in the open market at a cost of £4,810.

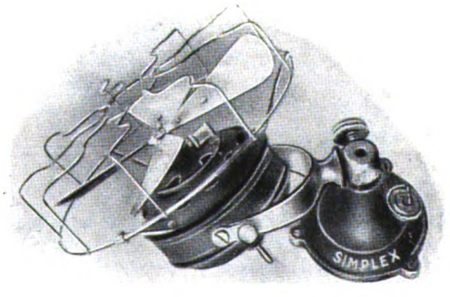
WESTERN TELEGRAPH.—The report and balance sheet for the half-year ended December 31st, 1907, shows a revenue of £353,815 and the working expenses £126,862. After providing £16,000 for debenture stock interest, and £4,464 10s. 11d. for income tax, there remains a balance of £206,488, to which is added the sum of £6,864 brought forward from June 30th last, making a total of £213,352. First and second interim dividends, amounting to £62,379, have been paid, and after transferring £120,000 to the general reserve fund, £5,000 to the maintenance ships' reserve fund, £10,000 to the marine insurance fund, and £10,000 to the land and buildings depreciation fund, there remains a balance of £5,972 18s. 2d., which is carried forward to the next account. The amount of £100,000 has been appropriated from the general reserve fund as a provision to meet the market fluctuations on investments, as shown on the balance sheet. The directors regret to report the death of their colleague, Mr. John Coppen, on November 20th, 1907. Mr. John Gordon has been appointed to the vacancy. The meeting is on the 13th inst.

CATALOGUES AND PAMPHLETS RECEIVED

AUTOMATIC FIRE ALARMS.—A booklet from the Pearson Fire Alarm Co., Ltd., calls attention to the advantages of the company's automatic fire alarm system, based on the use of automatic heat detectors or thermostats. Illustrations are given of the principal parts of the equipment, together with views of a number of important buildings where the system has been adopted. The thermostat itself is built in the form of an oblong chamber approximately 5 inches by 2 inches by 2 inches. This box carries upon the underside, fixed rigidly to it, two expansion strips. In the centre of each strip is erected a metal pin having an insulated tip. This pin passes into the box through a packed chamber, thereby guarding against any accumulation of moisture, acids, fumes, dust, &c., but leaving the expansion blade free to move for the purpose of making contact under the influence of heat. The internal apparatus consists of two contacts and a limit stop built upon an insulating base and connected to a terminal at each end. One contact is adjustable for a rapid rise of temperature, and can be safely and accurately adjusted to notify a rise of 15° F. The other contact is built upon a flexible hard-drawn phosphor-bronze spring, and rests upon one of the insulated pins of the expansion strips. Any deflexion of this strip by means of heat at once affects the position of the flexible contact, and when the heat reaches the dangerous temperature, contact is made and the alarm is given. Means are provided on the indicator board in connection with apparatus for periodically testing the circuits.

COOLING TOWERS.—A very handsomely produced catalogue is being issued by Messrs. Balke & Co., of 27 Clement's Lane, Lombard Street, who are specialists in water cooling plants and pumping machinery. The firm claim to have been the pioneers in 1894 of natural draught cooling towers of the chimney type, and inform us that they have supplied 1,900 cooling towers of all types and sizes in every part of the world. The internal arrangement of troughs, gutters, and lathes, where the flow of the water is broken up into drops and films, offering a maximum of cooling surface to the air, is usually of wood, but the tower itself can be of wood, steel, ferroconcrete, or brick construction, as most suitable under the local conditions. Diagrams are given showing the arrangement of typical towers, and no less than 25 large full-page illustrations are given, reproduced from photographs of cooling towers in this country and abroad. These represent a variety of types, and include apparatus at the Cardiff, Oldham, Clyde Valley, Bermondsey, Hampstead, Sunderland, and Charing Cross and City electricity works, and the fine new brick tower at the generating station of the Central London Railway, which is described in some detail in another part of this issue.

ELECTRIC FANS.—Appropriately to the advent of warmer weather, Simplex Conduits, Ltd., have issued a new catalogue of electric fans. In the continuous-current fan motors, the round field frame is of cast iron, protected by a coat of enamel. The former wound field coils are wrapped with tape and are of silk-covered wire, protected by a heavy coat of shellac varnish. They are subjected to a test at 1,000 volts before leaving the works. The armature is drum wound, and



special care is taken in the construction of the commutators and brush gear to avoid all possibility of sparking. Automatic oil cups and self-aligning bearings are provided. Speed regulation is obtained by means of a switch and rheostat concealed in the base of the fan. The guards of all fans are of stout brass, and the blades, heavily nickel plated, carefully balanced to prevent the motor from vibrating. The alternating current fans

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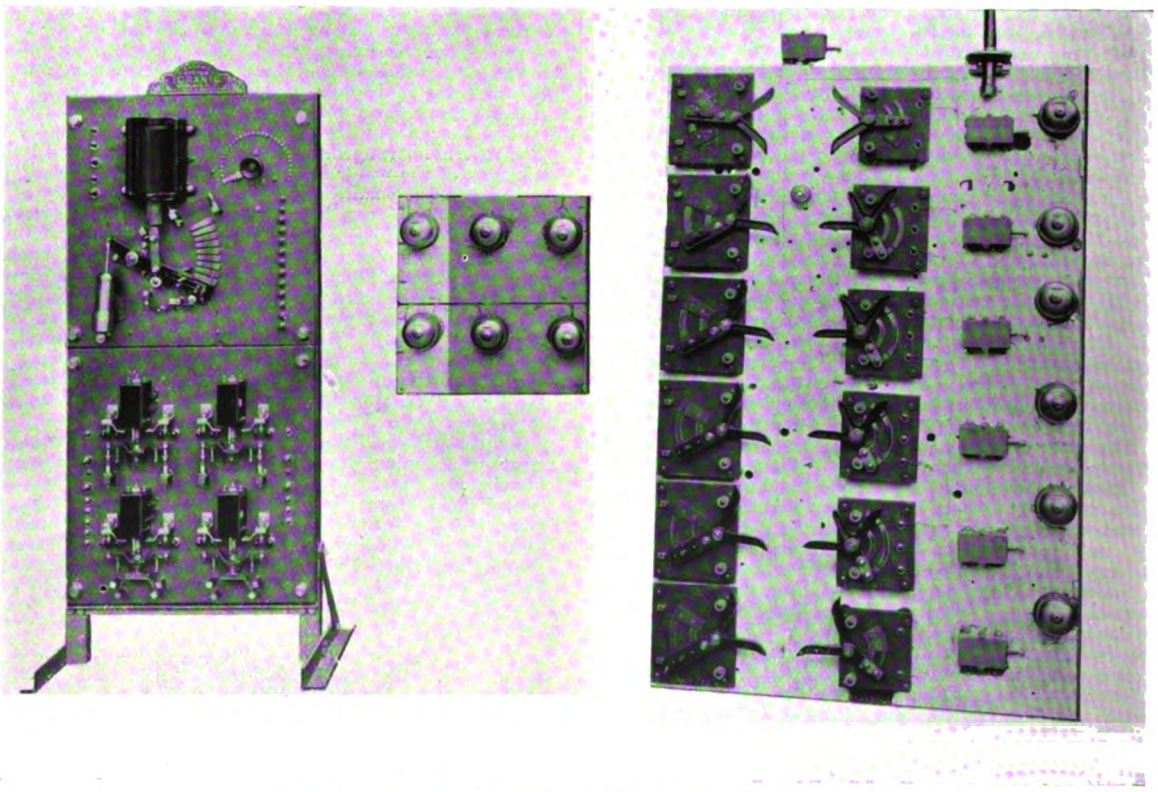
are of the induction type. The armatures are constructed of soft iron laminations assembled on brass spiders and held between copper discs at the ends of the cores. The air gap between stator and rotor is reduced to a minimum, which is essential if efficiency is to be obtained. The speed regulation on the fans generally covers about 300 revs. per minute; for example, on 12 in. fans it is 1,400, 1,300, 1,100, and so on. Most types are supplied with 10 in., 12 in., 16 in., diameter blades. The standard finish is of black enamel, relieved with gold lines. The accompanying illustration shows one of the many types listed.

ELECTRIC TRAVELLING HOISTS.—A leaflet has been issued by Kramos, Ltd., of Locksbrook Engineering Works, Bath, on which are depicted various types of electric hoists for foundries, shops, and warehouses. Among these are monorail trolley hoists arranged for hand travel and with remote control. Others are fitted with a pendant cord control, and some of the larger hoists are arranged for cab control. This firm also supplies lifting magnets up to 10 tons capacity for handling steel bars, plates, tubes, pig-iron, &c. Some spur-geared winches for both stationary and remote control are also illustrated. It is stated on the leaflet that a load of one ton can be lifted and lowered through a distance of 10 ft. fifty times with a total consumption of one B.O.T. unit, or for a total cost of 1d., assuming this to be the price per unit.

ELECTROSTATIC VOLTMETERS.—A new list which the Union Electric Co. are about to issue gives particulars of electrostatic voltmeters, having a range up to 120,000 volts. The design of these voltmeters is such that the capacity of the voltmeter remains constant at all degrees of deflection, the damping is by means of a disc working in a powerful magnetic field, and that the scales may be expanded at about that part which is most used. In addition to this the instruments are of the switchboard form, and therefore are easily mounted either on the face of the switchboard, or sunk so that the dial appears through a circular aperture in the same. For all instruments up to 13,000 volts the same rating is obtained with direct or alternating current of any frequency or current curve, while for higher voltages than this the instruments are only suitable for alternating currents and must be adjusted for the frequency while remaining independent of the current curve Owing to the very small energy taken by these instruments they are particularly suitable for measuring earth leakages on high-pressure circuits and for cable and other insulation tests. The instruments can all be supplied with two and three scale ranges, and in a portable form up to 13,000 volts.

A RECENT DESIGN OF LIFT CONTROLLER

THE accompanying illustration is reproduced from a photograph of a complete push-button controlling equipment for a six floor lift, which has recently been manufactured by the Adams Manufacturing Co., of London and Bedford. The apparatus is shown mounted all together roughly on a board for testing purposes, and will be seen to consist of a control panel, mounted in a convenient form so as to stand upon the floor, six patent magnetic push buttons, which are intended to be mounted inside the car, six patent magnetic push buttons which are intended to be mounted one upon each floor at each entrance to the lift, and also six tappet reversing switches, and six tappet switches to ensure accuracy of stopping.



SIX FLOOR PUSH BUTTON CONTROL LIFT EQUIPMENT.

There are also seven gate switches, one for each gate giving access to the lift, and one for the gate of the car itself, as well as a floor switch and a small emergency push button, which can be used by the passenger to stop the lift instantly at any position in case of emergency. The tappet reversing switches, as well as the tappet switches for accurate stopping, are operated by the travel of the car itself, so that the operation of this lift is entirely automatic and does not require the intervention of an attendant at all.

To call the car, the passenger presses a button just as if ringing a bell. If not already in use, this causes the car to come to the passenger, stop opposite to him, and unlock the gate for him to enter. Having entered and closed the gate behind him, he presses a button inside the car, which is labelled to correspond with the floor to which he wishes to travel. This causes the car to travel to that floor, where it stops and unlocks the gate for the passenger to alight. When he has alighted and closed the gate, the lift is at the disposal of any other passenger.

Among the advantages of the push-button method of control are the fact that the lift is always available, day or night; no attendant is required; the lift cannot be started while any gate is open; no gate can be opened unless the car is opposite to it; and the lift cannot be operated from outside while a passenger is in the car. In case of emergency the passenger can stop the lift instantly by pressing the emergency button, fixed inside the car, which works independently of the other push buttons. The lift can then only be restarted from the car, and the circuits are so arranged that the push buttons on the various floors will then have no effect.

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ELECTRICAL ENGINEERING

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SUMMARY

Mr. F. H. Webb, who was Secretary of the Institution of Electrical Engineers from 1878 to 1898, died last Thursday at the age of 84. (Page 762.)

Some notes are given on the Merz-Price system of automatic protection of high-tension circuits, in which the release of the circuit-breakers is effected when there is a lack of equality between the power flowing into and out of the ends of a feeder or inter-connector due to a fault on the section. It is claimed that this method avoids the isolation of healthy sections of the network, which is liable to occur when several overload circuit-breakers are used in series. The system is extensively used in the North of England. (Page 763.)

The Bournemouth tramway disaster inquest was resumed on Wednesday of last week, and further evidence was given as to the condition of the track and the efficiency of the brakes. The traffic manager, Mr. Barber, thought that the driver should have applied the hand-brake sooner than he did, and that he would have done so, had he known that the magnetic brake was not working. As the driver is still too unwell to attend, the inquest is adjourned until May 27th. (Page 764.)

The accounts of the Leeds Corporation Electricity Department show a considerable increase of business, especially in the power load. The working expenses per unit are 0·67d., and the total expenses (including capital charges) are 2·06d. per unit. An interesting item in the costs is "Wages incurred on extensions, but not chargeable to capital account, being paid to Corporation's permanent workmen, 0·02d. per unit." (Page 765.)

We give a few more particulars of the scheme relating to "Authorised Contractors" for wiring work in Birmingham. (Page 766.)

At the National Telephone Co.'s Staff Dinner last Thursday, the President and Secretary of the Company both gave assurances to the staff that their interests would be looked after when the system was transferred to the Post Office on January 1st, 1912, and that the Pension Fund would be not only equal to its obligations, but would show a handsome surplus in which all members would participate. From another note it will be seen that an announcement has been made by the Postmaster-General that, in some cases, the seniority of the present officers in the Post Office service may be affected by the transfer. (Pages 766 and 793.)

We are able to give this week the results of experience with metallic filament lamps for street lighting at Croydon and Exeter, which fully bear out the excellent figures of life and cost relating to a number of other places given in our last two issues. (Page 767.)

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A FULL-SIZE illustration of an E.H.T. submarine cable for laying across Sydney Harbour is given on Page 767.

WE have received several more letters on the suggested use of the term "wire lamp." It is again pointed out that only one of the metallic filament lamps at present on the market has a wire-drawn filament. Some correspondents favour the term metal lamp, and other titles based on the high efficiency of the lamps are proposed. (Page 768.)

DR. C. C. GARRARD's Paper on Switchgear control apparatus and relays for alternating-current circuits, read at last Thursday's meeting of the Institution of Electrical Engineers, was devoted partly to pointing out some principles which had been applied in a number of systems, but were, in the author's opinion, erroneous, and partly to the description of a system of protecting interconnector cables by means of electrically interlocked reverse relays. The question of long and short time limits was also dealt with. An interesting discussion followed, in which several well-known designers of switchgear and engineers with experience of high-tension systems took part. Mr. H. W. CLOTHIER and Mr. B. WELBOURN both spoke of the advantages of the Merz-Price balanced system, especially for interconnected sub-stations and complicated networks. Mr. J. G. STATTER gave some curves of time-lag settings for his own apparatus, and Mr. WEDMORE, in a long speech, answered some of Dr. Garrard's criticisms of polyphase relays, fuse-shunted trip coils, and other apparatus, and put in a plea for simplicity in switchgear. Mr. LEONARD ANDREWS, whose pioneering work in the subject had been referred to by several speakers, examined one of Dr. Garrard's curves in detail, and referred to the question of protection against the effects on the system of loss of field of one of several generators running in parallel. He admitted the excellence of the Merz-Price system for the protection of interconnectors, but for most purposes preferred a simple discriminating device. Mr. K. EDGCUMBE and Mr. B. JENKIN also spoke. (Page 769.)

AT the annual meeting of the Iron and Steel Institute last week, two Papers of electrical interest were included in the programme. The first, by Prof. B. IGEWSKY, described a new form of electric furnace for smelting iron. The furnace-bricks are arranged radially and set in a frame so that the whole may be rotated. The electrodes are placed radially between the bricks, and are connected to a commutator. The metal is placed in the centre of the ring of bricks as soon as these have been raised to a sufficiently high temperature at the surface to conduct the current. The second Paper dealt with the pyrometric installation of the Ordnance Factories, Woolwich. The construction of the thermo-couples and the recording galvanometers was fully described, and the sources of possible error in measurements were discussed. (Page 777.)

MR. MANSBRIDGE'S Paper on the manufacture of electrical condensers for telegraphy and telephony, an abstract of which was given in our last week's issue, was read and discussed on Thursday, May 7th. Sir JOHN GAVEY, who opened the discussion, said that when condensers were introduced for telephone work, it was expected that the same troubles would be experienced as with the plate lightning arrester, but fortunately the capacity of the condenser absorbed the charge. Mr. J. E. KINGSBURY said that Mr. Mansbridge's process had been adopted at the London factory of the Western Electric Co. Mr. A. WHALLEY referred to the possible use of condensers in electric lighting circuits, in which small transformers were employed, for the purpose of increasing the power-factor. Some statistics relating to the condensers in use in the telegraphic and telephonic departments of the General Post Office were given by Major W. A. J. O'MEARA. Mr. B. S. COHEN gave figures showing enormously different results in some cases between measurements of the capacity of condensers with continuous and alternating current respectively. Mr. H. OPPENHEIMER spoke of the excellent results that had been reached in the commercial manufacture of condensers, the percentage of "wasters" having been reduced from 7 to 0·2 per cent. Some difficulties in the use of glass condensers in wireless telegraphy were mentioned by Mr. J. E. TAYLOR. Dr. S. P. THOMPSON referred to the possible coherer action of the unburnished metallised paper, and Mr. W. M. MORDEY emphasised the importance of the losses in the dielectric if condensers are to be used in heavy electrical engineering work. (Page 780.)

THE engineering evidence on behalf of the London and District Electric Power Bill, which is being considered by Lord CROMER'S Committee in the House of Lords, was completed on Tuesday. Mr. PARSHALL, who was re-examined on Wednesday last week, was followed by Mr. ROBERT HAMMOND, who gave his views on the proposal for linking up the existing generating stations in London, contained in the other two Bills. He said that the idea had long been given up as an absurdity, for it only perpetuated the existing evils. He did not say that linking up was an engineering impossibility, but the expense involved would be against cheap generation. In preparing the tables which showed the savings to the authorised distributors by taking a supply in bulk from the power company and in estimating the capital charges which would still have to be paid, Mr. Hammond said he had taken 60 years for buildings, 25 years for plant, 30 years for cables, and 10 years for meters, these terms being now generally agreed upon by the electrical engineering profession. He thought the protection given in the Bill to the authorised undertakers in regard to consumers up to 250 kw. was a very strong protection indeed, and secured them the small consumer, a class of business which they were particularly able to cope with because they were so well situated for distribution. Mr. Hammond's cross-examination was commenced on Friday, and continued until the committee rose on Tuesday. As in the case of the cross-examination of Mr. Parshall, the general tendency of the cross-examination was to show that the figures upon which the estimates of saving to the authorised distributors had been based by the promoters, were quite wrong, and that in consequence the success of the scheme foreshadowed was erroneous. Most of the opposition council had worked out that instead of making a profit by taking a supply in bulk, they would actually make a loss as compared with their present financial position. During the proceedings Lord CROMER enquired what would be the effect of passing all the three Bills before the Committee. Yesterday, Sir HUGH BELL said he would be responsible for raising £250,000 of the capital required, and that Lord FITZWILLIAM would also contribute a considerable sum. (Pages 762 and 783.)

THE French Bullier patents for the manufacture of calcium carbide expire at the beginning of next year. M. GIROD, who has been so successful in producing ferro-alloys in the electric furnace, is installing two eight-ton and two six-ton furnaces for the electric manufacture of steel at Ugines in Savoy. Under "Electrochemistry and Electrometallurgy" a note on a new method of rust prevention is also given. (Page 787.)

UNDER "Electrical Science," in the British and American Section, is a note on some of the principal exhibits of electrical interest at the Royal Society conversazione. An account of a new form of voltameter is also given, and some experiments which throw doubt on the supposed radioactivity of the alkali metals are referred to. In the Papers abstracted in the Continental Section, FERY describes a new form of automatic

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photometer which is independent of eye observations; URBAIN finds that dysprosium is far more highly magnetic than iron; and VAILLANT proposes to employ Roentgen rays as a test for infant life. (Page 787.)

A PATENT specification by W. J. DAVY, published on Thursday last, describes an automatic switch for use with small house transformers. The primary of the transformer is connected to the mains only when one or more lamps in the secondary circuit are switched on. Another specification by F. J. PLANCHON deals with the manufacture of metallic filaments; and the BRITISH THOMSON-HOUSTON Co. have one relating to a new process for depositing a thin insulating film on armature or transformer laminations. The application of the flywheel machine for equalising the load on the generators of a direct-current series power system, when the motors are working on intermittent loads, is described in a specification by J. S. HIGHFIELD. A method of employing electricity for stimulating vegetable growth is patented by J. NEWMAN and L. LODGE; the method consists in maintaining a continuous discharge to earth from a wire network stretched on insulating supports above the surface of the ground, and dimensions and voltages are included in the specification. There are applications for amendments to three specifications, of which the first concerns switches, the second arc lamps, and the third incandescent lamps. A patent covering the use of electric lamps for the illumination of compass, clock, and other instrument dials expires during the current week. (Page 789.)

THE accounts of the Stepney Borough Council show a substantial increase of income, notwithstanding a 7 per cent. decrease in the price obtained per unit.—The revised terms of the North Metropolitan Electric Power Supply Co. for the bulk supply of Willesden have not been accepted.—The National Electric Construction Co. have offered to replace the arc lamps which have given trouble at Musselburgh.—The Borough Council are to purchase the plant in the Yardley power station of the City of Birmingham Tramways Co.—An arrangement has been arrived at for the through running of electric trams between Accrington and Haslingden.—The Provisional Order of the Llanelly and District Electric Light and Traction Co. has been transferred to the Llanelly Council.—At Burnley during last year £615 was spent in removing rail corrugations. The length of rail ground was 57,700 yards, and the proportion of rails corrugated 83 per cent. (Pages 791-793.)

TENDERS for condensing plant and switchboard extensions are required at Ilford, and for lead-covered cables at Handsworth.—A length of ⅜ of a mile of tramways now worked by horse traction by the Leyton Urban District Council, is to be converted to electric traction by the London County Council.—A large order for tantalum lamps for street lighting at Brighton has been received by Messrs. Siemens Brothers Dynamo Works.—The tender of Messrs. Hurst, Nelson & Co. for 175 car bodies, trucks, and equipments has been accepted by the London County Council. (Pages 794-5.)

AT the meeting of Callender's Cable & Construction Co. to-day, a 10 per cent. dividend will be recommended, with a bonus of 5s. per share; £10,000 is to be placed to suspense account, and £45,107 carried forward. The high price of copper and stringency of the money market has restricted business during the past year.—The Chairman of the Diesel Engine Co. reports the best year's working yet experienced. A new type of engine is to be produced.—The new issue of the Marconi Co. has been authorised at an extraordinary meeting.—Meetings have been held of several of the large cable companies during the week. (Page 795.)

WE publish some further letters this week with regard to Mr. MORDEY's proposal that the term "wire lamp" should be employed as the accepted designation of the new high-efficiency metallic filament lamp. Although the name would be undoubtedly convenient, and although it is, if considered as a description, sufficiently accurate for the purpose, it has not met with an enthusiastic reception; and, as a new conventional name for an article of common use, can only lead to confusion if it is not universally adopted, there is every probability that "metallic filament lamp," or its abbreviated form, "metal filament lamp," will remain. Several of our correspondents, it is true, have suggested "metal lamp" as a substitute, but we think that this name would tend to hinder rather than assist the conception of the lamp-user of the essential feature of this lamp. An arc lamp, a Nernst lamp, a mercury vapour lamp—and even a gas lamp or oil lamp—have all more metal about them than a metallic filament electric lamp. On the other hand, the public has been quick to accept the name tantalum lamp, which is more than a trade name for the Siemens metallic filament lamp, and the purely trade designation Osram for the lamp put on the market by the General Electric Co. has also become quite familiar. Names such as these, if sufficiently simple and pronounceable, are soon taken up by the retailers and the general public, and there is little danger of any article of real value being lost for want of a descriptive title. It will not be long, moreover, before the use of the new lamp is so widespread that the generic name "incandescent lamp" will be held to imply metallic filament lamp unless qualified by the words carbon filament or carbon.

WE are glad that Mr. HIRST'S Paper on the tungsten lamp is to be read this session, although it was received from the author at so late a date. It will be presented to the Institution to-night, and a good discussion may be expected, for it will afford an opportunity to the maker, seller, and user of lamps to give interesting and useful information. A second meeting has been allotted to the conclusion of the discussion, but nevertheless the time is none too long, and we trust that those speakers who usually express themselves only in generalisations and logical deductions will give way to others who are prepared to impart the results of tests and observations and real practical experience in connection with the new lamps. We have been fortunate enough to be able to collect some data of this character in our last few issues, especially as regards the life of the lamps under practical working conditions, but doubtless there is much more of a familiar character ripe for publication. To those who are unable to speak at the meeting and have useful data at their disposal our columns are open as usual.

THE Paper read by Dr. C. C. GARRARD at the last meeting of the Institution of Electrical Engineers was on a subject the importance of which is often underestimated. Some engineers are a little apt to look upon the relays and other protective appliances which form a feature of modern high-tension switchgear as the ingenious playthings of the instrument-maker, rather than integral and essential parts of the control equipment. When we reflect, however, that in large cable systems for power supply, working at high voltages, the

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continued existence of the valuable plant, as well as the avoidance of interruption of supply, may be said practically to depend on the correct performance of these delicate protective devices, the importance of the subject becomes obvious. As shown in the discussion, engineers are by no means agreed on all points as to the best protective systems, although there were several mistakes commonly made which they united to condemn. There is always a tendency for those whose work has brought them in contact with any particular system being unduly carried away by their enthusiasm in attempting to press its application too far. But, speaking generally, we were very glad to notice, among the rival switchgear designers who took part in the discussion, a most open-minded attitude in recognising the good points of their competitors' designs. While showing praiseworthy loyalty to their own firms, they realised that what is suitable in some special cases is not necessarily of universal application.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, MAY 21ST.

Institution of Electrical Engineers.

8 p.m. Meeting at the Royal Society of Arts, John Street, Adelphi, W.C. Paper to be read:—"Recent Progress in Tungsten Metallic Filament Lamps," by H. Hirst.

FRIDAY, MAY 22ND.

Physical Society.

5 p.m. Meeting in the Physics Laboratory, Royal College of Science, South Kensington. Among the papers to be read is the following:—"On the Production of Small Alternating Currents of variable frequency suitable for Telephonic and other Measurements," by B. S. Cohen.

SATURDAY, MAY 23RD.

Junior Institution of Engineers.

Visit to the Avonmouth Docks Works and Electricity Works, Bristol.

TUESDAY, MAY 26TH.

Faraday Society.

8 p.m. Ordinary Meeting at the Institution of Electrical Engineers, 92 Victoria Street, Westminster, S.W. Sir Oliver Lodge, F.R.S., will deliver his Presidential Address on "Some Aspects of the Work of Lord Kelvin."

THURSDAY, MAY 28TH.

Institution of Civil Engineers.

8.30 to 11 p.m. Conversazione at the Royal Albert Hall.

London Electric Power Bills.—A full report of the fifth, sixth, seventh, and eighth day's proceedings is given on pp. 783–786 of this issue. Yesterday, the financial evidence on behalf of the Bill was commenced Sir Hugh Owen Bell, managing director of Bell Bros., Ltd., and a director of Messrs. Dorman, Long & Co., and of the North-Eastern Steel Co., who is the chief promoter of the Bill, said he would be prepared to be responsible for the raising of £250,000 of the capital, provided the Bill passed in substantially its present form, and he was also authorised by Lord Fitzwilliam to say that he also would be prepared to be responsible for a considerable sum. Sir Hugh impressed upon the Committee that the promoters were not coming for this Bill as a matter of amusement, but as a serious matter of business, and, therefore, any restrictions as to the time in which a portion of the capital must be raised, should be as lenient as possible. The promoters were willing to agree to the term within which a substantial commencement with the work must be made being reduced from five to two years. He would not agree with any substantial alteration of the proposed purchase clause, and expressed the opinion that if conditions were imposed which precluded the possibility of the promoters getting their money back, the capital would not be found, no set of promoters would undertake to find it, and London would remain in the same position, as regards electric power and supply, as it was at present.

OBITUARY

FRANCIS HUGHES WEBB.

WE regret to have to record the death of Mr. F. H. Webb, who was for twenty years Secretary of the Institution of Electrical Engineers. He retired from the Secretaryship in 1898 on account of his advancing years, and has lived on to the ripe age of 84.

Mr. Webb had his first experience of secretarial work in 1844, when he was appointed Resident Secretary and Librarian to the Royal Institute of British Architects; he had previously been in the audit department of the London Brighton and South Coast Railway. Resigning this position in 1850, however, he entered the service of the Electric Telegraph Co., and subsequently became Private Secretary to the then Chairman of that company, the late General Leon Ricardo. Fourteen years later he returned to the London Brighton and South Coast Railway as Assistant Secretary.

From the start of the Society of Telegraph Engineers, in 1872, until Mr. Webb's appointment as Secretary in 1878, there were a number of Honorary Secretaries, including Mr. W. E. Langdon, Mr. George Preece, a brother of Sir William Preece, and Sir James Sivewright. In fact, Mr. Webb in 1878 at first was Honorary Secretary, and until 1885 only gave a portion of his time to the duties, but in that year he was appointed the first paid Secretary. The membership then was 958. The progress of the Institution during Mr. Webb's twenty years' tenure of the secretarial office is shown by the fact that the membership in 1898, when he retired on a pension unanimously granted by the Council, was 2,930. Mr. Webb, it will be remembered, was succeeded by Mr. W. G. McMillan, who died in 1904, when Mr. G. C. Lloyd, the present Secretary, was appointed to the office.

Mr. Webb's kindly manner, his unfailing courtesy to all, his sympathy with the aspirations of the younger members and students, and last, but not least, his entire devotion to the interests and well-being of the Institution, secured to him many friends, who will deplore his loss.

Breach of Contract for Electricity Supply.—In the Court of Appeal on Wednesday, May 15th, the case of Bourne and Hollingsworth v. The Marylebone Borough Council came before Sir Gorell Barnes and Lords Justices Moulton and Farwell. This was an application by the defendants for judgment or a new trial in an action tried before Mr. Justice Ridley. (See ELECTRICAL ENGINEERING, February 6th, p. 204, and February 13th, p. 253.) In the lower Court it was decided that certain letters written by Mr. Wright (Consulting Engineer) and by Mr. Wilkinson (Resident Engineer), and promising a supply of electricity at a certain date, were of the nature of contracts, and that, owing to failure to supply, the plaintiffs were entitled to £500 damages. Sir Gorell Barnes said that Mr. Wright's letter was not capable of being construed as a contract, and that although Mr. Wilkinson's letter might be looked upon as such, the latter had no authority to make a contract. The Electric Light Committee only could make an authorised contract. Judgment was accordingly entered for the defendants.

Telegraph Traffic.—The cable between Chio and Tenedos owned by the Eastern Telegraph Co., which was interrupted on 7th instant, was again put into working order on the 12th instant. This repair was followed by a breakdown on the 16th inst of the cable between Constantinople and Dardanelles, belonging to the same company, and a repair was effected on the 18th inst. On the same day traffic was stopped owing to a breakdown of the cable between Las Palmas (Grand Canary) and Arecife (Lonzarote). The *viâ* Fao route was, as usual, down and repaired within a short time, the trouble again occurring between Bagdad and Bassorah. The cables of the Compagnie Française des Cables Télégraphiques between Cayenne and Salinas and Martinique and Guadeloupe still remain interrupted. Owing to the break in the cable between Cadiz and Teneriffe, the Canary Islands can only be reached *viâ* the Cape Verde Islands, from whence there is a cable to Bathwest, which again is joined by cable to St. Louis. From the latter place there is a cable to Teneriffe.

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THE MERZ-PRICE SYSTEM OF AUTOMATIC PROTECTION OF HIGH-TENSION CIRCUITS

IN the discussion on Dr. Garrard's Paper at the last meeting of the Institution of Electrical Engineers, a good deal was said respecting the protective system of relays, &c., upon which Mr. C. H. Merz and Mr. B. Price have been working for some years, and which, we understand, is applied with considerable success on some of the high-tension cable systems of the large power companies in the north. Although this system is in somewhat extensive use, very little has hitherto

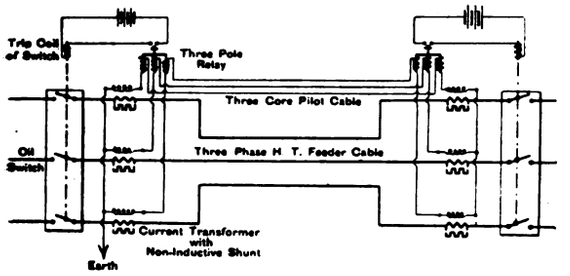


FIG. 1.—PROTECTION OF SINGLE FEEDER (E.M.F. BALANCING).

been published as to its working; and in connection with the discussion already referred to a few notes as to its aims and objects will be of interest. An idea as to the extent to which the system has been adopted may be gathered from the fact that something like 70 feeder-cables, covering a route length of about 200 miles, working at 6,000, 12,000, and 20,000 volts, together with 50 sub-stations with an aggregate capacity of 50,000 kw. of installed plant, are protected by apparatus of this nature, and it has been found that under ordinary working conditions a shock on the system at the moment of breakdown has been scarcely noticeable at the power station, and in no case has the synchronising plant in the sub-station been upset.

The general principle of the system is that a balance is created under normal conditions between the power which is flowing at the points of entry to and exit from the cable or apparatus to be protected, and means are taken whereby this balance is disturbed only when leakage takes place between the points of entry and exit due to breakdown. One way in which this system of balance is employed to control the relays may be seen by the aid of Fig. 1, which is a diagram of connections for a simple case of a three-phase feeder cable. A three-core low-tension pilot cable is laid in the same trough, and is connected up at each end to three-phase relays or to three single-phase relays and to the secondary windings of current transformers, the primaries of which are in series with the cores of the main feeder cable. These relays are of the simplest possible character. They only act as contact-makers, and are designed not only to instantaneously close the local battery circuit, but also to release a falling weight, which in turn short-circuits the contact just made. Since the current at both ends of the main cable (neglecting the inappreciable capacity current) must be the same at every instant, it will be evident that unless there is a leakage between the two sets of current transformers the inductive effects which this current will produce in the pilot wire circuits will be equal and opposite, so that no appreciable current will flow through the relays. As soon as there is a leakage, however, the balance will be upset, and a current capable of operating the relays will flow. In considering the advantages and disadvantages of this system as compared with others, the requirements which should be fulfilled may be classified as follows:—

(1) The system must discriminate with certainty, *i.e.*, it must be certain of action on faulty cables or apparatus, but must be inoperative with equal certainty on healthy sections.

(2) The system must be suitable for use on all possible arrangement of cables, whether these comprise separate feeders or form interconnectors on complicated networks, or consist of branch cables without switchgear at the points of junction.

(3) The system must be as instantaneous as possible in isolating a faulty piece of apparatus.

(4) The system must entail the simplest possible apparatus, as, although it only operates occasionally, it has to be capable of being absolutely relied on.

With regard to the certainty of discrimination, it is well known that with the ordinary systems of protection, when a fault occurs at some distance from the power station, the heavy rush of current has to flow through several overload relays in series. It is extremely difficult to prevent these from operating almost simultaneously and isolating the healthy sections of the system as well as those upon which the fault has occurred. The principle underlying the action of the balance system is such that this difficulty is avoided, as the action is the result of the combined effect of the current at both ends of the cable, whereas in the case of ordinary overload and reverse current system each end is controlled separately. It is thus seen that the operating system is independent of the magnitude of the current flowing, of the voltage on the network, and of the direction of flow of the power in any of the phases. Even if it were found possible in practice to discriminate satisfactorily between several overload and reverse current relays in series, it would still be impossible to apply this system to any great extent on extensive or interconnected systems. Take, for instance, a simple loop consisting of a number of sub-stations strung together, so to speak, by single cable links, power may flow in any direction around this loop under normal conditions, the direction depending on the relative loading of the sub-station at each particular instant, so that it is quite impossible to use reverse current relays. It is particularly for overcoming difficulties of this kind that the balance system has been devised. It should be pointed out that in order to obtain any discrimination at all between overload cut-outs in series, it is necessary to introduce an adjustable time element, with the result that excessive overloads have time to cause considerable disturbance before the circuit is broken. In the system we are considering it is not only possible for all the apparatus to be designed especially with a view to avoid time-lag, but in the majority of cases currents at both ends of the cable combine to operate the relay on the overload sections, and the apparatus is rendered doubly sensitive and rapid in action, besides being very considerably simplified in design.

This balancing may be obtained in several different ways; in some cases equal electromotive forces may be opposed to one another, and in others a form of magnetic balancing may be employed in which equal magneto-motive forces are opposed to one another in the same magnetic circuit. Experience has shown that the E.M.F. method is most readily applicable to the protection of feeder cables, whilst magnetic balancing is best suited to the protection of transformers and other

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station plant. When magnetic balancing is employed it is possible to combine the protective gear with measuring apparatus by using the same current transformers. The way in which these applications are arranged can be seen from the accompanying diagrams. The simplest case is that in Fig. 1, which represents the protection of a simple case by E.M.F. balancing with star-connected current transformers. In this connection it may be pointed out that it is advantageous to combine the armatures of the contact-makers for each phase into a three-pole instrument. The non-inductive shunts shown across the primary windings of the current transformers are not always necessary, but are usually employed. It is important that the pilot-wire circuits should be earthed at one end only, as otherwise there is a risk that current flowing in the earth at the moment when the breakdown occurs on some other part of the system may tend to flow through

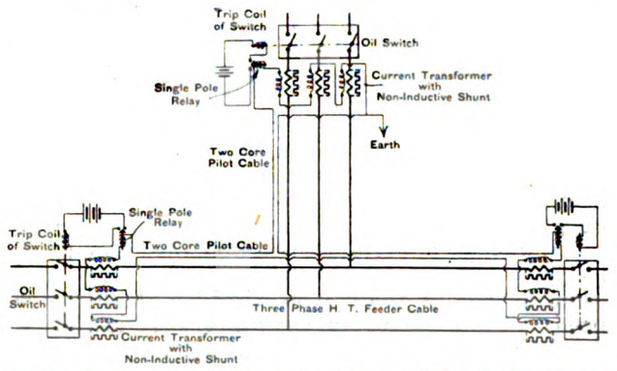


Fig. 2.—Protection of Branched Feeder (E.M.F. Balancing).

pilot wires and affect other parts of the system. In Fig. 2 is shown the method of protection of branched feeders by means of E.M.F. balancing with an open reverse delta connected current transformers. The protection of a transformer by means of magnetic balancing is shown in Fig. 3. As under normal conditions

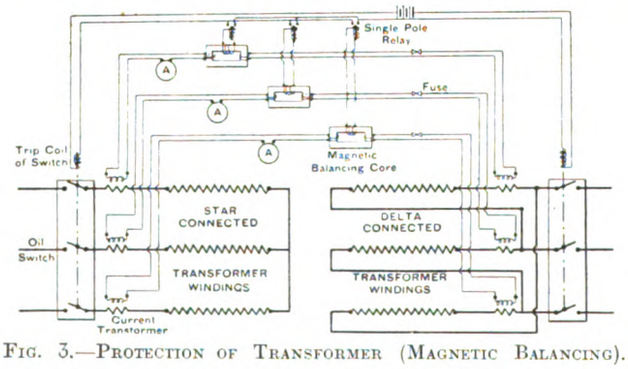


Fig. 3.—Protection of Transformer (Magnetic Balancing).

the magneto-motive forces in the magnetic balance cores are equal and opposite, the flux is practically zero, and the windings, therefore, are practically non-inductive; measuring instruments may, however, be connected as shown. Generators and other plant may be protected in a similar manner. Several further methods of applying the principle have been worked out and tried in practice with satisfactory results. Connections may be arranged in a variety of ways, but the principle is the same in all. A balance is created in effects due in same way or other to the current entering and leaving the system to be protected.

In the preparation of these notes upon the Merz-Price system we wish to acknowledge the assistance of the British Insulated & Helsby Cables, Ltd., to which firm the inventors have granted the sole patent rights on condition that they shall sub-let the licence to manufacturers of cables and switchgear on agreed terms.

BOURNEMOUTH TRAMWAY DISASTER

THE inquest on the death of seven persons, as a result of the tramway accident at Bournemouth on May 1st, was resumed on May 13th and continued on May 14th. The driver, who is still too unwell to attend, was represented by Mr. J. O'Connor, M.P. Details of the accident, and a report of the first two days' inquest, were given on page 713 of our issue of May 7th. It will be remembered that the car left the rails on a curve after descending a steep hill at a high speed. The hand brakes were found to be fixed tightly on the wheels after the accident, but the rear controller was found to be not in the off position, under which condition the magnetic brakes could not operate. It was admitted during the first day's inquest that three only of the four magnetic brake-shoes were in working condition, and also that on the day of the accident the controller had been found defective and had been repaired.

On Wednesday, May 13th, evidence was given by persons who had seen the accident to show that the car went down the hill at a high speed, and also that the driver was applying the brakes. Mr. F. W. Lacey, borough engineer, stated that the line on which the accident took place was relaid about two years ago, and would have been relaid again in six months or so. The rails were much worn, but there was a guard rail on the inner side at the curve. A car could go round safely at 10 or 12 miles per hour, but even with new rails a car would not get round safely at a speed of 15 or 20 miles per hour.

Mr. J. Bulfin, the borough electrical engineer, said that he inspected the rails an hour after the accident, and found both inner and outer rails in good condition for the proper speed, round the curve, of six miles per hour. He also confirmed the statement that, owing to the position of the controller handles, the magnetic brakes could not have been working, and that the only brake available was the hand brake. The latter, however, was sufficient if the speed was not allowed to get too high. With regard to the one defective magnetic brake-shoe, Mr. Bulfin said that of course four shoes would be more effective than three, but he would not have hesitated to allow a car to go down the hill with three instead of four shoes. Mr. C. Barber, traffic manager, said that the controllers and the brakes were examined twice a week. The hand brakes of the car in question were examined on the night previous to the accident and the controller on the previous Wednesday, but no report as to any defect was made. No car was allowed to go out with less than three shoes operative. He was perfectly satisfied that the magnetic brake of the car in question was working on the day of the accident.

On Thursday, May 14th, the examination of Mr. C. Barber was continued. He stated, in reply to Major Pringle, the Board of Trade inspector, that he had made the experiment of sending a car (similar to that which met with the accident), with 32 men upon it, down a gradient of 1 in 12, at a speed of 15 to 20 miles per hour. Full power was kept on up to a certain spot, and then, on shutting off the power and applying the four magnetic brake-shoes, the car was stopped after running an average distance of 80 ft. Three tests were made with three magnetic brake-shoes only, and the average distance in which the car was stopped was 84 ft. 3 in. The accident was, in his opinion, due to the failure of the magnetic brake, although, if the hand-brake had been applied in time, it should have been sufficient. He thought that the condition of the hand-brake indicated that it was not applied until the speed of the car had got too great. The failure of the magnetic brake was, he thought, due to the fact that the rear controller had become deranged unknown to the driver, in which case there would be no effect when he tried to put on the brake. There was also the possibility that the driver had accidentally left the controller in the wrong position when changing over at the terminus. Probably the driver did not apply the hand-brake soon enough because he was unaware that the magnetic brake was not working. If applied in time the hand-brake would have been sufficient, as for six months the cars had gone down this hill without magnetic brakes. W. Rushton, divisional inspector, stated that the car came in to be seen to on the afternoon of the accident. He made some adjustments to the controller, and satisfied himself that it was in good working condition, and the car went out on service again. W. Lait, depôt superintendent, who examined the controller after the accident, stated that he found the rear controller set one notch backwards, whereas it should have been in the neutral position. He did not think that the fall of the car could have caused that; it was more likely that it was in that position when the car left the terminus. This concluded the evidence on Thursday, and the inquest was adjourned until May 27th.

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LEEDS CORPORATION ELECTRICITY ACCOUNTS

WE have received from the Electric Lighting Department of the City of Leeds a comparative statement of the results of the past year's working with those of the preceding year, which was submitted to the Electricity Committee with the revenue accounts on Monday. The following table summarises the chief figures of interest, and shows the marked improvement in the business of the undertaking:—

	1906-7.	1907-8.
	£	£
Receipts from sales for private lighting	79,251	80,928
,, ,, street lighting	4,536	4,661
,, ,, power	24,472	27,847
Total receipts	108,260	113,436
Working expenses	32,468	35,276
	75,792	78,160
Extraordinary renewals	14,272	13,372
Gross profit	61,520	64,788
Income tax, interest, and redemption fund ...	58,110	57,866
Surplus	3,410	6,922
Units sold	11,368,956	12,412,861
Average price per unit	2·28*d.*	2·19*d.*
Expenses per unit including extraordinary renewals, interest, and redemption fund	2·21*d.*	2·06*d.*
Surplus per unit	0·07*d.*	0·13*d.*
Capital expended during the year (less credits)	£15,468	£35,425
Total capital expended to end of year	£843,323	£878,748

The following statement analyses the year's receipts for lighting and power purposes respectively, and indicates the growth of each branch of the business separately:—

LIGHTING.

Number of 35-watt lamps installed at 31st March, 1908	317,890
Number of 35-watt lamps installed at 31st March, 1907	307,933
Increase during the year	9,957 (3·2%)

Units sold:—	1906-7.	1907-8.
Private lighting...	5,627,089	5,771,597
Street lighting	870,925	895,009
	6,498,014	6,666,606

	1906-7.	1907-8.
Revenue	£83,787 3 5	£85,589.16 6
Average price per unit...	3·09*d.*	3·08*d.*
Units sold per lamp installed ...	21·40	21·25
Revenue per lamp installed ...	5/6·22	5/5·47

POWER AND HEATING.

Aggregate horse-power of motors installed at 31st March, 1908	8,379
Aggregate horse-power of motors installed at 31st March, 1907	6,880
Increase during the year (in horse-power)...	1,499 (21·8%)

	1906-7.	1907-8.
Units sold	4,870,942	5,746,255
Revenue	£24,472	£27,846
Average price per unit	1·21*d.*	1·16*d.*
Units sold per horse-power installed	796	754
Revenue per horse-power installed	£4	£3 13 2

The revenue from sales of current for lighting purposes has been somewhat severely affected in the final quarter of the year by the introduction and rapidly increasing use of metallic filament lamps, by means of which a large reduction is effected in the quantity of current consumed in the production of a given amount of illumination. It is anticipated, however, that the temporary loss of income by this cause may be ultimately recouped by a large influx of additional consumers, induced by the lower cost at which electric light can be obtained. The use of electricity as motive power again shows a satisfactory extension, the aggregate capacity of the motors installed on consumers' premises having increased by 21·8 per cent. during the year, and the sales of current for this purpose are also much higher than during any preceding year, although the consumption in proportion to the horse-power installed shows a decrease, no doubt due to reduced activity in some of the principal industries of the city. The recent reductions in the scale of charges for electricity used for power and heating purposes are estimated to affect the ensuing year's income to the extent of about £5,000, without allowing for the increase of business which is likely to result. It will be seen that the revenue has again had to bear a considerable charge under the heading of extraordinary renewals, the bulk of this representing the cost of replacing plant of a capacity of 700 kilowatts, which was only suitable for the now obsolete system of supply at a frequency of 83 periods per second. It is satisfactory to know that the replacement of the whole of the 83-period plant has now been provided for, and the charges for extraordinary renewals are therefore likely in the immediate future to be much smaller than in the past two years. Notwithstanding the favourable effect of contracts made during the period of lower prices, the expenditure has also been increased by an advance in the price of coal, the fuller effect of which will be felt in the ensuing year. The increased cost due to this cause during the past year is calculated to have been £1,336. The weight of coal used per unit sold has been reduced by about 5 per cent.

The following statement shows the cost per unit in detail for the past and the preceding year:—

	Year ended 31st March, 1907.	Year ended 31st March, 1908.
	d.	*d.*
Coal	0·19	0·21
Oil, water and stores	0·02	0·02
Wages	0·13	0·12
Repairs, maintenance and renewals ...	0·15	0·12
Rates, taxes, and insurance	0·07	0·08
Engineers' salaries	0·08	0·08
Office salaries and general expenses ...	0·05	0·04
Total ordinary working expenses per unit	**0·69**	**0·67**
Wages incurred on extensions, but not chargeable to capital account, being paid to Corporation's permanent workmen	0·00	0·02
Extraordinary renewals	0·30	0·26
Interest	0·60	0·54
Redemption fund charges	0·62	0·57
Total charges per unit	2·21	2·06
Surplus profit per unit	0·07	0·13
Average price obtained	2·28	2·19

A 3,000-kilowatt steam turbo-alternator has been installed at the generating station during the year, and after deducting the 83-period plant discarded, as before mentioned, the capacity of the plant is 12,740 kilowatts. An additional turbine set of the same capacity (3,000 kilowatts) is on order, and expected to be available for use before next winter. The maximum load upon the plant has been 8,300 kilowatts, compared with 7,470 kilowatts in the preceding year, and therefore the load factor (being the proportion between the units sold and the quantity which would have been generated if the load had been continuous and uniform throughout the year) has been 17 per cent. During the previous year it was 18 per cent., and the decrease is due to the two facts already mentioned, viz., the reduced consumption per horse-power of motors installed on consumers' premises, and the saving of current used for lighting purposes, during the last quarter of the year, by the introduction of more economical lamps.

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"AUTHORISED" CONTRACTORS

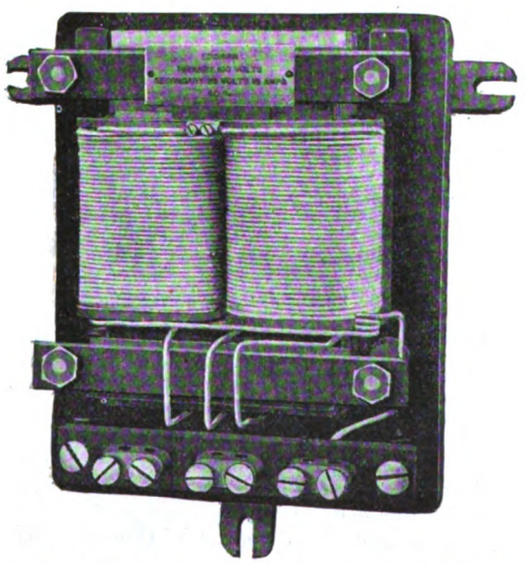
As announced in our issue of May 7th, the Birmingham Corporation has given notice that on and after June 30th next all installations intended to be connected to the Corporation's mains should be carried out by "authorised" contractors. A printed list will be drawn up of these firms, and will be available to any consumer in the Birmingham City area who may apply for it.

On further inquiry we learn that, while on the whole the quality of the wiring work done in Birmingham is good, there are, as always, some cases of shoddy work being done. It is partly with a view to lessening this, and partly for the convenience of having a list of good firms to recommend to prospective consumers, that this step has been taken. The Corporation electricity department are constantly being asked to advise as to what firms consumers should go to for their installation work, and the practice has hitherto been to recommend certain high-class firms, strictly in rotation, from a list kept at the offices. The present plan of having a printed list is regarded as preferable. Every firm desiring to be placed on the list of "authorised" contractors will be asked to give six recent installations as a reference; the department will examine some of these, and will decide from this examination whether the firm shall be "authorised." Doubtless, in the case of firms in other towns applying, information will be obtained from the supply authority in the town in question.

We understand that the scheme is not meeting with any opposition on the part of the contractors; in fact, the National Electrical Contractors' Association has applied to have all its Birmingham members placed on the list.

SMALL TRANSFORMERS FOR METALLIC FILAMENT LAMPS

THE Edison Swan United Electric Light Co. have sent us some particulars of a series of small transformers for metallic filament lamps, which they are now manufacturing at their works at Ponder's End. We have on more than one occasion pointed out the advantages to be obtained by this class of apparatus.



Ediswan Transformer for Metallic Filament Lamps.

The construction of these transformers is seen from the accompanying illustration, which represents one of these with the cast-iron cover removed. The whole construction appears thoroughly mechanical, and we are assured that only the best selected transformer plate is used for the cores, with the result that the no-load losses are very small. The design is such that the voltage regulation is within one or two per cent., and the power factor is given as 0·98 at half and 0·99 at three-quarter and full load. The arrangement of the cover allows of good ventilation, and as regards the insulation it should be said that every transformer is tested with 1,500 volts alternating before being sent out.

They are listed in sizes ranging from 300 to 1,000 watts, both as plain auto-transformers for secondary voltages of 100, 50, and 25 volts, and also as balancing transformers for half the primary voltage. The following particulars of a medium size transformer for 450 watts, 200/25 volts, 50 cycles, will give a general idea of the sizes, weights, efficiencies, &c.:—No-load loss, 9 watts; efficiency at half to full load, from 96 to 98 per cent.; overall dimensions, 10¼ in. by 9½ in. by 5⅛ in.; weight, 34 lb.

NATIONAL TELEPHONE CO.'S STAFF DINNER

ON Thursday last, the National Telephone Co.'s annual staff dinner was held. The guests this year included Mr. George Franklin (the President of the company), Lord Harris, Sir Albert Rollitt, Mr. G. H. Robertson, and Mr. C. S. Agnew (Directors of the company), Sir John Gavey, C.B. (Consulting Engineer to the Post Office), Sir Robert Hunter (Solicitor to the Post Office), Major W. A. J. O'Meara, C.M.G. (Engineer-in-Chief to the Post Office), and Mr. G. F. Preston (General Manager of the London Post Office Telephones). The chief officials of the company were also present, including Mr. Albert Anns (secretary), who occupied the chair, Mr. Frank Gill (Engineer-in-Chief), Mr. S. J. Goddard (General Superintendent), and Mr. C. B. Clay (Metropolitan Superintendent). In several of the speeches, feeling reference was made to the loss which the company had suffered by the death of Mr. W. E. L. Gaine, the late General Manager.

As usual, interesting statistics were given of the growth of the company during the year. Not including replacements, such as at Gerrard Street, 176 new exchanges had been established at an expenditure of over £150,000. The total number of exchanges up to date is 1,480. On April 30th last there were 457,564 telephone stations, an increase of 36,085 over last year. No less than 1,313,511,576 messages were sent over the wires during last year (on the usual basis of an assumption of two messages per conversation), an increase of 136,204,744. These figures apply to the National Telephone Co. only, and do not include the Post Office system. The number of stations represents one to every 96 of the population;—including the Post Office figures there would be a large reduction in this figure of 96. Excluding Germany, Mr. Franklin said, we have more telephones in Great Britain than any five other European countries put together. During the twenty-eight years of the company's licence, 2½ millions sterling, he said, had been paid to the Post Office as royalty.

Both Mr. Anns (who received an enthusiastic reception) and Mr. Franklin reassured the staff as to their positions when the Post Office takes over the business of the company on Jan. 1st, 1912. It was absolutely erroneous, Mr. Anns said, to think that the Pension Fund would not be equal to its engagements, and when it was wound up he was confident that there would be a handsome surplus, in which all members would participate. As to the actual status of the staff when the transfer takes place, Mr. Franklin said that it was quite clear that they were properly protected by the agreement of 1905 between the company and the Post Office, and also by the subsequent statement in the House of Commons by Lord Stanley (then Postmaster-General). Moreover, the Board of the company would take every opportunity of seeing that no member of the staff suffered by the transfer.

Other speakers were Mr. Goddard, who proposed "The Guests," and Sir A. K. Rollitt and Major W. A. J. O'Meara, who responded to this toast.

Electrical Association of Victoria.—The report of the Council for the past session states that a gradual improvement in the progress of the association has been distinctly noticeable. Mention is made, says the *Australian Mining Standard*, of the useful work done by the special tariff committee which was appointed for the purpose of modifying the new Australian tariff. The rules of the association have been redrafted in order to make them as far as possible uniform with the Association of New South Wales. The officers for the ensuing year are as follows:—President, Mr. Noel Murray; past presidents, Mr. H. Noyes and Mr. Alcock; vice-presidents, Mr. Harper and Mr. Jackson; hon. secretary, Mr. Brearley; hon. treasurer, Mr. Mountain; auditors, Mr. R. O. Moore, Mr. Cresswell; council, Mr. J. L. Newbigin, Mr. Walker Fowler, Mr. W. Cumming, Mr. Woodward, Mr. Morrison.

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METALLIC FILAMENT LAMPS FOR STREET LIGHTING

IN our last two issues (pages 703 and 740) we gave some interesting letters containing results of experiences in the use of metallic filament lamps for street lighting at a number of places, including Derby, Harrogate, Horsham, Bray, Kettering, Sutton Coldfield, Cambuslang, and Yarmouth, from which it was seen that excellent results of life tests had been obtained, pointing in the case of Osram lamps to an average of about 1,500 hours. In those undertakings where the lamps had been in use long enough to enable accurate figures of costs to be arrived at, it was evident that the street lighting by metallic filament lamps is generally cheaper than gas. In some cases it has been found necessary to adopt some care in pairing the lamps suitably, and some difference of opinion was expressed as to the effect on the life of the lamps of enclosing them in outer globes and the desirability of permitting a certain amount of play in the holders to allow of movement in windy weather. In connection with the figures of life and cost, the following letter from Mr. A. C. Cramb, Borough Electrical Engineer, Croydon, who has devoted a great deal of attention to the subject, is of interest:—

We commenced experimenting with these lamps for street lighting about 18 months ago, and we have had 44 posts running since February, 1907, and 38 since September, 1907. Each post has two 104-volt 35-watt lamps in series on 200-208-volt A.C. circuit. The average number of burning hours obtained per pair of Osram lamps has been nearly 1,300, but this is without taking account of lamps still running, which will bring the average well over 1,500. There is no appreciable diminution of candle-power throughout the life of these lamps. We have been running "Metalik" lamps since the end of January this year, and so far the results have been satisfactory; but there has not yet been a sufficient lapse of time for us to form a just comparison between the two lamps.

Perhaps you will permit us to observe that the figures of running cost whch you publish in your article of May 7th issue appear to be somewhat biased. A 35-watt Osram lamp gives about 28 candle-power, which is not equal to a gas mantle, if these are renewed with reasonable frequency, as they are in Croydon. We have been running several 200-volt 60-watt Osram lamps for the past two months, and we consider that nothing less than these could compete with the gas mantle, nor do we think that a longer average than 1,500 hours can be reckoned upon, at least with any of the lamps which are now upon the market.

Our running cost meantime with one pair of 35-watt lamps per post is as follows:—

	£	s.	d.
70 watts, 3,800 hours, 270 units at 1¼d. per unit ...	1	8	2
Lamp renewals (average 1,500 hours per pair), 2½ pairs per annum	0	9	6
	£1	17	8

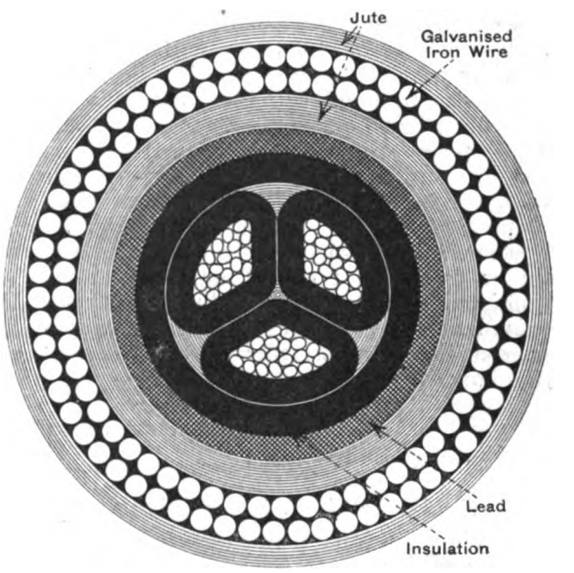
We obtain the same price per annum for electric incandescent street lighting as the Gas Company. Our aim in Croydon is to instal one 75 candle-power lamp per post, and so give a much better light than the ordinary gas mantle, and to charge the same price. This lamp, however, has not yet made its appearance.

The following notes sent us by Mr. H. D. Munro, City Electrical Engineer, Exeter, are of interest. It should be pointed out that Exeter was practically the first place where Osram lamps were adopted to any great extent for street lighting. In addition to the lighting referred to below, some of the main streets are lighted by Osram lamps after midnight, when the flame arcs are extinguished. Mr. Munro writes:—

We have had an unusually extensive experience in this matter in Exeter, as we took over the lighting of some twelve miles of streets, in which our mains were laid, in the autumn and winter of 1906, with Osram lamps on our 100-volt supply, as soon as they were obtainable for that pressure. There are now some 500 lamps in all, of which 135 are 110-watt lamps, mostly on tramway standards, and the rest 55-watt lamps on brackets on the old gas-lamp posts. We had at the time to make a somewhat conservative estimate, as there was little information to be had as to the life of these lamps, or even as to their being obtainable in sufficient quantities, and the estimate (including cost of conversion) came out some 10 per cent. to 12 per cent. above that of the local gas company, which tendered with single and double low-pressure incandescent mantles. The electric lighting is at least equal to the incandescent gas lighting in other streets, and on the tramway routes is far superior, and I think the lighting generally is well worth the extra cost. The life of the lamps, however, has considerably exceeded the estimate, with a consequent reduction in cost of renewals and attendance, and as a result we have obtained over 1¾d. a unit for the supply, which I consider a very satisfactory figure. Some of the lamps have shown exceedingly long life, ranging to above 4,000 hours, but the average of some 1,400 of them so far is about 1,200 hours. A good deal depends on making sure that they are not seriously overrun, and I hope to get the average considerably higher if the present quality of the lamps is maintained. Other metallic lamps than the Osram have also shown good results, but I have not enough data for definite statements as to their average life. Now that metallic lamps for the higher voltages are obtainable, I believe, from my experience, that any electricity department in the country should be able to compete on even terms with the incandescent gas mantle for street lighting, and make a profit on the transaction, in view of the high load-factor of this class of supply.

A LARGE SUBMARINE E.H.T. CABLE

THE illustration below is a drawing of the section of a heavy cable recently supplied by the British Insulated & Helsby Cables, Ltd., for laying across Sydney Harbour. It is an extra high-tension cable, and each core has a section of 0·062 sq. in. The cores are insulated with paper and lead-covered in the usual way. Above the lead is a layer of jute to serve



as a bedding for the armouring, which consists of two layers of No. 10 S.W.G. galvanised iron wire. Over the armouring is a protective layer of jute. The heavy armouring is to prevent damage by ships' anchors and from other causes. To obviate the necessity of making joints in the cable, it has been supplied in one length of 2,400 ft., and it weighs no less than 15 tons. The cable is to be used as a feeder on the Sydney tramways.

Wireless Telegraphy.—Twenty-four new wireless stations are to be installed for the Spanish Government by the Compagnie Française de Télégraphie Sans Fil. Of these, fifteen will be along the Spanish coast, seven will be on the Canary Islands, and nine will be on the Balearic Islands in the Mediterranean. It is stated that one of the new stations will also communicate with the Marconi station at Clifden, and the station at Teneriffe will probably soon be in communication with Pernambuco in Brazil.

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CORRESPONDENCE

"WIRE LAMPS."

To the Editor of ELECTRICAL ENGINEERING.

SIR,—If the term "wire lamp" is to be used simply for the sake of a shorter "fancy name," it is as good as any other invented name, and I, personally, have no objection to raise against it. It should, however, be well understood that "wire lamp" is a failure from a descriptive point of view when applied to the tungsten lamp, as no tungsten lamp at present in the market has a wire as its filament. Might I suggest "metal lamp" as being distinctive from "carbon lamp"?

Yours faithfully,

Queen Victoria Street. H. HIRST.
May 7th, 1908. (General Electric Co., Ltd.)

To the Editor of ELECTRICAL ENGINEERING.

SIR,—Referring to our letter of May 5th, we beg to say that in the closing sentence a slip of the pen has occurred. It should read as follows: "We have used the term 'metal lamps' for a considerable time, and our customers are quite used to it."

Yours faithfully,

Charing Cross Road. J. STOTTNER.
May 8th, 1908. (The Electrical Co., Ltd.)

To the Editor of ELECTRICAL ENGINEERING.

SIR,—I am inclined to agree with your correspondent, "E. C. L.," that, although the term "wire lamp," suggested by Mr. Mordey, is more convenient, it is, nevertheless, somewhat of a misnomer. It seems to me, moreover, that to the non-technical public, who form the bulk of the users, the term "wire lamp" would express no new idea, because to them the carbon filament lamp has always been a "wire lamp." Again, the pre-carbon platinum lamp actually was a "wire lamp," and a "metallic filament" lamp too, but such a lamp, giving only one-sixth of a candle or less per watt, is not one that the term which is being sought for should be capable of including. It seems to me that what is really wanted is a term which will convey the idea of high efficiency or economy. The word "economic" might be used, but I rather fancy that it is already appropriated as a trade name by some firm. As all the new lamps have an efficiency in the neighbourhood of one candle per watt, why not call them "candle-watt" lamps?

Yours faithfully,

GILBERT SCOTT RAM.

London, May 12th, 1908.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—We think the point that has been raised is interesting, as these metallic lamps are now making such headway with the certainty of coming more widely into use, and if a better name can be found than is at present employed, this is the time for it. The term "wire lamp," however, we think is not suitable, and a word seems to be needed which covers the fact that the filament is composed of something more than metal. There is, in fact, something introduced with the metal under special chemical process, making distinction between one metallic lamp and another, and which many people might like to know of, but which at present cannot be divulged. The most appropriate name we can think of is that at present in use, viz., metallic lamp, which is what we had in view when we went into the matter and named ours with phonetic spelling.

Yours faithfully,

G. M. BODDY.

Newington Works, Liverpool,
May 13th, 1908.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—While we agree that the term "Wire Lamp" is more concise than the term "Metallic Filament Lamp," it is quite evident that the term "Wire" should only be applied to a filament which has been drawn through a die. It is apparent that the "Tantalum" is the only lamp now on the market that really possesses a filament which may correctly be described by the word "Wire," as it would be quite a misnomer to apply this term to filaments which are squirted in the process of manufacture. It is, of course, recognised on all sides that the wire lamp, viz., the "Tantalum" lamp, is at least as strong as any carbon filament lamp, and this lamp has now been widely adopted for ship and train lighting, as it withstands an amount of vibration and unfavourable usage which would be too great for any other type of metallic lamp.

We are, dear Sir,

London, Yours faithfully,
May 12th, 1908. E. P. BARFIELD.
(Siemens Bros. Dynamo Works, Ltd., Supplies Department.)

METALLIC FILAMENT LAMPS FOR STREET LIGHTING.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—You state in your issue of 14th inst. that I could have avoided trouble by pairing Tantalum lamps. Before making this remark I think you should have found out our practice in regard to this. For the past two years every lamp we have put into the streets has been *carefully* paired. Not only this, but when a lamp gives out a new pair is put up and the odd lamp brought in. After this all odd lamps are paired again in the same manner. Nobody has taken greater care nor been more particular in pairing Tantalum lamps than we have, so that your remark seems rather hard. I should be glad if you would be so good as to publish this letter. My trouble in 1907 was neither due to want of pairing nor bad voltage, but to the lamps themselves. This is proved by our 1906 results, using Tantalum lamps of 125 volts as against 130 volts in 1907. During 1906 we had not a battery, and our volts were steadier in 1907 with a battery.

Yours faithfully,

A. J. ABRAHAM.

Cambuslang, May 16th, 1908.

Swiss Electricity Supply Statistics.—According to the Year-book of the Schweizerischer Elektrotechnischer Verein there were at the close of 1906, in Switzerland, 539 electricity works. Of these 240 were generating stations, 50 partly sub-stations, and the remaining 249 purely sub-stations. Of the generating stations 51 per cent. were water-power stations. In 36 per cent. mixed water and heat engines, in only 3·5 per cent. steam engines, and in 9 per cent. explosion engines were the prime movers. The water-power stations delivered 37·5 per cent of the total output, and the mixed stations 60 per cent. The capacity of the largest station was 16,000 kw. Of the 240 generating stations 60 generated continuous-current, 25 single-phase alternating, 75 three-phase alternating, and the remainder generated on two or all three systems. The usual transmission voltages employed were 1,000 and 5,000 volts, but in four cases the voltage was 25,000 volts. One high-tension direct-current transmission system operated at this pressure also. The distribution pressures were between 100 and 120 volts in over 50 per cent., and between 200 and 240 volts in 30 per cent. of the cases considered. The usual frequency was 50 cycles per second. The total kilowatts connected for all generating stations were 161,000, of which 67,500 kw. was for lighting purposes, 11,000 kw. for heating purposes, and the remainder for power. The following are given as average installation costs per kilowatt installed:—(1) For a water-power station: Electrical part £22, remainder £26, total £48 per kw. (2) Mixed water-power and steam station: Electrical part £26, remainder £28, total £54 per kw. (3) Explosion engine station: Electrical part £62, remainder £38, total £100 per kw. The above figures are taken from an abstract in *Elektrotechnik und Maschinenbau*.

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ALTERNATING-CURRENT SWITCHGEAR RELAYS

IN the introductory portion of his Paper, read last Thursday before the Institution of Electrical Engineers, Dr. C. C. Garrard remarked that the installation of control relays on high-tension alternating-current circuits had become standard practice, and was likely so to continue, but it was somewhat remarkable that many systems were in operation designed on what seemed to him to be erroneous lines. The object of the Paper was to deal with a number of such instances which had come under his notice, and to examine some other systems of control working at present in use or proposed to be put into application.

Polyphase Relays.—A considerable number of polyphase maximum time-element relays have been installed in various supply stations. They consist of a polyphase-wound relay having a single moving element which moves under the action of the currents in two or three of the phases. We will consider such a relay in use on a three-phase four-wire circuit, in which case it would have three windings energised by each of the three phases. Let us suppose it to be set to operate after, say, 30 seconds continued overload at 150 per cent. of full load. This means that after 150 per cent. of full load has flowed in *each phase* for 30 seconds the relay operates. Suppose now that instead of the overload occurring on each of the three phases simultaneously, it only took place in one phase. It is clear that in order to operate the relay the overload on the single overloaded phase must be much greater than before; in fact, the current in the single overloaded phase will have to rise to two and a half times the normal full-load current before the relay will operate. For this reason polyphase relays should never be used, but always single-phase relays connected separately on two or three of the phases on three or four wire systems respectively. The same objection applies to the use of polyphase reverse relays. In fact, under some conditions with a reversal in one phase only the tendency towards operation in the relay due to this reversal is neutralised by the increased forces in the opposite direction due to the unreversed phases, and the relay quite fails in its action.

Solenoid Relays.—These consist of a solenoid having a movable iron plunger, which is sucked up when the current in the solenoid exceeds a certain value. The iron plunger is attached to a dashpot or air-bellows, which retards the travel of the plunger, the amount of the retardation being varied by means of a small valve which controls the clearance in the dashpot, or the rate at which air can pass in or out of the bellows, &c. Thus the plunger is caused to take a certain time to travel to its top position. When the top position is reached, contact is made in the trip-coil circuit and the controlled circuit is opened. As the plunger goes up the magnetic reluctance goes down. Now, with a constant magnetising force in the relay the attractive force on the plunger varies inversely as the square of the reluctance. It follows that if, due to the passage of a certain current through the relay, the plunger is caused to travel upwards, the higher the plunger goes the less the current necessary to keep it in its new position. Thus the current in the controlled circuit can fall again to its normal value, but the plunger will not fall, but remain "floating" for an indefinitely long period near its top position. If, now, the current again increases, the plunger will complete its upward journey, but without any time element whatever, this being due to the fact that the first small movement in a dashpot is unretarded, no matter from what position in its travel the plunger starts. Translated into practical conditions, these results mean as follows :—At time of full load a short comes on the system which is intermittent in nature. The current increases sufficiently to pull up the plunger of the solenoid relay, but not for a sufficient time to close the trip contacts. The short goes off, but the full load remains flowing in the circuit. Consequently the plunger does not fall, but remains floating near its top position, and the next time the short comes on the relay operates without any time element whatever, and the whole object of the apparatus is vitiated. These results show pretty conclusively that the dashpot solenoid type of maximum relay is not to be relied upon for dealing with intermittent overloads or shorts.

Fuse-shunted Trip Coils.—A method sometimes adopted to impart a time element characteristic to an ordinary circuit breaker is to shunt the trip coil with a fuse. Normally, the secondary current of the current transformer flows through the fuse and not through the trip coil, until the fuse blows and the current is diverted through the coil. The time taken for the fuse to blow gives the time element. It is only possible to use this scheme for alternating currents, as with continuous currents the whole of the current passes through the trip coil, and a sufficient volt-drop to blow the fuse cannot be obtained. The chief advantage of this scheme is cheapness. Its efficiency may be judged from the following considerations. The two essential functions of a time-element device are that the time lag should prevent the circuit breaker opening with every momentarily abnormal rush of current, and that if two time-element circuit breakers are in series, it should be possibe to adjust one to open before the other. The point to be ascertained is how far this discriminating action can be attained. The following experiments were made to elucidate this. The trip coil used was a standard 10-ampere one, having a volt-drop of 2·8 volts at 50 cycles, the plunger being set so that it was pulled up with 10 amperes through the coil. In order to approximate to working conditions, the current through the coil and fuse in parallel was kept constant at 8 amperes, and then suddenly increased by definite amounts, and the time noted which elapsed before the trip coil operated. Curves (Fig. 1) give the results obtained by varying the thickness of the copper fuse wire. It will be seen that altering the thickness of the wire not only alters the current at which the combination works, but also affects the time element enormously. Thus independent adjustments of the time and the current calibrations are not feasible—at least, if fuse wires of constant length and of the same material are used. A characteristic of all the curves is that on large overloads the times taken all become practically zero. That is to say, on heavy overloads any time discrimination disappears altogether. The fuse-shunted trip coil may,

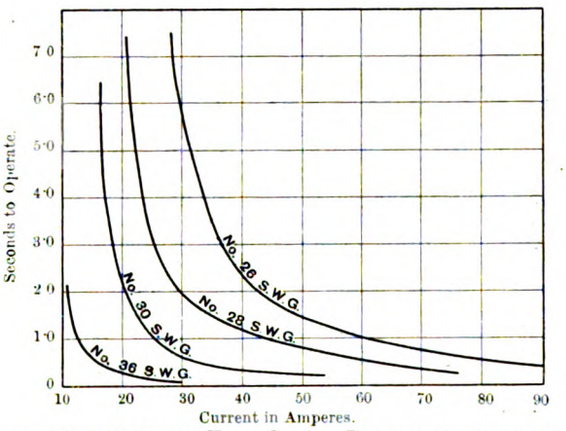


FIG. 1.—FUSE SHUNTED TRIP COILS. LENGTH OF COPPER FUSE =2. 50 CYCLES. VOLTS ACROSS TRIP COIL AT 10 AND 50 CYCLES = 2·8.

however, find useful application on motor-control panels where ordinary fuses are not desired, and where a discriminating action, apart from the prevention of the machine being cut off due to every temporary overload is not wanted.

Maximum Relays Connected on the "Resultant Principle."—For three-phase three-wire systems two separate single-pole relays are theoretically necessary to afford complete protection. When what may be designated the "resultant" scheme of connections has been used a single one-phase relay only has been installed, but in conjunction with two current transformers, so connected that the current in the relay is the vectorial resultant of the current in each of the phases in which the current transformers are situated. A superficial examination would lead one to think that as the relay current is the resultant of the currents in the two phases, an overload in either will cause the relay to operate and thus afford complete protection. In three-phase four-wire systems three current transformers are necessary, but only two relays are used, the idea being to save the cost of the third relay. Exactly the same consideration, however, can be applied to this case as above, as it is quite possible for one phase to be overloaded, since it has a return path through the fourth wire. If this overload has a large phase displacement relative to the currents in the other phases, then the condition may arise of very big overloads in the one phase and the circuit breaker not operating. The only safe arrangement is to have the same number of relays as current transformers. If the circuit be a four-wire one, then three relays are necessary; if three-wire, then only two relays are essential.

Reverse Relays on Generators.—These should only come into operation when a serious fault has developed on the generator or prime mover of the nature of an insulation breakdown in the winding, or a total failure of steam power. A short consideration will show several cases of accident to the prime

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mover, in which an automatic disconnection from the busbars would only be an aggravation of the trouble. For example, consider two or three large compound Corliss engines, with three-phase generators running in parallel. A not uncommon fault is the failure of one of the admission valves to open, with the result that steam is admitted to only one side of the piston. Under these circumstances a large surging current passes backwards and forwards from the faulty to the good machines. The fault with the valve is but a small matter, and the driver attends to it immediately, the surging current ceases, and everything goes on as before. If, however, this set had been cut off the busbars, the other generators would have become seriously overloaded, with probable variation in volts, and all the trouble of synchronising would have had to be gone through.

With the diminution or total failure of the field current of a generator, the current in the windings increases greatly and leads considerably on the machine volts. Provided the set remains in synchronism, and the steam supply is in order, the alternator continues to supply energy to the system, and there is no reason why it should be disconnected from the busbars. The large increase of current is noticed by the switchman, who immediately seeks for and remedies the fault without any serious disturbance of the supply. If when the field circuit fails the set drops out of step, then it should rightly be disconnected.

It will be understood that any form of relay, one of whose constituent parts is a shunt coil, will be affected by variation in the voltage applied to the same. The shunt coil of the generator reverse relay is excited (through the intermediary of potential transformers) directly from the busbars. On the occasion of an accident to one of the generators, the busbar volts will tend to go down. The trouble is intensified by the fact

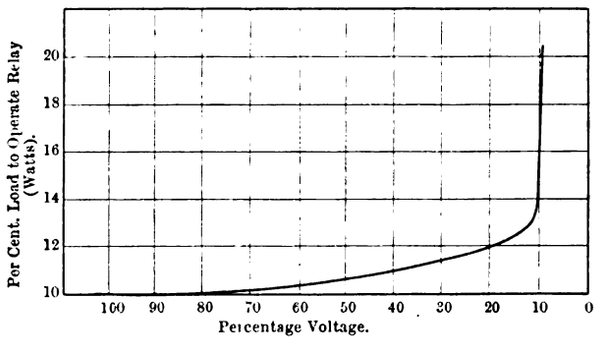


FIG. 2.—A.C. REVERSE RELAY. VARIATION OF CALIBRATION WITH VOLTAGE.

that, as has been shown, an instantaneous relay cannot be used, therefore there is more time for the voltage to fall. It must be remembered, however, that a failing generator in parallel with one or more good ones is not likely to pull the volts down to any very alarming extent. Probably a 50 per cent. reduction is the maximum to be expected. It is clear, however, that the calibration of the relay should be as little affected by variation in the busbar voltage as possible. Fig. 2 shows the effect of reduction of the shunt voltage on the calibration of a reverse-power relay of the wattmeter type.

The most suitable value to which a generator reverse relay should be set is such that it will operate, after the requisite time element, with an energy reversal of 10 per cent. of the full rating of the machine. With this setting the current which can flow in the generator windings is never very excessive.

Reverse Relays at the Ends of Feeders.—The function of such relays is to prevent a fault on the feeder being fed back from the sub-station or distribution network. The currents which flow into such a fault will have passed through long lengths of feeder, the C R and inductive drop in which will cause the voltage applied to the shunt of the relay to fall. Thus reverse relays, situated at the ends of feeders, are far more likely to be affected by drop in volts than are those on generators. For this reason it is desirable for the relay to operate as quickly as possible after the occurrence of the reversal. The objection to instantaneous reverse relays on generators does not apply here, as a similar action to the slow surging of current, or cross-current, from one generator to another cannot take place. Temporary reversals of energy in a feeder may happen, however, due to hunting of the sub-station machinery. The hunting may be set up by a temporary disturbance in the system, such as a short circuit with consequent lowering of voltage. With an instantaneously operating relay the first reversal, provided it be of sufficient amplitude, will cause the relay to operate, and thus the circuit may be opened when there is not any need for it. As the time-limit relay is inadmissible, this action must be obviated by other means. The determining factor is obviously, to what degree may hunting occur in the sub-station machinery without the same falling out of step? Naturally, if it be going to fall out of step the opening of the circuit is an advantage. On the other hand, a moderate temporary swing might be set up between the sub-station and the generating station, which will be damped out immediately and not do any harm. The instantaneous reverse relay at the far end of the

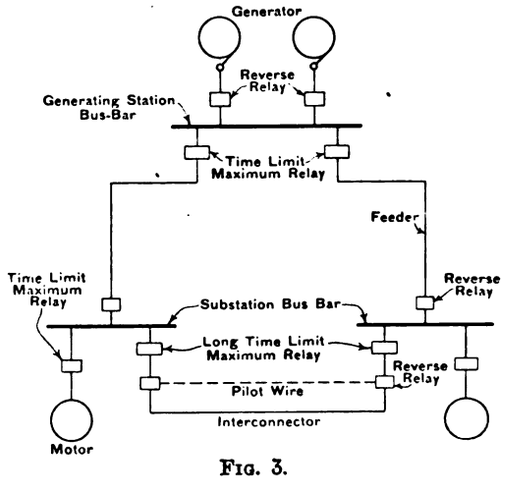


FIG. 3.

feeder should be set, therefore, so that the minimum power required to operate it should be above that likely to flow back, owing to such a harmless hunting of the sub-station machinery. It follows that the feeder-end relay should be set proportionately higher than the reverse relay on the generator; probably if it were set to operate at 25 per cent. of the normal full-load capacity of the feeder it would form the most suitable arrangement. Other considerations also indicate that a higher power setting of the feeder-end relay than the generator relay is admissible. With the latter the motoring current may be of very low power factor, and in order to keep the current within moderate limits the power setting of the relay must be kept relatively low. The feeder-end reverse relay is intended, however, to prevent a feeding back into an earth or short circuit. Such current would be of high-power factor, and, if not interrupted, of considerable magnitude. Thus the high watt setting of the relay is justified.

Protection of Interconnector Cables.—Interconnector alternating-current cables are used generally to connect up one sub-station with another. The standard method of protection for ordinary feeders is by means of an inverse time-limit maximum circuit breaker at the generating station end and a reverse circuit breaker at the sub-station end. It is obvious that this system is not applicable to the interconnector, as power may flow in either direction from one sub-station to the other. A diagrammatic representation of a generating station feeding two sub-stations connected together by an interconnector is given in Fig. 3. It is obvious that the interconnector should be protected against excessive loads going through it of such a magnitude that the cable itself is likely to be damaged. It is conceivable that owing to faulty superintendence the current in the interconnector may mount up to such an extent that damage

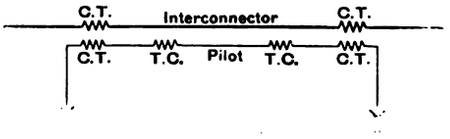


FIG. 4.—MERZ AND PRICE'S SYSTEM OF PROTECTION OF INTERCONNECTIONS.

to it may result. Some kind of maximum circuit-breaking device is desirable therefore, and as the only object of this is to prevent thermal damage, the time element should be very long—longer than any of the other maximum circuit breakers on the system, whose function it is to deal with shorts and accidental temporary overloads. For shorts and overloads on the system, other than those caused by the failure of the interconnector itself, the circuit breakers on the feeders, motors, and generators must be relied upon. The interconnector, from the point of view of control, virtually makes two sub-stations into one—that is, it is a prolongation of the sub-station busbars. So long, therefore, as the interconnector is in good condition, and not permanently overloaded sufficiently to be

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burned, overloads and shorts on the system should never cut it out of circuit. The occasion when it should be cut off is when it goes wrong itself either by grounding or shorting. It is obvious that to attain this end something more is needed than simply maximum or reverse relays at either end of the inter-connector, as these cannot discriminate between shorts or grounds in the interconnector, or in other parts of the system. To solve the problem it is only necessary to consider that the function of the interconnector is to pass energy from one sub-station to the other in either direction. So long as it is doing this it may be said to be performing its function. It is, however, not doing so when it takes energy from one sub-station and does not deliver it to the other—that is, when energy flows into the cable at both ends at the same time. It follows that a circuit-breaking apparatus must be installed at either end, and that these must be interconnected together. This is done generally by means of one or more pilot wires.

Merz and Price's Systems.—The principle on which this method depends is illustrated in Fig. 4. A current transformer (C.T.) is included in the interconnector at either end, the secondaries of which are connected together through the trip coils (T.C.) and the pilot, the return circuit being *viâ* earth. So long as the current flows through both current transformers in the same direction, it is immaterial in which direction; the E.M.F.'s induced in the secondaries of the C.T.'s balance, and current does not flow through the pilot and trip coils. So soon,

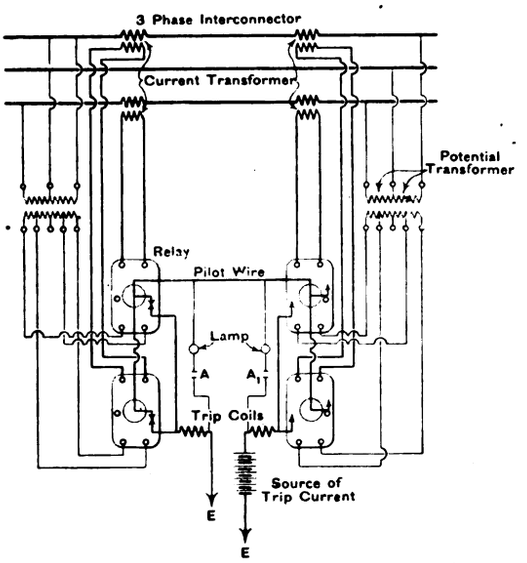


FIG. 5.—PROTECTION OF THREE-PHASE INTERCONNECTOR BY MEANS OF ELECTRICALLY INTERLOCKED REVERSE RELAYS.

however, as the currents at either end become unequal, or a reversal at the one end relatively to the other takes place, current begins to flow in the trip coils, and when this has reached sufficient value the switches are opened. It may be mentioned that differential relays are used usually, in addition, for operating the tripping mechanism of the switches as the arrangement of Fig. 4, although quite right theoretically, cannot be applied practically in the simple form shown. The advantage of Merz and Price's arrangement is that potential transformers are done away with altogether. In order to secure full protection, however, more than one pilot wire has to be run for each three-phase interconnector.

Protection of Interconnector Cables by means of Electrically Interlocked Reverse Relays.—As the criterion of failure of an interconnector is simultaneous flow of power into it at either end, such a circuit can be protected by the installation of reverse power relays at both ends, both relays being connected in a common tripping circuit arranged so that only when energy is flowing into the cable at both ends is the trip-coil circuit closed at both relays and the main switches caused to open circuit (see Fig. 5). Normally, the trip circuit is broken at one relay and made at the other, or *vice-versâ*, according to the direction of flow of power in the circuit. The relays close circuit with a slight time-element, so that, on the flow of current reversing, one of the contacts is opened at the one relay before the other one is closed. On reference to Fig. 4 it will be seen that only when power is flowing into the cable at both ends at the same time is the trip-coil circuit complete through each trip coil and the circuit ruptured at both ends. A and A_1 are each a pair of contacts which are closed automatically when the main circuit breaker at the corresponding end opens. Thus, if the switch at the left end of the interconnector opened slightly before the one at the right-hand end, the trip-coil circuit would be closed at A and by the relay at the right-hand end. Thus the circuit breaker at the right-hand end would also operate. The object of this arrangement is to ensure that both ends of the interconnector will be disconnected, even if the two switches do not act quite as quickly as each other. Each trip coil is also

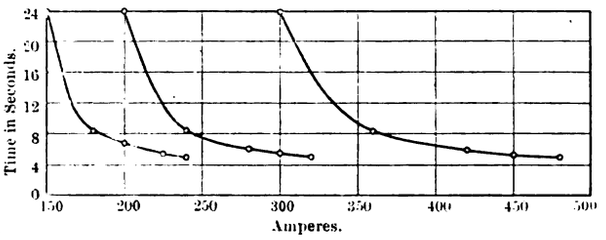


FIG. 6.—STANDARD 10-AMPERE RELAY, 25 CYCLES, SET TO OPERATE AT 60 PER CENT., 80 PER CENT., AND 120 PER CENT. OF FULL LOAD—THAT IS, 150 AMPERES, 200 AMPERES, AND 300 AMPERES, IN CONJUNCTION WITH A 25/1 RATIO CURRENT TRANSFORMER.

arranged so that it is cut out of circuit when its main switch has opened circuit, after, however, A (respectively A_1) has been closed. The trip coils, therefore, experience no danger of burning out. The state of affairs might, however, arise that the left-hand switch was open and the right-hand switch was closed, there being a short or earth on the interconnector. By the act of closing the right-hand switch the trip coil of this switch will be put into circuit ready for operation, and the circuit through the same will be complete through the right-hand relay, which operates due to the flow of current into the fault, and through A. Thus the right-hand circuit breaker will be opened, while at the same time cutting out its own trip coil. Thus it is impossible to connect up the interconnector at either end while there is a fault on the same. The arrangement as set forth above, of course, necessitates that there should be some voltage in order to operate the relays. If the voltage absolutely disappears, the reverse relay will not work, and it may be thought that in the case of a very bad short circuit this will happen. Considerable experience has shown, however, that even under the worst conditions the voltage does not entirely disappear, and that if the calibration of the apparatus is unaffected by fall of potential down to 10 per cent. of the normal working voltage, all working conditions will be met. As the pilot wire only carries the tripping current, it will be seen that only one pilot is necessary whether the relays are single-, two-, or three-pole. On a three-phase system the relays will be two- or three-pole, according as to whether the system be three-wire or four-wire. Messrs. Merz & Price suggest that the pilot wire, or wires, can be made up in the same multicore cable as the main conductors, there being generally sufficient space for this in the filling, which is used to make up the cable to a cylindrical cross-section. This, however, is open to the serious objection that if a serious fault or burn-out occurs the

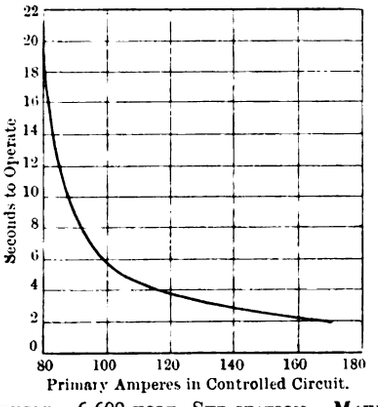


FIG. 7.—25 CYCLE, 6,600-VOLT SUB-STATION, MAXIMUM TIME-LIMIT RELAY WITH INDUCTION MOTOR GENERATORS IN SUB-STATIONS.

pilot wire will be broken most probably. It would be much better to keep the pilot wire quite distinct from the main cable, preferably laying it in a different duct. A system, therefore, which, under all conditions, only requires one pilot wire is of advantage in this direction.

Time-limit Maximum Circuit Breakers.—At the present time

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it is general practice to instal time-element maximum circuit-breaking devices, in various positions, on all large systems. There have been a variety of forms used. Some have had a constant time-element independent of the degree of the overload. These are but rarely required, and we will only consider inverse time-element circuit breakers. Of course, apart altogether from the difficulty of arranging two fuses in series with the certainty of one operating before the other, high-tension fuses cannot now compete with automatic circuit breakers either in cost or efficiency.

If it has been decided that a time-element circuit breaker is necessary on the outgoing feeder, the next point to determine is what this time-element should be. If it were only a question of arranging the various switches so that they opened in a predetermined order the feeder time lag would be made as long as possible, as, naturally, the longer it is the more chance have the distant circuit breakers of operating before the feeder. Fig. 6 shows the calibration of outgoing feeder relays installed on the 6,600-volt 25-cycle three-phase feeders in a large generating station in Scotland. I am indebted to the chief engineer for the curve in Fig. 7, which shows the curve of the switches which are installed on the machines in the sub-stations. The curves of Fig. 6 were arranged so that, under all conditions, the machine breaker should operate before the feeder breaker had time to do so. These settings have proved to be satisfactory on the system in question. The sub-station machinery in this case consisted almost exclusively of induction motor-generators. Relays having time-elements, as in Fig. 1, were subsequently installed on the outgoing feeders in a similar English 6,600-volt system, except that in this case the sub-station machinery consisted almost exclusively of 50-cycle synchronous motor-generators. The difficulty was at once experienced that with the comparatively long time-elements whenever a severe high tension short came on the system, the shock was so great that a great deal of the synchronous sub-station machinery fell out of step.

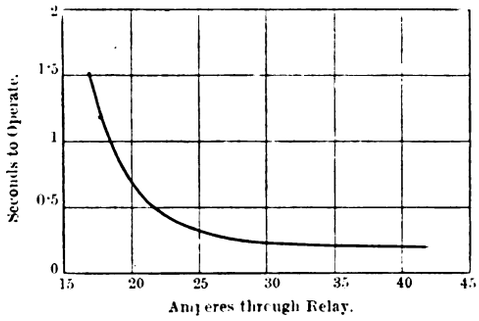


FIG. 8.—CALIBRATION CURVE OF OUTGOING FEEDER RELAYS FEEDING SUB-STATIONS CONTAINING 50 CYCLE SYNCHRONOUS MACHINERY.

Generally a swinging of the current to and from the sub-stations was set up which increased until the motors fell out of step. To get over this the time-elements were shortened several times until the calibration curve as given in Fig. 8 was obtained on the outgoing feeders. It is considered that with such settings the system will be able to clear itself of high-tension short circuits without any danger of affecting the synchronous machinery other than that fed by the faulty feeder.

It will be seen that in order to prevent the falling out of step of the synchronous machines the advantage of the long time-element circuit breakers has (in this case) to be dispensed with. On examining Fig. 8 the thought arises, Is this very short time element worth keeping? Would it not be just as good to abolish the time lag altogether? This may seem a plausible thing to do, as it might be considered that the difference between Fig. 8 and an instantaneous action is inappreciable. Really, however, this is not so, and there is more difference between curve No. 8 and an instantaneous action than there is between curves Nos. 6 and 7. In order to get an idea as to what time a so-called instantaneous release mechanism took to work, an ordinary alternate-current trip coil was investigated. An examination showed that the time taken for the plunger to rise from the bottom to the top position did not exceed $\frac{1}{10}$th of a second. It follows that the time element of an instantaneous release is less than $\frac{1}{15}$th of the time-element shown in the curve No. 8, and to go from this curve to the instantaneous release is a larger step than the sum total of the previous steps taken in arriving at curve No. 8. There is no doubt that instantaneous releases have been tried and found unsatisfactory by reason of too often and unnecessary operation. If now it should be found that the transitory currents that have given trouble with the instantaneous release are of shorter durations than the times of the curve in Fig. 8, then the retention of the time-element, even if shortened to the extent of Fig. 8, is desirable. The general conclusion to be drawn from these notes is that the necessary and desirable time-elements of the circuit-breakers on each system must be determined experimentally. When installing maximum relays, therefore, they should be such that their time-elements may be varied within wide limits independently of the currents at which they operate. It is not desirable to have the time-element too easily adjustable by means of a screw or some such arrangement outside the relay, as this provides grave danger of the time settings being altered by unauthorised persons. The time-elements of all the circuit-breakers on the system must be considered as a whole, and after the correct values have been found the settings need never be altered. The curve in Fig. 5 gives a time-element which need not be exceeded on the outgoing feeders on the 50-cycle synchronous sub-station system considered. Relays set with longer times than this resulted in the synchronous motors falling out of step when a high-tension short came on the system, and to get over this difficulty very short time settings had to be resorted to. This entailed a sacrifice of a great deal of the possibility of arranging a selective action of the circuit-breakers in series one with another. It would, however, be inadvisable to resort to absolutely instantaneous-action circuit-breakers on this system. Much longer time-elements can be used on a system consisting of induction motor-generator sub-stations, and therefore a better grading of the circuit-breakers can be obtained.

DISCUSSION.

H. W. CLOTHIER (Messrs. Reyrolle & Co., Ltd.) said he generally agreed with the contents of the Paper. When a bad fault occurred on a system it was generally the practice to look round and see what things had been isolated which ought not to have been isolated; in fact, it became a sort of second nature with electrical engineers to expect to find these discrepancies in the operation of their gear. One of the worst offenders in this respect had been the reverse current relay. He had discussed the matter of protecting gear with a very large number of engineers, but he had seldom found a man who was in sympathy with the use of reverse current relays, or reverse power relays, as the author called them. Mr. Andrews had from the earliest stages been the great instigator of them, and the work that he had done with them had been very great. But apart from that, there still seemed to be the danger of reverse current relays tripping when they should not trip, particularly when there were surging currents and low voltages. He could state as an absolute matter of fact that on the supply systems in Northumberland and Durham, when they had reverse power relays installed, they had experienced so much trouble with them tripping at the wrong time that they had been taken out from the generators and from the feeder system. With regard to time-limit relays, he thought these were almost as undesirable, the trouble being that they allowed a fault to maintain on the system and so caused surging, with the result that their synchronous machines were thrown out of step and the whole system disorganised. The author was rather advocating the time-limit attachment to his reverse power relays. He admitted that this might avoid a good deal of trouble due to relays dropping out on momentary surges. At the same time, by putting the time element on the reverse current relay the same objection occurred as was the case with the use of time-limit overload apparatus, *i.e.*, the faults were not cut out instantaneously enough. The successful features of a feeder-protection system on any high-tension network were these:—(1) The gear must part absolutely instantaneously; the fault must be brought out before it had risen to any dangerous dimensions, and before there was a chance of serious surging. (2) The gear must be as simple as it could be made. (3) It must be applicable to all systems of network. (4) It must not bring out a healthy section for a bad fault developed in another section. This brought him to the question of the Merz-Price protection. His company had been privileged to manufacture and carry out a good deal of the early development work, and, therefore, the subject was of particular interest to him. The Merz-Price system was explained clearly enough in the Paper, but there were one or two details which were not quite correct. It was the only system he knew of which complied with the conditions he had just enumerated. The author's proposal of interlocked reverse current relays was certainly ingenious, but it did not cover all the points. In the first place, it had a serious objection. Supposing they had a generating station feeding two sub-stations, but an interconnector between them, with time-limit overload relays in the main feeders and interlocked reverse-current relays at both ends of the interconnector, this was all right in the event of a fault occurring on the interconnector cable, provided the first relays did not trip out when they should not trip. Supposing, however, that the incoming feeder

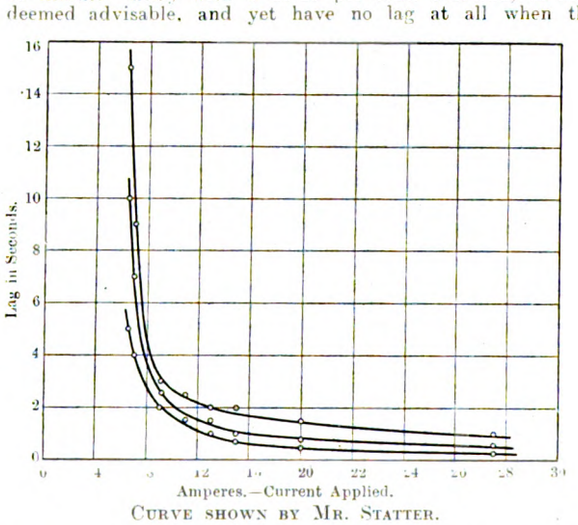
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switch to one of the sub-stations was opened and a fault developed on the interconnector, there was no current being fed through that feeder, and therefore the gear became inoperative. It also had the objection that there were time-limit overload relays, and therefore faults on the interconnector did not come off the system instantaneously enough. Supposing they wanted to put a T at some point on the interconnector leading to another sub-station, that could not be done on Dr. Garrard's system, because it was obvious they would get reverse currents through the ends which would trip the circuit breaker, so that, in these circumstances, Dr. Garrard's system had its limitations as compared with the Merz-Price gear. One of the great features of the Merz-Price gear was that they could have complicated networks, such as ring mains, loops, tees, and in every case absolutely instantaneous isolation of a faulty section without interruption of supply to the sound sections was assured. He had had a demonstration of this which was not a test-room development. Only recently a 20,000-volt joint box developed a fault and was simply scattered to pieces. The section was instantaneously isolated without interruption to a single consumer. In this connection he would like to say what a large capital saving in the cable network could be obtained by the use of this system. Assuming a power station and a row of sub-stations, the ordinary system, carrying duplicate cables from the sub-station to the power station, called for five sets of cables each with its overload and reverse-current relay, and, provided the reverse-current relays worked and the overload relays did not run the synchronous machines out of step, then that system applied. But with the Merz-Price system it was possible to take the five sub-stations and join them to the power station in a complete loop. Roughly, the saving on capital expenditure in cable was 25 per cent., a saving which more than compensated for the extra cost of the pilot cable, but not only that, they could use bigger cables for the two main cables, which in a small system would be found more mechanical and reliable than the small cables used in the other system. The use of the Merz-Price system enabled the supply undertaking to connect consumers in a manner which was impossible under the old system, and he thought it would surprise many people to know what a very large system had been developed on this gear.

Mr. B. WELBOURN (British Insulated and Helsby Cables, Ltd.) said that on reading the Paper he had found that the references to the Merz-Price protective gear were rather short, and he thought that they hardly give an adequate idea of what had been done with it, so he would like to make a few supplementary remarks on the subject. First of all, he wished to point out that Fig. 4 was incorrect, and that in practice a complete metallic circuit, and not an earth return, was used, and for this reason it was important that the pilot-wire circuit should be earthed at one end only, because when a breakdown occurred on any part of the network there was a risk that the earth current caused thereby might tend to flow through the pilot cores and operate the relays on a healthy cable, if there was an intentional earth on each end of the pilot circuit. With reference to the statement about multicore cables, Merz and Price did not use, and had never tried to use in practice, a system of pilot wires laid up in one cable with the main conductors. In all cases they had laid a separate three-core pilot cable with each three-core feeder, and had been gradually installing this system on this plan since 1904. The author's two objections to the Merz and Price proposals seemed to him, therefore, to disappear. It might be well to state that Merz and Price began their experiments in 1902, and by 1904 were so assured of the results they could obtain, that they commenced systematically laying pilot cables with all new feeders. A large amount of money had been spent in the development of the system, and now practical experience had shown its unfailing reliability, with the result that there are at present 70 individual feeders totalling about two hundred miles of cable, and about fifty sub-stations containing some 50,000 kw. of plant protected on the networks, controlled by Mr. Merz, and there had been no case of faulty operation to date. A very extensive experience on the large networks under Mr. Merz's control had shown that all the old systems for the protection of any interconnected network were the cause of endless trouble, and even on a small system where there was no interconnection, but where duplicate cables were used and where more than one supply was given in series, it was extremely difficult and very often impossible to get the old style gear to discriminate properly. In the earliest stages of development in Newcastle, down to about 1905, Mr. Merz tried nearly every make of overload and reverse-current relay then in existence, and soon was forced to the conclusion that it was impossible to discriminate with more than two, or at the most three, overloads in series under the conditions which exist on the high-tension network at the moment of short circuit, and that reverse-current relays were very erratic in action when surges took place, that is, they tripped just when they were not required to. With such complicated networks as those of the Newcastle and County of Durham Companies, it would be hopeless to attempt discrimination by any other principle than that of balanced gear. The feeder cables were of every possible description, those fed from one end, those fed from both ends as interconnectors, and those with branches taken off feeders by direct Tee joints. The Newcastle engineers had worked very hard at this problem, and could now claim that they had the only large installations of well-tried and perfected protective gear, and that they could not do any automatic control worthy of the name unless they had this balanced gear.

On the northern systems there have been a number (about twenty in all) of breakdowns on cables and transformers due to known causes, and the faults had in every case been isolated without dislocating the supply on the healthy sections, and without shock being noticeable at the power station. It was fair to claim that this highly satisfactory result could only be obtained with this balanced gear, which operated instantaneously and was especially valuable on circuits involving synchronous plants. It was of the utmost importance to note, when failures occurred, that the only sections which were isolated were those containing the faults, and the balanced protective gear on adjacent healthy feeders was quite unaffected. The whole point was that there never could be any question of the gear failing to operate on a faulty section, there is no disturbance of healthy sections, and at the same time it operates instantaneously. Unless he misunderstood Dr. Garrard's proposals, the electrically interlocked reverse relay proposed in the Paper necessitated a time-limit element, and he did not gather that instantaneous isolation of a faulty interconnector cable was claimed. This seemed to be a decided disadvantage on any system containing synchronous machinery which might be thrown out of step. To sum up the case for the Merz-Price system, first, it discriminated with absolute certainty, and was certain in its action in isolating faulty cables, transformers, or other plant, and was inoperative with equal certainty on healthy sections. Secondly, it was suitable for use on all possible arrangements of cables, whether these comprised separate feeders or formed interconnectors, or consisted of branch cables without switchgear at the points of junction. Thirdly, it was as instantaneous in action as it was physically possible for any cut-out to be. Fourthly, the apparatus is of the simplest possible character, and needed only very slight occasional attention to keep it in perfect working order.

Mr. J. G. STATTER, as a maker of, and experimenter with, relays, agreed with the author that the solenoid dash-pot form of time lag was more or less useless for the reason that it climbed up the setting. With regard to the proper definition of time lag apparatus, specifications for time lags should state the number of seconds required at a given overload, and also the requirements under conditions of short circuit. All breakers in series with one another, and which are desired to come out in some definite order, should have their time lag so arranged that there still remained a small fraction of time lag even under short-circuit conditions. On the other hand, circuit-breakers for some purposes, such, for example, as the protection of motors, were better arranged to act instantly at a predetermined overload, say, two or three times the normal working load of the motor. A circuit-breaker provided with time lag of this description could easily be arranged to give as much as 10 minutes' delay with a 10-20 per cent. overload, as may be deemed advisable, and yet have no lag at all when the



CURVE SHOWN BY MR. STATTER.

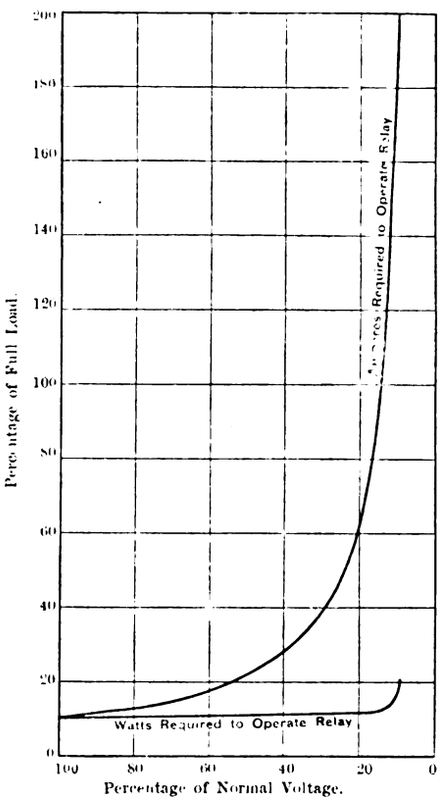
overload reaches 100 per cent. An arrangement of this sort was obviously preferable to the use of time lags giving some lag with six or seven times the full load. His own device could be arranged for either conditions. Referring to the curves shown in the diagram, it would be seen that there was an appreciable lag with six times the full load. The curves shown correspond to those shown by Dr. Garrard in Fig. 6, but whereas in Dr. Garrard's figure the settings for each relay were different, that is, one is set for 150, the next for 200, and the last one for 300 amperes, the curves shown in his diagram were all taken with the relay set at 6 amperes. It would have been interesting to know what would have been the result of increasing the overloads in Dr. Garrard's experiments, and continuing the curves to much higher readings. It would seem, from the direction taken by the first two curves, that there was some

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possibility of their meeting, in which case selective action would be at an end. Referring to Fig. 2 it was unfortunate that the author had plotted the percentage of load required to operate the relay in watts. This was not what we wish to know; it was value in current that an engineer was concerned with in the case of a reverse-current relay. If current values were plotted instead of watts, the results were quite different, and appeared to show that the particular wattmeter movement described by the author was not desirable in cases where a reduction exceeding 50 per cent. of the volts might occur. In fact, taking into consideration phase displacement, the reverse-current might reach considerable dimensions on a reduction in bus-bar voltage of less than 50 per cent.

Mr. A. E. Wedmore (British Thomson-Houston Co.) remarked that considerable advance had been made in the art since the Paper on the subject was read by Mr. L. Andrews, than whom no one had done more to create a demand and to fill it. He held no brief for the defence of the polyphase relays referred to in the beginning of the paper, but he would like to point out one feature in their favour, a fault which occurred on all three phases was generally so serious that as soon as it was cut out the better. A fault on one phase might be only momentary, and it might be argued that there was an advantage in a device set to go at a higher current on such a fault. Turning to the solenoid relay of the bellows type mentioned in the Paper, this, he believed, had been the standard for the purpose of one of the largest manufacturing concerns in the world for seven years. He had had an opportunity of checking the test results given in the Paper, applied to this device, and found that they were substantially correct. The rating given to this device was an altogether spurious rating, viz., 3½ amperes continuous rating. If the device were applied to a number of generators, of the normal standard guarantee, it would be set at a materially lower setting than this. It would recover itself at a current which was above the lowest current which the generator ought to be allowed to carry. Referring to the use of a fuse shunting the trip coil, he had a particular interest in this device. It was suggested in the Paper that it was possible to obtain a discriminating action with this device, and that small changes in the current setting affected the time limit enormously. It seemed to him that that was exactly what was required. In other words, material control of the time element could be obtained without making material changes in the current setting. Another way of doing this was suggested in the Paper, viz., by using fuses of different materials. He at one time developed quite a number of fuses of different materials. One material had been found to answer all the requirements of service. The author stated that they improved distribution, and therefore the fuse shunted trip coil was not suitable. Several of the largest London electric supply companies were employing this device extensively. Turning to the author's remarks relative to cross-connected transformers, the same arguments might be used in their protection as he had applied to the polyphase relays. It was quite a question whether it was not an advantage to have a somewhat higher setting against faulty conditions than against conditions of overload. At any rate, he had never received any complaints of faulty action due to low power factor where this device had been installed under his supervision, of any such action, and, as was shown by the Paper, the device had been very extensively used. To the faulty relay connections on three-phase four-wire circuits, a very similar argument applied. There was an objection, however, which limited its use in a manner well known to the makers. He had spoken of simplicity in the evolution of switchgear. Whenever a simpler service replaced a more complicated one, it nearly always came to stay. The cross-connected transformer was not a simple device, although it appeared to be more simple than that of employing two transformers or relays where one could do the work. Personally he had actually advocated in some cases the employment of two or three, as the case may be, trip coils or relays where expense had not been the primary consideration, solely on account of the simplicity of the connections that it led to. He would like to raise a point with regard to the suggested setting of the reverse-current device on a generator. Dr. Garrard suggested a setting of 10 per cent. of the full rating of the machinery for the time element. He thought the time element all right. He had had an opportunity of testing generators under very special emergency conditions, using the solenoid type of relay, which filled all the conditions laid down by Dr. Garrard, and previously by Mr. Andrews, and he found it quite easy, owing to the slight hunting action of the governors, to obtain cross current during good parallelling amounting to 40 per cent. of the normal load current. The conditions laid down by Dr. Garrard were accompanied by cross currents of very much higher values than that due to setting the relay at such a low value as 10 per cent. He believed in setting the reverse relay at very much nearer the value assigned to the cross currents which were likely to occur, and then put in only just sufficient time element to prevent the cross currents doing damage.

Mr. Leonard Andrews (Key Engineering Co.) said that some of the speakers had very kindly referred to the work which he had carried out in this connection, but he would like to go back still further, and give credit where credit was due, viz., to Mr. J. S. Raworth. It was he who first drew attention to the mistake of using excess current circuit-breakers between generators, feeders, and transformers, and the bus-bars they were supplying. Generally, he agreed almost entirely with Dr. Garrard's remarks. There was a point that Dr. Garrard would expect him to disagree upon, and that was on the question of dealing with the failure of the field current. That was a matter which Dr. Garrard, Mr. Field, and himself had considerable discussion after his Paper at Manchester. Mr. Field had, however, pointed out subsequently that relays of the reverse power factor type, which Dr. Garrard had referred to, would operate with any reverse power down to 10 per cent. of the full load current. In reply to that, he pointed out to Mr. Field that when the field circuit of a generator was open, there was no reverse power, and Dr. Garrard had admitted this to be a fact. But Dr. Garrard stated, "Provided the set remains in synchronism, and the steam supply is in order, the alternator continues to supply energy to the system, and there is no reason why it should be disconnected from the bus-bars." This, however, was where he disagreed with Dr. Garrard. In effect, the author stated that if the machines were still running in synchronism, there was nothing to worry about, but he could not help thinking that in making that statement Dr. Garrard could not have tried the experiment of opening the field of a generator when there were two or three machines running in parallel. There was a leading current in the one machine which gave an artificial field which kept the generator in step. What became of this heavy leading current? If there was only one other generator going, it was bound to go into the other machine, and it became a leading current 180 degrees out of phase in the one machine and a lagging current in the other



Curve Exhibited by Mr. L. Andrews.

machine. There were thus two machines in parallel, one with a direct current field and the other artificially produced by the leading current; the direct current field was soon wiped out by the enormous reactance of the lagging current in the other machine, and in a very short time the volts dropped down to something like zero, and if there were synchronous machinery running, it was almost bound to drop out of step. All this was theory, but he would like to add that there were numbers of cases of breakdown and of entire shutdowns due to a field circuit being open, and he thought that a discriminating device that did not deal with the open field difficulty gave a sense of false security. He was grateful to Dr. Garrard for having given the curve of variation of calibration with voltage for an alternating current reverse relay, which Mr. Statter had also referred to, because it enabled him to run to earth a rumour which had given him some trouble for a long time. He had been told time after time that Dr. Garrard's instrument would operate on a reverse current of less than 20 per cent. when the potential fell to 10 per cent. But that was not Dr. Garrard's meaning, as he now made quite clear. Engineers had been accustomed to specify the reverse current in amperes, and he had often seen specifications in which it was stated the device was to cut out with a current of 20 per cent. at normal potent[illegible]

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and perhaps cent. per cent. at 10 per cent. full load. If they took this in current, they got a totally different shaped curve, as Mr. Statter had shown. In the curve, given below, he had reproduced this. The bottom curve was Dr. Garrard's curve expressed in watts, and it was drawn to a similar scale. The other curve showed the reverse power in amperes. It would be seen that when they got down to about 20 per cent., the reverse current in amperes was about 16 per cent. of the full load current. This, he thought, explained why Dr. Garrard had always advocated a 10 per cent. setting. He entirely agreed with Mr. Wedmore that this was a great mistake; he would like to see 30 per cent., for then nothing would be heard of these discriminating devices coming out when they should not. Imagine the curve starting on normal potential with a 25 per cent. setting, and it would be seen where the curve would go to when 20 per cent. or 30 per cent. of the normal pressure was reached. Those who had been working with him had aimed at—and it was a very difficult thing to get—arriving at a curve that would give some such condition as this, viz., that the reverse current necessary to operate the device at normal potential should be something like 30 per cent., and that the current required to operate it at, say, 10 per cent. of the normal potential, about as low, perhaps, as they would get, should be cent. per cent., and that still left a chance of the device coming out with something like 5 per cent. of the normal, which was quite possible to obtain. He hoped Dr. Garrard in future would speak of the behaviour of his device in amperes instead of watts. (Dr. Garrard: No.) Reference had been made to the Merz-Price system. This, he thought, was a most ingenious system, and enabled them to deal with the ring main problem. He was quite sorry to see Dr. Garrard was trying to make reverse relays work on the ring main principle. He thought the Merz-Price system was certainly the best way of dealing with a ring main system. On the other hand, he did not agree with Mr. Clothier, who apparently would have them believe that the Merz-Price system was the best for all conditions. His view was that switchgear designers should aim at supplying devices to meet conditions as they were laid down. The Merz-Price system was not applicable to the majority of systems laid down because they had no pilot wire, and there were other reasons. For many purposes a simple discriminating device was the best. Mr. Welbourn, who spoke after Mr. Clothier, also referred to the Merz-Price system, and talked a great deal about the reasons why Messrs. Merz and Price went in for this system, and the difficulties they had experienced with discriminating cut-outs. According to this speaker, Messrs. Merz and Price had tried *nearly* every discriminating cut-out which had been brought out. Some years ago Mr. Merz read a Paper in which he said he had not been able to get a reverse-current device that would work satisfactorily, and referred to his own experiments on different types of apparatus. After that Paper he had told Mr. Merz that he could guarantee to supply him with a device that would do what he wanted, but so far as he knew Mr. Merz never tried one then, and he knew he had never tried one of his devices since. The speakers who had advocated the Merz-Price system had referred to various cases in which they worked satisfactorily, but he himself had had numbers of cases of devices which were working satisfactorily and never failed, years before Messrs. Merz and Price began on their system. Some of them might remember that a few years ago he invited a number of engineers to Hastings to see a nail driven into a 2,000-volt feeder. He should not have done that if he had not felt pretty certain what he could do with it, and that system had never failed; there was no earthly reason why it should any more than the Merz-Price system.

Mr. KENELM EDGCUMBE (Messrs. Everett, Edgcumbe & Co.) said that all Dr. Garrard's curves of time lag stopped at about three times the full load, but it should be remembered that a short circuit might be anything over ten times the ordinary full load. In one well-known type of induction relay, which was made by a firm not 100 miles from Manchester, a damping magnet was used for getting the time lag, and the time setting was arranged by altering the position of the magnet on the damping disc, with the result that first-rate curves could be obtained, as shown in the Paper, but, unfortunately, when the overload was fairly large the disc reached synchronous speed, and consequently all the time lags were about the same independently of the setting of the magnet. They might, of course, alter the setting current rating, but with large overloads that was not of much use. It appeared to him that it was important that the time lag should be independent of any protecting force, *i.e.*, that the movement should be set in motion and be moved through a definite distance depending on the setting. He felt it was very essential that reverse-current relays should be reverse-current relays and not reverse-power relays; it was not the current but the power that did the damage.

Mr. B. JENKIN (Messrs. Kennedy & Jenkin) said one very important point had not been touched upon in the Paper or during the discussion. Dr. Garrard mentioned that it was necessary to set the cut-outs to deal with synchronising the currents between the sub-stations, motors, and the generators. He thought they would have to go a great deal further than that. Where there were a number of motor generators their power of generating current from their flywheel effect was so great that it was necessary to treat the sub-stations as if they were as much generators as the power station. That accounted for so many of these troubles with reverse-current relays. People did not take into effect the power from the sub-station coming back to the generating station. A simple instance of this was where he had four generators running in a power station, there being no interconnector between the two sub-stations. It was wanted to separate the four generators, putting two on each sub-station. They cut the busbars, and the cut-outs opened, and two of the generators simply dropped out. In another case, with a Highfield booster and a motor generator, the man opened the exciter switch and two of the main engines promptly dropped their reverse-current cut-outs. It was the power coming from the sub-station which upset things. In Fig. 5 this had not been taken into account, as the interconnector with pilot wire was only shown between the two sub-stations. The feeders between the power house and sub-stations should be protected in the same way, otherwise the reverse-current relays at the sub-station end of the feeders would open at once on any interruption or short circuit on the system. He had constantly found that not only would reverse cut-outs open in that way when one sub-station was feeding back to the power house and into another sub-station, but the motors would open their maximum cut-outs, the feeder maximum cut-outs at both ends would come out, and if there were separate busbars at the power house these would be disconnected. This was a very important matter and must be taken into consideration. With the time-element one might possibly find what was wanted by going a step further than Mr. Statter, viz., by the use of an inverse time-element until a point was reached where they opened at short circuit; this could be a fixed time-limit, which could be set with absolute certainty. It should be a very small fraction of a second, but only in that way would they be able to make certain that maximum cut-outs in series would open in the order they were wanted to. At present they almost invariably did not.

Dr. GARRARD replied shortly to the discussion, and will reply more fully in the *Journal*. With regard to the Merz and Price system, this was a very excellent one, and he had nothing to say against it. The only thing was that it was complicated, and it certainly appeared that the makers found it more complicated than had been originally thought. If they took the original patents of Merz and Price and saw the very simple arrangements there, and then saw the price list now issued, there was a very great difference. The difficulty was the pilot wire. With an interconnector the pilot wire was essential, and could not be done away with, but it was an evil. There was an extra cable and tremendous expense and complication. The sub-station attendant did not know what was happening at the other end of the pilot wire, and it was an evil which should be kept down to the very minimum. With regard to Mr. Clothier's remarks, it was quite true that the system in Fig. 5 was a system for the protection of an interconnector, but if the switch was open the thing was not an interconnector any more, and it did not protect it, and, as Mr. Clothier rightly said, it did not apply then. His ring main system was very good, but he thought if they were going to work five sub-stations on this principle this was going a bit too far. If the two main cables happened to break down at once, which was not unheard of, the whole system would break down. Of course, if they had pilot wires between every sub-station and in parallel with every feeder, and had pilot wires running round every corner and between secondary and primary of all transformers and on generators, they would get a very good system of protection, but it would be an extremely complicated system and not a bit in advance of the ordinary system of maximum time-circuit breakers and reverse-current breakers. Of course, the maximum system had its limitations, every system had, but still he thought it preferable. Messrs. Merz and Price had carried it to the very extreme extent. Their system for the protection of interconnectors was very good, and he had said so in the Paper, but he thought it was rather a large statement that, because it had operated with success twenty times, this was proof that it was a good system. He had made thousands of relays, and had had excellent results. He agreed with Mr. Andrews that Mr. Merz had not tried all maximum devices; he certainly did not try his. On the question of solenoid relays he was glad Mr. Statter agreed with him. As to his remarks upon Fig. 6, the relays themselves were identical, but the transformers were different. All the relays were 10 ampere; in the first instance, they had a 10–1 current transformer, in the second instance a 20–1, and in the third instance a 30–1, and, therefore, it was that the various curves differed. Therefore, there was not much in the point raised by Mr. Statter on this matter. Mr. Statter also made some remarks about direct-current time-limit relays, but the Paper was headed "Alternating Current," and he had not dealt with direct current at all. He had not wished to discredit the apparatus made by Mr. Wedmore's firm, all he had done was to describe his own mental evolution. He had tried all these things, and it was very unfortunate that it had come out in this way; he could not help it. On the question of different materials for fuses, he did not think this possible. The Paper by Messrs. Schwarz and James gave curves for fuses of different materials, aluminium, copper, and so forth, and in a contribution to the discussion on this Paper he

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showed that it was impossible to do that which Mr. Wedmore suggested. The curves invariably crossed. If they kept the same normal fusing current the curves crossed one another, and the order in which they would fall would depend on the overload. With regard to the failure of the field current, that was a question of opinion; the opinion he had stated in the Paper did not agree with that of Mr. Andrews. If they wanted to guard against this they should put a very simple device in the field-current circuit, so that when the field broke it cut the main switch out. This could be done for a few shillings, and they need not rely on the reverse relay doing it. He did not think that when the field broke the reverse relay should operate unless the flow of power into the faulty generator exceeded 10 per cent. Mr. Andrews' curve was no news to him at all; in fact, he did not quite see the point of the curve at all. The machine would easily carry 60 per cent. overload; under conditions of breakdown, they got 10, 20, or 30 times the full-load current. As a matter of fact, he had made parallel tests on 6,000-volt generators with Mr. Andrews' arrangement, and the results were favourable to his own. (Mr. ANDREWS: I also have made tests.) Dealing with Mr. Edgcumbe's remarks, Dr. Garrard said he understood him to say that on a dead short circuit with an induction type relay, the time might become zero, because of the synchronous speed. But in all the figures the lower curve was practically asymptotic and would give a time excess.

Mr. EDGCUMBE said he did not suggest they would go to zero, but, if they all coincided, the times would be the same irrespective of the setting.

Dr. GARRARD said there were two methods of adjustment, one by the magnet and the other by altering the travel, and if they got over this, the minimum value of the time, was the time which determined the order in which they operated; and this was met in the different relays by different lengths of travel. He was interested in Mr. Jenkin's remarks as to the very large flow of power that can come back from the sub-station. It was suggested in the Paper that the sub-station relay should be set for 20 per cent. He would be willing to put this at 100 per cent., or even higher, but the correct value could only be found by actual experiments on the system.

Several written contributions to the discussion have already been received.

Mr. H. BEVIS (General Electric Co.) wished to comment on Dr. Garrard's remark that a detrimental feature of the solenoid relays he tested, was the variation in the magnetic reluctance of the circuit due to the different positions of the plunger. It might be that the relay tested had a return iron circuit, whilst if the circuit was mostly air, the flux was rendered proportionate to the current. Relays could be made with the return circuit of air, in which case the defects mentioned would be greatly minimised. He did not agree with all Dr. Garrard's criticisms on the solenoid relay. He had found them reliable owing to their simplicity, and pointed out that the overload and time adjustments could be made quite independent just as readily as any other types, whilst the cost of manufacture is very much less. A reverse-current relay with a wattmeter movement lacked all provision for differences in power factor. He did not consider it good practice to have a time limit on a reverse-current relay. The small reversals that took place during synchronising were negligible. A device was required to take care of a big reversal, and when this occurred the action should be instantaneous. The present tendency inclined towards too many automatic devices: whilst, taken in moderation, they were essential for central station work, multiplication of such devices was not to be desired, and the object should be only to install the smallest number really necessary.

Mr. W. J. P. ORTON and Mr. G. NORTH (British Westinghouse Co.) did not think the author's remarks on solenoid relays were altogether correct. No doubt there were relays of this type which could be made to float in the manner described, but if the movable iron plunger and the pole-piece to which it is attracted were properly designed, they could be made to work with practically no danger of floating. It was obvious that in both the solenoid and disc types of relay, if the overload came on again in such a short space of time that the mechanism could not reset itself, then the relay would operate with a very short time limit in the second case. This, however, was in their opinion rather an advantage, as an intermittent short of this description should be disconnected from the circuit with the least possible delay. Referring to Fig. 2, from the author's description it would appear that the A.C. reverse relay in question acted on a drop in voltage without a corresponding increase in current, but on referring to the curve it would be noted that the ordinates were represented in watts, and, since the relay acted at 10 per cent. of full load watts with full voltage, it would act about 10·5 per cent. of full load watts when the volts had dropped 40 per cent. This meant that the current would be practically doubled, and is the result which would naturally be expected with a wattmeter relay. The author's method of protecting interconnector cables had the advantage over the Merz-Price system of employing only one pilot wire, but since, according to Fig. 2, the reverse relays proposed were dependent solely on the actual power in watts passing through them, it would be possible, when the sub-station voltage fell to a very low value, that the current required to actuate the relay would be so great that the inverse time element maximum relays in series with the fault would act before the relays in question, thus shutting down the whole or part of the supply without isolating the faulty interconnector. The author recommended time element maximum relays with varying time element in series, whilst they agreed that this was the best method of protecting distribution in sub-station systems, they believed that it was the subject of Mr. Stillwell's patent 25,422 of 1899.

CATALOGUES AND PAMPHLETS RECEIVED

ARC LAMPS.—A handsome brochure from the Union Electrical Company gives nearly forty reproductions of the photographs of applications of the company's Excello and other arc lamps, both at home and abroad, for a very large variety of purposes.

CONDUIT TUBES AND FITTINGS.—A comprehensive catalogue from the Sun Electrical Co., Ltd., of 118 and 120 Charing Cross Road, gives full particulars of the component parts of the "Kalkos" system of tinned tube conduit wiring, which was described in ELECTRICAL ENGINEERING, Vol. II., page 533. In brief, the system consists of specially drawn tinned brass tubes, tinned inside and out and socketed together with slip sockets and soldered. All fittings, such as switch-boxes, elbows, tees, ceiling rose boxes, &c., are also tinned, so that the matter of soldering and making the circuit continuously metallic is an easy one. The material is not liable to corrode, and absolute electrical continuity is attained by simply slipping a socket piece over a butt joint, and applying a blow lamp, no screwing being required. Useful features of the catalogue are the hints on estimating these equipments, and instructions for erecting.

DRAWING OFFICE SUPPLIES.—A folding card from Messrs. A. E. Mallandain, of 51 Cheapside, contains samples of drawing and tracing cloths and papers, and particulars of instruments, pencils, calculating rules, &c., and a useful ink-erasing liquid.

ELECTRIC CLOCKS.—A catalogue from Mr. G. B. Bornell, of Terminus Chambers, Holborn Viaduct, gives particulars of a series of silent electric clocks on his patented system, which comprises any number of electrically propelled dials, the hands of which are moved periodically by the operation of a contact in a "master pendulum," fixed in any convenient place in the circuit. The dials rely for their action upon the effects of electro-magnetism and gravity alone, there are no springs or ratchet teeth, the movement is definite, and the period of time cannot be exceeded or missed. The master pendulum is self-winding, and, once regulated, requires no further attention. The contacts are absolutely sparkless, means being provided for obviating the effect of self-induction both in the master pendulum and in the dials. The system can be driven from batteries or from direct-current lighting circuits. A number of forms of dial are listed, including a pattern used throughout in the Piccadilly Hotel.

ELECTRICAL PLANT.—A pamphlet from the Schorch Electrical Co., whose works are at Rheydt (Germany), describes and illustrates a number of varieties of motor-generators, &c., which this firm manufacture. The English branch has just been established, but the works in Rheydt have been established since 1881, and we understand that, during the past few years, about 6,000 installations, totalling 250,000 h.p., have been supplied. Among the special features to be introduced are complete electrical equipments for mines and collieries, loom motors, and high voltage switchgear.

MACHINE TOOLS.—A booklet entitled "Equipment Buyers' Finance," by Mr. Arthur Winder, of Leeds, points out the economy of high-speed machine tools; illustrations are given of various machine tools by Leeds and Sheffield manufacturers, including Messrs. J. & P. Hill, E. Dennison & Sons, Bateman's Machine Tool Co., and Peter Pilkington, Ltd.

The Corps of Electrical Engineers.—The movement in connection with the electrical engineers required for the Territorial Army is making considerable progress in Birmingham. As we have already announced, three companies are being raised in Birmingham by Mr. J. F. Lister, who will be in command with the rank of Lieutenant-Colonel. The three companies being raised are to be known as the Southern Wireless Company, the Southern Cable Company, and the Southern Airline Company. The Wireless Company will be commanded by a captain, and the Cable and Airline Companies each by a major. These officers will be responsible for their own companies on mobilisation. The companies will be what are known as "Army Troops," and on mobilisation they may not necessarily be attached to the Birmingham Regimental District. The period of annual training is from eight to fifteen days, the August Bank Holiday week being included. The place of training has not yet been fixed, but in all probability it will be Salisbury Plain. We hear that about 150 men have already been attested, and no difficulty is anticipated in raising the required number, namely, 500. Several well-known members of the local section of the Institution of Electrical Engineers have been offered, and have accepted, commissions in this new unit.

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THE IRON AND STEEL INSTITUTE

THE thirty-ninth annual meeting of the Iron and Steel Institute was held on Thursday and Friday last at the Institution of Civil Engineers, under the presidency of Sir Hugh Bell. As previously announced in these columns, two Papers of electrical interest were down for reading. The first of these, by Prof. B. Igewsky, described a new form of electric furnace for the smelting of iron, and was included in the programme for Thursday. There was, however, no discussion to this Paper.

A New Electric Furnace for Smelting Iron

Professor B. Igewsky points out that a supply of electrical energy equal to 500 kilowatts is usually sufficient for the smelting of one ton of steel. Under modern conditions the electric furnace should be capable of producing steel more cheaply than by the open-hearth process; the crucible steel process may be excluded as a method for the production of steel on a commercial scale. Many works already employ electric furnaces, of the Stassano, Kjellin, and Heroult types. These furnaces work very successfully, but they all either employ low pressures (not exceeding 100 volts), or they themselves act as transformers. The author describes a method of working with high-pressure electric current, of which he has had seven years' experience. The furnace is one of a type employing what may be called second-class conductors, such as magnesia, lime, silicates, or their colloids, such as Al_2O_3, $2SiO_2$, which, on being greatly heated, become conductors. It is absolutely necessary that the current should pass in the thinnest possible layer over the lower surface of the bricks. The pressure should be 1,000 volts for each metre space between the electrodes. By bringing the electrodes nearer together, or placing them further apart, or by providing the furnace with a number of electrodes, and only charging those which are immediately needed, it is possible to obtain a furnace which will work with all pressures in ordinary use. Such a furnace should work as steadily as an incandescent lamp, and should develop the highest temperature that the bricks can support. The problem is, however, not entirely solved. Difficulties are presented owing to a phenomenon analogous to that which the author has found to occur in the blast-furnace, and to which he gave the name of differentiation.* The electric current only flows over the whole surface of the brick during the earlier stages. In a very short space of time it concentrates itself along the lines of least resistance. Little by little the path selected becomes the only zone affected, and the remaining surface remains quite cool. Differentiation can be obviated by dividing each electrode into a number of smaller electrodes furnished with regulators. Such a system could be employed for the firing of porcelain, for example.

The application of the principle to the manufacture of steel and to the fusion of other smelted materials is more easily solved by the furnace being made to revolve, and supplied with a sufficient number of electrodes, so that the current does not suffer interruption. In such an arrangement the bricks will at one time form the vault and at another the bottom of the furnace. By this means the variations in temperature can be avoided, and each brick passing beneath the metal will have the same conductivity over the whole of its surface as any other brick. In addition to this the bricks will be automatically moistened with slag, so that their surfaces become better conductors than their interiors. If the principle of a revolving furnace be adopted, it is necessary that it should be furnished with a commutator, otherwise the current will short circuit through the metal. Fig. 1 shows a plan for a rotating furnace using three-phase current. Such a furnace should be rotated about twenty times per minute. It is possible to construct a free commutator connected with the furnace by a cable. In the section shown in Fig. 2, the rollers can be seen, as well as the pivot which allows of the furnace being tilted in order to empty it completely. All the plates are of cast iron; *a*, *a*, are bricks, *b*, *b*, are electrodes placed between the bricks, and *c*, *c*, parts of the commutator; *e*, *e*, are the brush holders. The inside diameter of the furnace is 175 millimetres, and the depth 215 millimetres. The cubic capacity is 5·17 litres. The space that can be occupied by metal is, however, only about 2 litres, and at the commencement little more than 10 kilogrammes can be charged. In the course of time the interior bricks wear, and the capacity of the furnace becomes greater. The author prefers a three-phase electric current, but usually employs a continuous current of 250 volts and 56-60 amperes, *i.e.*, 12-15 kilowatts. When cold the furnace is a non-conductor.

The process of smelting is conducted in the following sequence of operations: The flame of a gas or Bunsen burner is made to impinge through the working opening, and when the furnace has been slightly warmed a little damp potassium hydrate is charged and the furnace is rotated. It will now be found that the furnace acts as a conductor, and the electric current begins to warm it. After a short time sodium hydrate is added, and

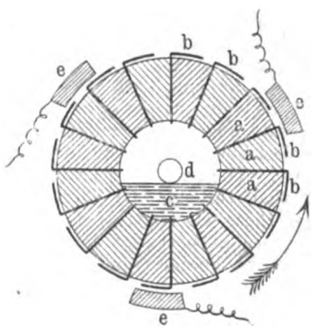


FIG. 1.—DIAGRAMMATIC SKETCH OF FURNACE.

a, *a*, Firebricks; *b*, *b*, Electrodes and parts of Collector; *c*, smelted metal; *d*, working opening; *e*, *e*, Brushes which remain stationary during the rotation of the Furnace.

when the interior of the furnace is red hot sodium carbonate is charged. The corrosive alkalies which evaporate within the furnace do not cause as much harm as might be expected. Rapid heating is, however, a danger to the bricks, which begin to crack. The best plan is to warm the furnace with gas during the night preceding the experiment. When the temperature of the furnace reaches a light red heat, cast-iron may be put in, and then scrap, or the order can be reversed. In the first case the author is in the habit of adding the new material gradually as the charge melts. In the latter case, when the iron becomes sufficiently hot, the smelting takes place at once on the addition of cast iron. If a quantity of cold metal be suddenly introduced at one time, it is easy to reduce the temperature to such an extent that short circuiting occurs. The same thing occurs if the furnace becomes cool with the metal inside; small furnaces cool down in an exceedingly short time. In a large furnace where there is a considerable margin of heat, such an accident is hardly likely to occur. Indeed, in order to bring them into working condition, it would suffice to charge some hot slag from some other furnace and to avoid having recourse to soda, which could not be other than injurious to the bricks. The outer bricks of the author's furnace are of fireclay,

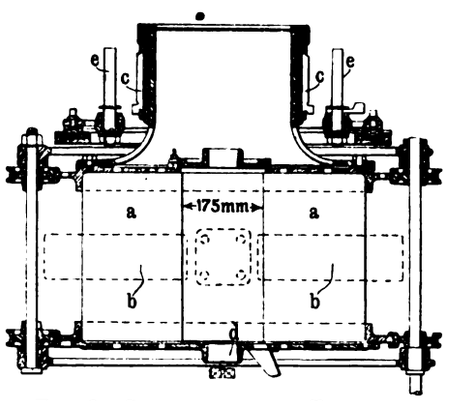


FIG. 2.—SECTION THROUGH FURNACE.

and the inner of fireclay or dinas. The fireclay bricks are fairly good conductors, but the dinas bricks are exceedingly poor conductors. The author has, however, used both for years with successful results. With fireclay bricks care should be taken that less slag should be used. With dinas bricks it is his custom purposely to add fluorspar, cryolite, magnesia, and similar substances, in order to increase conductivity. Magnesite bricks appear to be ill adapted to the purpose, because they conduct too easily, while the current of 250 volts would, with the existing dimensions of the furnace, be too great for these bricks. Ex-

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periments with dolomite and other bricks have not yet been carried out by the author.

The electrodes in the furnaces illustrated are of iron. At first sight it seems astonishing that they could be made to work in a furnace in which steel is being smelted. As a matter of fact, the electrodes melt and become slightly absorbed in the interstices of the bricks. But as the heat is developed on the surfaces of the bricks lining the inner side of the furnace, the crevices around the electrodes remain at a moderate temperature, because they retain the slag and even drops of metal, which act as conductors. The author at first employed electrodes of 3 to 4 millimetres in thickness, so as to drive them into the furnace from time to time by means of a hammer, but as that appears to be unnecessary he now employs thin sheet-iron electrodes. There are in the furnace twenty-four electrodes placed at intervals of 23 millimetres from each other. As in the furnace filled with liquid steel only, the fourteen upper bricks constitute the working surface, a difference in potential of $\frac{24}{25}$", or nearly 35 volts, is obtained between adjoining electrodes. As a result sparks are emitted on the collector on replacing each electrode, and frequently the spark is transformed into an arc. The path of the voltaic arc to the collector is shorter than that through the conducting brick. On the distance between these electrodes being reduced to 12 millimetres, the difference of potential falls to 17½ volts, and the formation of the arc becomes impossible. The author has, however, adopted an alternative. Each flat piece of the collector is divided into three parts, connected to each other with rheostat wires. By these means each electrode becomes gradually shut off whenever the difference of potential reaches the vicinity of 12 volts, and the formation of an arc is impossible. Besides that, he has fixed an additional brush on the electrodes, joined to the rheostats. This brush similarly serves to lessen sparking The method employed to obviate sparking is the only complicated part of the furnace, the remaining principles being quite of an elementary nature. The manipulation of the furnace is likewise exceedingly simple, although with its present very small dimensions it requires constant attention. As a rule the author smelts a small quantity of cast-iron and afterwards adds scrap. The softest steel produced possesses an ultimate strength of 56·8 kilogrammes per square millimetre, with an elongation of 20 per cent.

On smelting iron turnings with charcoal (1 per cent.) steel was produced with an ultimate strength of 85·6 kilogrammes per square millimetre, and an elongation of 3 per cent. Experiments for the production of steel from cast-iron by the ore process were also successful, and the fireclay bricks suffered less than might have been anticipated. The advantages claimed for a furnace of the construction indicated above are as follows:—High voltage and low expenditure of current; the possibility of using any form of current ordinarily employed; compactness and high efficiency; homogeneity of the metal produced; minimum amount of surface contact with air or with the walls of the furnace; slag at a high temperature, favourable to the reactions needed for the refining of the metal; minimum superheating of the furnace; avoidance of carbon electrodes; and the possibility of using the furnace for the production at a high temperature of any material in a fluid state.

The other Paper, by Mr. W. Lambert, discussed on Friday, described the pyrometric installation of the Ordnance Factories, Woolwich. At this meeting, previous to the reading of the Paper, the Carnegie Gold Medal for research was presented to Dr. Carl A. Benedicks, of the University of Upsala, Sweden, for work in connection with electro-metallurgy.

The Pyrometric Installation in the Royal Gun Factory, Woolwich

After reviewing the circumstances which led to the adoption of pyrometrical methods in the factory, Mr. W. Lambert describes the simplest form of pyrometer, which consists of the thermo-junction and an indicating galvanometer. The thermo-junction simply consists of a pair of wires of dissimilar metals, one end of each wire being twisted together, thus forming a junction which, to all intents and purposes, is regarded as a battery, since such a junction when heated is the seat of an electro-motive force which is a function of the temperature. The wires forming the hot-junction must necessarily withstand fairly high temperatures, seeing that the couple has to be introduced into furnaces, the heat of which sometimes exceeds 2,000° F. A suitable couple consists of a pure platinum wire, together with a wire of 10 per cent. iridio-platinum alloy, and thermo-couples of these two metals are used exclusively throughout the present installation. The free ends of the two wires are available for the copper leads joining up to the indicating galvanometer. The wires of the couple for furnace work are preferably threaded through double-drilled fireclay tubes, which serve to keep them apart throughout their length, and the whole inserted in a covering sheath of gas or steam barrel, the junction end of which is closed by a thin iron disc welded securely into the end. To the open end of the sheathing is fixed a head which serves to carry two terminals, on the under side of which the ends of the wires forming the couple are connected, thus ensuring a clean contact. The copper leads to the galvanometer being attached to the exposed portion of the terminals, care is necessary to secure a clean contact whenever connection is made. The galvanometer is a modification, devised by Colonel Holden over twenty years ago, of the D'Arsonval galvanometer, and consists of a built-up, laminated horseshoe magnet, between the poles of which an adjustable frame holds a circular iron core round which a light silver "former" wound with a coil of wire partially revolves. This coil is held suspended between the top and bottom of the frame by a fine metallic strip of flattened phosphor-bronze wire. Fixed to the upper portion of the moving coil is a small, circular, silvered mirror. This form of galvanometer is practically dead-beat. Its internal resistance is about 80 ohms. The galvanometer, together with a suitable illuminating lamp and transparent centimetre scale, are erected upon a rigid though light frame of cast iron.

An instrument of this type was the first contribution to the present-day installation, and was used for ascertaining the temperature of the lead bath for heating test-specimens. A second instrument was ordered for use at the big furnaces of the oil-hardening and annealing section. Here, on account of the close proximity of the heavy hammers and other ponderous machinery, some difficulty was experienced as the result of vibration, even though the instrument was placed on a solid pedestal of concrete, the footings of which were several feet below the ground level. Closely following this second instrument, a further addition was introduced, an instrument of the recording pattern. With this instrument also some slight trouble was experienced through vibration; but this, after a few experiments, was successfully overcome by suspending the galvanometer from a tripod in such a manner that the vibration was absorbed by three small spiral springs so arranged as to be in partial compression. This method of suspension has proved an admirable one, and has been adopted throughout the system. Several interesting thermo-metallurgical observations having been made concurrently with the calibration experiments upon this instrument, it was finally decided that it should be permanently retained in the metallurgical laboratory as a standard instrument available for comparison and for such experimental work as might arise, and that the oil-hardening section should be wired up to the laboratory in order that photographic records of thermal treatment in the mass might be obtained for permanent record as occasion might demand. These three instruments formed the nucleus of what is now regarded by experts as one of the most complete pyrometric installations in the kingdom.

The recording pyrometer consists of two light-tight mahogany cases, the larger of which contains a Holden-d'Arsonval dead-beat galvanometer. The other case contains a drum which is made to revolve by contained clockwork. The surface of this drum is covered with sensitised photographic paper. A ray of light, from either a gas jet or a lamp, is thrown by means of a mirror, at an angle of 45°, on to the mirror of the galvanometer, and is projected thence to the surface of the drum, and acts photographically on the sensitised paper. The galvanometer is then connected by copper leads to a thermo-junction inserted in the place, the temperature of which it is wished to record.

The heating of the thermo-junction causes a very small current to pass through the coil of the galvanometer which is deflected, and the mirror attached to it projects a spot of light on the surface of the drum. The amplitude of this deflection indicates the temperature, and a continuous curve is traced on the photographic paper, which at once indicates what temperature had been attained at any particular period. A scale is also provided on which the temperatures can be read from time to time without interfering in any way with the record. Two recording instruments of this type are in constant use day and night, and constitute the laboratory end of the system. These two recorders are also regarded as the standard instruments of the department. They are mounted on simple iron pedestals, the galvanometers being suspended inside the cameras from their respective tripods. The following branches are now wired up to and are under pyrometric control from the metallurgical laboratory—the heavy forges, the oil-hardening and tempering branches, the case-hardening shop, the drop-forging plant, the

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lead bath (specimen treatment plant), and the gas muffles throughout the department used by the tool-smiths and other craftsmen. The various sections of the gun department are also in direct telephonic communication with the metallurgical laboratory through a small local exchange board. Each of the larger sections previously named has an independent instrument room fitted with a simple indicating instrument. An attendant is always present in each room whose duties are: (1) To connect up the respective furnaces, take observations, and communicate temperatures from time to time to the furnace-men, and also to record all such temperatures in a book. (2) To test repeatedly the zero of the instrument in his charge, and confirm the readings by telephonic reference at frequent intervals to the standard instruments in the metallurgical laboratory. (3) To report periodically the condition of the couples under his charge, and to keep clean all terminals, connections, &c. (4) To annotate and file the photographic records received from the metallurgical department.

The temperature of boiling water is taken as a common zero for the temperature scale of the whole of the instruments comprising the installation. The standard instruments are calibrated by the arrest representing the boiling point of water as zero and the freezing points of the following substances:—

Substance used for calibrations.	Solidification Temperature in degrees Fahrenheit.
Tin	450
Lead	621
Zinc	786
Aluminium	1,215
Sodium sulphate	1,580
Copper	1,983

The metals are ordered from the trade as "especially pure for pyrometer calibration," the purity of each parcel being ascertained before use by chemical analysis. A small crucible charged with about 8 ounces of a metal is placed in a Fletcher injector furnace until the contents are molten, a thermo-couple protected by a small porcelain tube sealed at one end is then placed in the molten metal and the gas and blast turned off. Observations are taken of the cooling of the metal, the temperature of solidification being indicated by the arrest in the downward movement of the beam of light upon the glass scale. In the construction of the recording instrument the glass observation scale is fixed, as is also the drum; but the adjustment of the zero of the instrument is provided for by means of a tangent screw actuating a pivoted plate, upon which is mounted the tripod from which the galvanometer is hung.

The sensitised bromide sheet after a twenty-four hours' run on the drum is removed, carefully excluding actinic light, placed in a printing-out frame containing a sheet of plate glass, the inner side of which is painter black, and upon which surface longitudinal and vertical lines are scratched, in such a manner that upon exposing the frame to active light lines representing both periods of time and temperature are printed. Common flashed ruby-red glass may be substituted for the painted glass, the lines being etched upon the ruby surface by exposure to the action of hydrofluoric acid. The exposed paper is then developed, fixed, washed, and dried, dated and forwarded to the responsible foreman of the particular section for whom the record is intended. Each sheet represents a day's record in the form of curves of the temperatures of the various forgings treated in the furnaces of the section during the preceding twenty-four hours.

A simple plug board of a double-pole pattern is employed, to the back of which the respective leads from each furnace are conducted. These leads are of standard wire, gauge No. 18, of high-conductivity tinned-copper, insulated with pure and vulcanised india-rubber, taped and braided. Each pair of leads is enclosed in common gas or steam barrel, which is maintained throughout the whole circuit from the furnaces to the pyrometric cabin of each branch, thus insuring freedom from injury by the corrosive action of any escaping furnace gas or damage by abrasion from ladders, scaffolding, &c., during furnace repairs. The short flexible portion of the leads at each furnace, by which connection is made to the pyrometers in the furnaces, is protected by an asbestos covering, thus preventing any liability of faulty insulation by the scorching of the ordinary coverings. Two plugs suspended on short flexible leads serve either for connection to the pyrometer cabin, or to transmit the thermo-electric current to the recording instrument in the metallurgical laboratory—according to whichever of the two plugs is inserted in the plug holes of the particular leads of the furnace under observation. The metallurgical laboratory being situated at some distance from the sections previously named, the resistance of the conducting leads is carefully measured, and in calibrating the respective instruments due allowance is made for this. Moreover, with each galvanometer a considerable predetermined series resistance is used, approximating some 500 to 600 ohms, and with such a resistance the slight differences in the lengths of the leads from one furnace to another is not sufficient to impair the accuracy of the readings.

The method of insuring that, as far as possible, the actual temperature of the article heated is ascertained as distinct from the temperature of the furnace itself, is by sheathing the pyrometer tube in a circular muffle of non-conducting material in such a manner that the extreme end of the pyrometer, which is in close proximity to the couple itself, shall be in actual contact with the article. The muffle ensures the absence of any false reading due to the temperature of the gaseous atmosphere of the furnace being conducted down to the thermo-couple. As many as five and six thermo-couples are sometimes inserted in the long vertical furnaces of the oil-hardening section employed in heating the larger forgings forming the inner tubes of the heavier guns. These gun tubes in the larger nature of ordnance sometimes exceed 60 ft. in length. The furnaces are gas heated, and by means of air ports combustion may be regulated with great uniformity, especially when controlled by a number of thermo-junctions placed at regular ascending intervals in the walls of the furnace. The cold-junction of each couple with the pyrometer leads is maintained at an equable temperature by having sufficiently long pyrometers. The further precaution is taken of calibrating the whole system with an allowance for the average cold-junction temperature of the various pyrometers.

The details of the construction of the pyrometers in use are as follows:—The ends of the couples are twisted together for a length of $\frac{3}{10}$ of an inch; the twisted junction is then "autogene" soldered by holding the ends in the oxyhydrogen flame until they become fused to a small globule. Merely twisting the ends results, after repeated heatings of the same couple, in loose contacts, and leads to false readings. The unsecured ends of the wires of the couple are then threaded through the double-drilled porcelain tube of highly refractory clay. This refractory covering, together with the couple wires, are maintained throughout the whole length of a pyrometer, even should this approximate 15 or 16 ft. in length, as is actually the case in the longer forms. The wires in the head are wound into two spirals, which are insulated from each other by short lengths of rubber tubing. This affords a few inches of spare wire, use of which is made from time to time as necessitated by the re-making of a new junction, &c. The double-drilled fireclay tube, immediately at the junction end of the couple, is sawn through longitudinally for a short distance, just sufficient to little more than cover the end of the junction, and thereby preventing liability of any contact between the couple and the welded end of the iron sheath. The head is of cast metal, bored and tapped to fit the iron sheathing. The cover of the head carries the two terminals to which the wires of the couple are connected to the galvanometer leads. It is made of ebonite, and simply fastened by three screws. The iron sheathing is ordinary $\frac{3}{8}$-in. gas barrel. For use at the lead bath the sheathing is a solid-ended tube bored from mild steel rod. Welded tubes have not proved satisfactory in use at these baths on account of the lead finding its way through after being in use but a short time.

Upon exposure at long-sustained high temperatures, more or less crystallinity of the platinum and iridio-platinum wires takes place. Neither the thermo-electric value nor the conductivity is materially affected by slight changes of this nature, but excessive crystallinity, however, renders the wire brittle. The malleability of the wire may be restored by momentarily glowing to incandescence by passing a current through the wire. If this is not convenient, the brittle portion of the wire may be cut off and the wires pulled down from the head, for which purpose the spirally coiled length at the end of the wire is provided, or, failing sufficient length to allow of shortening the wire, the whole couple may be transferred end for end. The gauge of the platinum and the iridio-platinum wires employed throughout the installation in making up the couples is of a uniform size, viz., 25 standard wire gauge. The advantage in securing a single coil of each of the wires is evident. It favours the chances of the metals being of the same composition throughout and of the same thermo-electric value. Too much care, however, cannot be expended in satisfying oneself that each couple made up is practically of the same thermo-electric value, as otherwise the calibration of the instruments does not hold good for the whole of the pyrometers throughout the system. The variableness of the coil of wire may be tested on its receipt by cutting off portions from each end of a coil.

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twisting the ends of the *similar* metals together, and connecting the free ends to the galvanometer. On applying heat to the junction no appreciable movement on the galvanometer scale should be observable, thus demonstrating the purity or uniform composition of the wire.

There still remains a form of pyrometer which is in daily use for ascertaining shrinkage temperatures in the building up of ordnance, &c., and also for ascertaining the given temperature below which it is not deemed desirable to put further work upon a forging. This couple is similar in most respects to those previously described, but differs in one important feature. The fire end of the couple terminates in a small exposed platinum plate made up of two small circular discs, $\frac{1}{10}$ of an inch in diameter, of sheet platinum, between which the wires of the couple are lead, and the two discs secured by riveting each to the other. This small plate or disc standing proud of the end of the pyrometer is supported some distance from the end of the tube by a small spiral spring, thus ensuring a good contact when the couple is pressed to the face or side of the heated body. The platinum plate serves as a collecting disc, and, being very light and small, almost instantly acquires the temperature of the heated mass, and, being itself the actual hot-junction, proves a most efficient thermo-couple.

A short discussion followed the Paper, but owing to the absence of the author the reply will be given in the *Proceedings*.

The discussion was opened by Sir Thomas Wrightson, who referred to the successful use of the pyrometer in the experiments which he had made in connection with the decrease of temperature when blocks of iron or steel were pressed together in the same way as when two pieces of ice were pressed together and were frozen together on account of the lowering of temperature. The results of these experiments were embodied in a Paper before the Royal Society.

Mr. W. Rosenhain (National Physical Laboratory) thought that the potentiometer method was far preferable to the deflection method of measuring the thermo-electric effects on account of the possibility of a change of zero of the galvanometer. He suggested the use of bifilar suspension galvanometers as a further precaution against zero errors. He remarked on the importance of protecting the leads from the furnace gases, as mentioned in the Paper, but did not agree with the author that annealing the couple by means of the electric current was sufficient to bring the couple back to its original condition.

Mr. J. M. Gledhill (Manchester) emphasised the importance of temperature in the treatment of alloy steels, particularly in the case of large forgings. The records of the temperatures during the treatment of forgings were most valuable, as in the case of any forging being found faulty its history could be traced back.

Dr. C. A. Benedicks (Upsala, Sweden) was surprised that the author did not attach more importance to the control of the cold junctions, and wished to know whether any arrangements were made for this purpose.

Mr. W. H. Hatfield (Sheffield) referred to the different results that were obtained with the couples in silica and iron tubes respectively owing to the travel of the heat along the iron.

Prof. T. Turner (Birmingham) recommended the employment of deflection readings and calibration curves in preference to direct-reading instruments. The calibration should be made frequently and under working conditions.

THE MANUFACTURE OF ELECTRICAL CONDENSERS FOR TELEGRAPHY AND TELEPHONY

IN the Paper read before the Institution on Thursday, May 7th, and reported fully in our last week's issue, Mr. G. F. Mansbridge described the methods employed in the manufacture of electrical condensers for telephony and telegraphy. In the author's process, used by the Post Office for manufacturing condensers for telegraph and telephone work, metallic tin, precipitated chemically or electrically from a solution of tin in nitrohydrochloric acid, is mixed with an adhesive and pasted on the paper; after drying, the metallised surface is burnished, and forms a coherent thin metallic film. The paper is then subjected to a high voltage, which fuses away the film of metal surrounding the weak spots in the dielectric. The drying, impregnation, and compression of the rolled condensers were dealt with at length in the Paper. In an appendix the Post Office and National Telephone Co.'s specifications for condensers for telegraphic and telephonic use were given. A long discussion followed the reading of the Paper:—

Sir John Gavey, K.C.B., said that he would like to make one remark with reference to the introduction of the rolled method at Mount Pleasant. This method was not of his design, as might be gathered from the Paper; but a hint had been given him by his friends, the Western Electric Co., of New York and Chicago. The manner in which Mr. Mansbridge overcame the difficulties of obtaining the well-conducting foil paper seemed to him like a stroke of genius. The fact also that this new method involved a self-sealing condition which eliminated accidental faults was also one of very great value. Many of them would remember the old days, when the plate lightning arrester was first introduced. These arresters certainly protected the instruments they were intended to protect, but they generally put the line to earth and caused an interruption of considerable duration. This earthing of the line was due either to the carbonisation of the paraffined paper separating the earth and the line plate, or to the fusing of small particles of metal, which made the necessary contact. He must confess, personally, that when these condensers were first introduced on a large scale in telegraph circuits for quadruplex and other methods of working, he rather anticipated that they would get a good deal of similar trouble; but he was glad to find that in that he had made an error, because, although in theory the condenser would be a huge lightning arrester, in practice it absorbed the charge without causing a disruptive discharge to earth.

It must be borne in mind, of course, that an ordinary lightning discharge from a telegraph circuit was rather an inductive than a direct charge; in other words, when the pressure from a lightning cloud was reduced by a stroke of lightning, the static stress in the telegraph wire was released, a discharge took place, and when the end of the wire was connected with a condenser of about the same capacity the discharge harmlessly divided itself between the wire and the condenser. The use of condensers had increased marvellously in the telegraph and telephone services. He would not like to say how many millions of condensers were now in use. Every modern telephone circuit had a condenser in it. They had also been largely used for telegraph purposes, and that use was increasing day by day, so that he did not think it was a very far-fetched idea if he were to say we were within measurable distance of having a condenser on every telegraph circuit, as was the case on every telephone circuit. The use of condensers had led to the introduction of the universal battery system on many circuits which had previously been supplied with separate batteries at every small station. This involved an enormous improvement in telegraph working. From this point of view, therefore, anything which tended to facilitate their manufacture, to reduce their price, or to render them more suitable, was a very great advantage to both services.

Mr. J. E. Kingsbury (Western Electric Co.) dealt with one or two historical facts in connection with the use of condensers on telephone circuits. One of the earliest indications of the use of condensers on telephone circuits that he had been able to find was in a patent which was deposited in the United States Patent Office in 1878, and which was for the use of a condenser in place of a type of apparatus mentioned in a previous specification of Roseburgh, and it was interesting to note that the type of apparatus which this patent displaced was practically the same thing as the tube which Mr. Mansbridge had explained in connection with the Moscicki high-tension condenser. The following was the fourth claim of the Roseburgh patent:—"In telephony, a glass tube filled with glycerine and water or other suitable liquid, and provided with air-tight fitting caps connected with platinum points forming a high resistance medium capable of offering a high resistance to the galvanic current, and comparatively little resistance to the induced current, applied substantially as and for the purposes specified." This patent was No. 212,510 of February, 1879, and was filed on May 25, 1878. A few days later, however, Roseburgh had apparently found that a condenser was far more suitable for the purpose he had in view than glycerine and water and the first claim of his second specification was as follows:—"At any station on a telegraph or telephone line and on a derived line of the same, the combination of a telephone with or without secondary current apparatus and a condenser, so that the secondary current apparatus may be used without interfering with the action of the galvanic circuit, and so that the galvanic circuit may be broken between the two points where the two ends of the derived line are attached without breaking the secondary current circuit substantially as set forth." Until

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about 1896 condensers were only used in a small degree in telephony and for very special purposes. But in 1896 the central battery system was being actively developed. This system eliminated the magneto, and hence provided, other things being equal, a cheaper sub-station outfit. The condenser of the period, however, was a costly apparatus, difficult to make, unobtainable in large quantities, and generally he thought it might be said the invention of a cheap and practical condenser was as much an invention of necessity as was any other invention with which they had had to deal. There were three engineers in the employ of the American Bell Telephone Co., Lea, Westcott, and Robes, who developed a condenser manufactured from rolls of paper and rolls of tin foil, very much in the manner which Mr. Mansbridge had shown, and this having been brought to a practical conclusion, condensers were supplied for shillings instead of guineas, and in millions instead of tens. This was the position of the art when Mr. Mansbridge took a further step forward. It seemed obvious that if one single sheet of paper could carry with it the metal there must be economy; and there ought to be greater certainty than in the case of running two separate metals. In their London factory, the Western Electric Co. were adopting Mr. Mansbridge's process. If they had not been able to convince other factories of its superiority, perhaps it was only a question of time before this would be done.

Mr. A. WHALLEY (British Insulated and Helsby Cables, Ltd.) thought that condensers of the type dealt with in the Paper might also be of some slight interest at the present time to electric light engineers, especially after the manner in which it was brought out in the discussion upon Messrs. Handcock and Dykes' Paper on metallic filament lamps that the use on lamp circuits of transformers or auto-transformers had seriously lowered the power factor of the special lighting circuits. These condensers with only a single interleaving paper could quite suitably be used up to 10, 20, or 30 microfarads capacity, and worked on circuits up to 250 volts without any serious or scarcely noticeable rise of temperature; no doubt they could be made to stand 450 to 500 volts, and if they could be made cheaply they should be worthy of consideration, as a means of increasing the power factor. As regards the break-down point mentioned in the Paper, namely, 150,000 volts per centimetre for the metal foil condensers, the practice at Helsby was to strain these condensers with a direct current of 500 to 600 volts sent through a commutator so as to give a flat top curve alternatively positive and negative, and they tested and sorted out the weak condensers at that pressure. It was found th they stood it for quite a long time. The degree of electrification mentioned in the Paper as falling seriously with temperature was the *percentage* fall of electrification. It was not quite clearly stated whether the temperature coefficients given at the end of the Paper were to be used for correcting both the megohms and the percentage fall of electrification. Frequently the condenser shops were at high temperature about 85° F., and it would be interesting to know whether temperature had also a like serious effect on the difference in the National Telephone Co.'s specification between the absolute capacity measurement with direct current and that with alternating current. The formulæ given in the Paper for measuring megohms per microfarad of the condenser were interesting, and he presumed they were maximum possible figures and not specification figures. Apparently they were based on figures something like 1,750 megohms per microfarad at 60° F. at a pressure of 300 volts. The Post Office telegraph condenser specification admitted 1,000 megohms per microfarad, and the telephone condensers about 300, so that slightly different constants would be needed to get specification figures. He believed artificial cables (which had been referred to in the Paper) would be of very great use in technical colleges if they were used to cultivate the spread of knowledge in the telephonic art. As a matter of fact, such cables would soon be on the market at a reasonable price up to 60 or more miles.

Major W. A. J. O'MEARA (Engineer-in-Chief to the General Post Office) gave a few statistics as to the use of condensers in the Post Office. During 1906 there were issued for telephonic use 14,130 condensers, representing 32,200 microfarads. Last year there were issued 14,800 condensers, representing 33,550 microfarads and it was rather interesting to note that at the present time the Post Office had in use on their telephone circuits some 80,000 condensers, representing 0·182 farad. Sir John Gavey had referred to the increasing use of condensers for telegraphic purposes, and he was able to give a few figures in relation to that matter also. In 1906 the Post Office issued 2,130 condensers, representing 15,270 microfarads. Last year they issued 2,470 condensers, representing 12,130 microfarads. He had not the exact figures relating to the total number of condensers in use on telegraphic circuits, but he understood that in this country there were at least 6,000 condensers used in this way. All these figures referred to the paper condensers as described by Mr. Mansbridge. The Post Office had had these condensers in use for over seven years, and he could support the author in his claim that they were satisfactory from every point of view. They had not found them to fail from loss of insulation or in any other way.

Mr. B. S. COHEN (National Telephone Co.) said there was one very important point which Mr. Mansbridge had not referred to, and that was the effect of alternating current upon capacity. In the specification of the National Telephone Co. for condensers, reference was made in the first clause to a test with both alternating current and with the ordinary discharge method. Many forms of commercial condensers possessed considerable dielectric losses, which in some cases had resulted in a reduction in capacity when measured by alternating current to such an extent as to cause serious trouble. The necessity for testing condensers in practice with alternating current was, he thought, first pointed out by the engineering staff of the Western Electric Co. A few years ago an investigation was carried out by the National Telephone Co. to determine the capacity of various types of commercial condensers at telephonic speech frequencies, and perhaps a few of the results might prove of interest. A batch of 21 condensers of one pattern with a mean discharge capacity of 2·09 microfarads when tested by alternating current had a mean capacity of 1·76 microfarads, or a decrease of 18·8 per cent. That was with a current frequency of 800. Another batch had a percentage decrease in capacity which amounted to just under 1 per cent. A further batch with a discharge capacity of 2·43 m.f. had an alternating capacity of 1·81, or 34·2 per cent. decrease. One condenser, which actually passed the insulation and breakdown tests, had an actual discharge capacity of 1·88 m.f., and an alternating capacity of 0·6 m f., or 21·3 per cent. decrease. This implied a very important source of trouble, and the condensers referred to might have been accepted under a specification which only covered a discharge, capacity, insulation, and breakdown tests, although many of them would give trouble in telephone instruments or currents. He might mention that, given an alternating current of about 800 frequency, the workshop capacity test of a condenser with this current was, if anything, simpler than the corresponding direct current test, as all that was required was a standard condenser, slide wire bridge, and telephone receiver; and this was a method which could be used in practice by men of not very high grade. The question of the insulation resistance variation of commercial condensers with alternating current did not appear to have been studied to any great extent. Could Mr. Mansbridge give any information on this subject? Tests for this, involving as they did small phase angle measurements, were more difficult to make than the corresponding capacity tests, which in all probability covered the effect. In this connection he would like to refer to the artificial cable for telephone work mentioned by Mr. Mansbridge; and Mr. Whalley had also mentioned them as being shortly on the market. Whilst probably of very great use for educational work, he thought it very possible that such cables might introduce some dangers in use. The general artificial cables manufactured for actual cable work had the capacity and resistance lumped to such an extent that the result was the same as if they were evenly distributed within a very small percentage. Such artificial cables were also manufactured with silvered mica condensers and almost in the same manner as a telephone dry core cable. The tests of telephone dry core cable showed very little variation with alternating current; on the other hand, there was a very considerable variation in insulation resistance, viz., a very considerable decrease with alternating current. If artificial cables were manufactured with capacities made up with paraffined paper, it appeared very possible that trouble would be caused by variations in capacity.

Mr. H. OPPENHEIMER (International Electric Co.) said that two years ago his firm took up the manufacture of condensers under Mr. Mansbridge's patents. The manufacture of commercial condensers was mostly a matter of practice, and those firms who had taken the matter up had been initiated in the elementary stages, so that even from the start the relative results were very satisfactory. In the first batch of condensers his firm made there was about 7 per cent. "wasters"; in the second lot this came down to 3·8 per cent.; the fourth lot showed 1·6 per cent.; the next 0·36 per cent.; and to-day he had arrived at 0·2 per cent. It was remarkable, when comparing the various specifications, to notice how the various departments had come practically to the same conclusion and fixed the tests almost alike. So far as the pressure to be applied was concerned, the Post ffice specification prescribed 300 volts, the National Telephone Co. 400 volts, the Colonies 1,000 volts, and the Continent 350 volts. The time for applying the test was two minutes in the Post Office specification, half a minute in the National Telephone Co.'s, five minutes by the Colonies, and one minute on the Continent. The insulation resistance was as follows:—G.P.O., 300 megohms; National Telephone Co., 200 megohms; Colonies, 1,000 megohms; Continent, 400 megohms. the Colonial specification was, he thought, detrimental to progress; to ask that an ordinary telephonic condenser should withstand 1,000 volts pressure for five minutes, and that its insulation resistance should be 1,000 megohms was practically nullifying the efforts at progress made by the author.

Mr. J. E. TAYLOR (Assistant Superintending Engineer, General Post Office) said he was interested in the question of high-tension condensers, more especially with the silvered Leyden jar type for wireless telegraphy purposes, to which Mr. Mansbridge had referred. These had not been altogether successful. In the first place, he might explain that the silvered Leyden jars to which he referred were made before the Moscicki condensers were put on the market, and were not of the same pattern.

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but they had some disadvantages. For instance, they had the self-sealing effect which Mr. Mansbridge referred to, but when this effect came into play in connection with wireless telegraphy it was a considerable disadvantage. One was tempted very often in using Leyden jars for wireless telegraphy purposes, to make temporary connections, such as standing the Leyden jar on tin foil sheets to effect a connection between several jars or between a jar and another part of the circuit. If the silver was unprotected, sparking occurred, which rapidly burnt away the silver coating. There were objections to the backing of these coatings also. If they were backed with a copper coating of any thickness, the contraction and expansion due to temperature quickly loosened the coating. If they were backed with insulating varnish, then the first objection again came in, because if the outer portion of the jar came against any part of the circuit or a loose wire, or was stood on a conducting material, sparking again occurred, and the silvering was eaten off underneath the backing. Another trouble which it was a little difficult to overcome arose from the brush discharges, which were a source of so much trouble in wireless telegraphy. These caused a certain amount of erosion or eating away of the silvering, which gradually increased and ultimately rendered the jar useless. These brush discharges were a source of serious loss in Leyden jars for wireless telegraphy, and he had considered to some extent what was the real explanation of these brush discharges. He had not been satisfied with the explanations which had been based on the surging of the charges round the circuit or the decrease of specific inductive capacity of the glass due to high frequency oscillations, as the effect was too large to be explained completely in that way. The view which seemed to explain the formation of these brush discharges better to him was that the successive oscillations of the condenser circuit built up an ionisation or conductivity of the air at the edges of the foil, so that the longer the oscillations lasted the more conducting did the air become, and the same effect was very often noticed in sparking. Some of the sparking troubles between knobs of the wireless telegraph transmitter, were very often due to a similar cause in that the spark gap was set so that the first rush did not cause a spark, but perhaps caused spitting; the air was then ionised, and the major portion of the electrical energy was dissipated. Referring to Mr. Mansbridge's form of condenser, he could support some of the advantages claimed for the self-sealing properties of these condensers. He had found that they could be used for shunting electro-magnets energised to a very considerable extent, *i.e.*, for shunting electro-magnets to prevent sparking when the circuit was broken. On 100-volt circuits, an ordinary condenser of one or two microfarads capacity would not stand for a moment the discharge effect from such an electro-magnet. When the circuit was broken in the ordinary way, the dielectric would be perforated, but although in this case perforation might take place, the dielectric had the property of sealing itself, so that it would withstand a large number of perforations before it would be incapacitated, or, as he might put it, decapacitated. These condensers had stood for some little time past a test of this sort, and they might ultimately be pushed to the extreme loss of their capacity, but they were becoming so cheap that it paid one to use them for apparatus of this kind when it was important that sparking troubles should be eliminated. Mr. Mansbridge had referred to the advantage in some circumstances of using leaky condensers for spark suppression; although this might have an advantage, he was of the opinion that, on the whole, it was better to have a good condenser and not a bad one, and that if any leaks were required, these should be obtained by the use of artificial resistances.

Prof. Silvanus P. Thompson, F.R.S., said he should like to ask two questions. They had seen a strip exposed to the test, flashing with sparks, as all the faults in the paper and its edges were discovered by the machine and burnt out. He wanted to know what would happen if this paper were sent through the machine a second time. Would it flash at all, much or little? Did it really successfully burn out all the faults, or would it find some more a second time? The other question was this. It was an exceedingly interesting physical fact to be told that the metal-deposited paper before being callendered was almost a perfect non-conductor, and he wanted to know whether, in common with other metallic filings, it became a better conductor in the presence of electrical oscillations; in fact, would a strip of that uncallendered paper act as a coherer? He had been making enquiries as to how much a microfarad cost nowadays. He was the possessor of several of them, and had paid two and a half guineas for a third of a microfarad. At this rate a farad would cost £9,600,000, but he thought that a farad could be bought to-day for £50,000.

Mr. W. M. Mordey thought the Paper was illustrative of the close connection between telegraphy and telephony and heavy electrical engineering. He wished to ask some questions concerning the value of the dielectric hysteresis in these condensers. It might be remembered that seven or eight years ago he read a Paper on this subject entitled "Dielectric Losses in Cables," and he had been unfortunate in making his experiments on a cable which had an exceptionally high power factor of something like 0·1, and he was led to draw certain general conclusions as to the losses which occurred in cables due to the dielectric capacity, which were much too high when applied to cables of the sort that were now generally used. On going into it later he found that although he was laughed at a good deal, the dielectric hysteresis losses in even the best cables that could be obtained were very often so high that with alternating current these losses wasted more energy than the copper. It would be very interesting if the author, who evidently had exceptional facilities, could go into the question of what was the power factor and the dielectric losses in condensers of various types. With regard to the Moscicki condenser, which was intended for high-tension work, it would be particularly easy to make such calculations by a simple calorimeter method, as the condenser was provided with water circulation, and one had nothing much more to do than to treat the whole thing as a calorimeter, put the various volts on, and take the temperature ingoing and outcoming, and they would get a close approximation to the actual losses. He would be very surprised to find that the loss in this or in any other condenser was less than would be represented by a power factor of 0·03. If that were the case, then he thought the matter ought to be considered from the point of view of the energy wasted. There was every possibility now of getting what they had all been trying for for many years, viz., condensers that would be of actual use in power distribution work. They would all remember that, at the Crystal Palace Exhibition many years ago, Mr. Swinburne, who was then a manufacturer, had a tempting exhibit of condensers intended for such work. They had cast-iron boxes outside, but what there was inside he did not know. Anyway he knew that Mr. Swinburne fully recognised at that time the very great importance of having practical condensers for power distribution work. If they were going to have them now, they should look at them from the very beginning, viz., from the energy point of view. If he was right, and it was impossible to get a power factor of less than 0·05, it might be found that the losses in condensers might be more than double the magnetising losses. Some years ago he had tried to get some idea how heating was caused in alternating current cables at light load, and he then arrived at a conclusion that was worth consideration. The mere static attraction between electrified surfaces was very great indeed, and being oft repeated, as it was in alternating current work, it was in itself sufficient to cause a considerable amount of heat merely by making a number of blows upon the dielectric. These blows being often repeated might be sufficient to account for what they called the dielectric hysteresis losses. It might be somewhat of a mechanical loss. He would like to give an example. If his arithmetic was correct, with a 20,000 volt condenser and a dielectric of 0·2 inch thick, then the static attraction was about 2 lb. per square foot. Imagine a blow of 2 lb. per square foot being given 100 times per second on any dielectric: this might easily account for a good deal of the heat. Applying that figure to the interesting example which the author gave in Fig. 5 of breakdown of a condenser at 1,100 or 1,200 volts, and assuming that the dielectric thickness was about 0·001, and taking 1,000 volts as the voltage, the actual pressure between the actual metallic films of the condenser was about 13 lb. per square foot at the time of breakdown—quite an appreciable thing—and he would like to see experiments carried out to ascertain whether dielectrics would stand that kind of pressure or whether his estimate was a correct one.

The President (Col. Crompton) said that he had, during the South African War, a very interesting experience with condensers in the portable telephones which were carried by the Electrical Engineer Volunteers. These telephones were of a Swedish pattern and they enabled them to do good service by signalling through broken circuits laid on the bare veldt. Sometimes they could get speech through several feet of gap in the thin lines laid on the ground, and they could buzz through many yards of broken circuit. This was of great importance, for it enabled communications to be maintained at a time when all telegraphic service had been destroyed by the enemy, and no doubt prevented a good deal of anxiety to those at home because they got news which they otherwise would not have done, and this was entirely due to the combined Swedish pattern telephones each having a condenser.

Mr. Mansbridge, referring in his reply to Mr. Whalley's suggestion that these cheap condensers might be used for the improvement of power factor of the lines feeding small house transformers, presumed that Mr. Whalley intended that the customer who paid for the transformer would also pay for the condenser. If this could be arranged he thought it was a very happy suggestion. Mr. Whalley had also raised the point as to whether the formula in the Paper was applicable to the electrification. No; it dealt with the megohms only. The variation of the electrification with temperature was a problem which, up to the present, he would not like to be responsible for the solution of. With regard to Mr. Cohen's remarks, he had intended to deal with the alternating current problem in the Paper, but he had purposely cut out what he had put in because he had hoped to hear Mr. Cohen's answer to the question he had put. At the Post Office they had tried alternating current tests, and although it sounded something like an advertisement,

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their condensers were so good that they did not get very much difference—scarcely a measurable difference—between the alternating current and the continuous current. The conditions at the Post Office were rather different from those of Mr. Cohen, inasmuch as the former made practically all their own condensers, and Mr. Cohen had to deal with a number of manufactured condensers. In reply to Dr. Thompson's inquiry, he did not find that any advantage was obtained by running the paper through the breaking down machine two, three, four, or five times. If it was taken through a dozen times there would probably be some places which would give way. The dielectric strength of the material was a function of the time, and this was a point to be taken into consideration in that connection. With regard to the coherer capacity of the uncallendered paper, he could not say; he had never tried it. But a strip of the callendered paper which had been so creased that it had become a non-conductor had answered as a coherer. Mr. Mordey had remarked that there were facilities at the Post Office for carrying out tests with regard to dielectric hysteresis, but as a matter of fact the only tests that could be carried out at the Post Office were those which were carried out in the regular course of the work. He would, however, check Mr. Mordey's figures and reply more fully in the *Journal*.

Written communications to the Discussion have been received from G. L. Addenbrooke, A. W. Ashton, J. W. Record, Mr. Alex. Russell, and Dr. W. E. Sumpner.

LONDON ELECTRIC POWER BILLS

LORD CROMER'S Committee of the House of Lords has continued its consideration of the London Electric Power Bills since our last issue. On Wednesday Mr. Parshall was re-examined, and was followed by Mr. Hammond. The Committee did not sit on Thursday owing to several members desiring to be present at the opening of the Franco-British Exhibition, and on Friday the Committee adjourned at one o'clock.

WEDNESDAY, MAY 13TH. (FIFTH DAY.)

Mr. PARSHALL, re-examined by Mr. Fitzgerald, first referred to the suggestion that the power company might quote a ridiculously low price in order to get into a district and compete with the authorised distributor, and pointed out that the opponents to the Bill had apparently overlooked the fact that under Clause 52 the company must supply authorised distributors substantially at the same price at which they themselves would supply a consumer. On the point that no power company had been successful, Mr. Parshall referred to the Newcastle Company, which, he said, had paid 8 per cent. for many years, and further had reconstructed their system out of revenue. The Committee would also hear from the Chairman of the Yorkshire Electric Power Co. that, although they were quite in the initial stages, very satisfactory progress was being made. If the company were to adopt a policy of buying up electric lighting companies, as had been suggested by Mr. Bushe (for some of the London companies), in view of the very satisfactory financial position of some of the companies, it was clear that the power company's capital would be totally absorbed in making such purchase before a start was made upon their generating station. It might be in the power company's interest to purchase some of the smaller municipal undertakings; for instance, in the case of Barking they knew that that undertaking was to be had at a very moderate price. With regard to the position in Chicago and New York, he pointed out that in both these places the original condition of affairs of a large number of small generating stations had given way to one bulk station, the smaller stations being retained only for the purposes of the peak load.

Mr. R. HAMMOND was then called, and gave his views on the proposal for linking up the existing generating stations which was contained in the other two Bills. The general idea, he said, that London could be benefited by putting all the existing mains into one great network, was quite impossible on account of the variation in the class of supply given in the different districts. The idea that the network of mains could be linked up in this way had long been given up as an absurdity. It only perpetuated the existing evils, and what was wanted was a perfectly new and model generating station. The promoters could do for London what Niagara had done in America. The mere fact that generation was by the use of coal did not alter the problem at all. At the same time he did not say linking up was an engineering impossibility; it was a question of expense, and the extent of this was illustrated by an example. At Hackney, generation took place at 480 volts direct current, and Islington, which adjoined Hackney, generated at 2,000 volts alternating current. If Islington asked Hackney for a supply, it would be necessary to put down transforming plant to transform from 480 volts direct current to 2,000 volts alternating current. This sort of thing would have to take place at a very great many of the stations, and the expense would be enormous. In addition, the existing authorities could not generate as cheaply as a bulk station on the lines of the present proposal; although they might link up, they were only exchanging current which was being manufactured at a high price. Mr. Hammond then went into the details of the various tables which had been placed before the Committee. The figures upon which the estimates were based had all, he said, been taken from the last published accounts of each undertaking, and the results given in the tables had been arrived at by analysis. With regard to management, in order to get a figure which was as correct as possible, he had debited to the cost of generation only 25 per cent. of the charges appearing under the head of "management," presuming that the heaviest cost of management was that connected with distribution. In order to arrive at the absolute cost of generation it was necessary not only to add the money spent in coal and wages, but also something for depreciation of plant, and interest. In the case of local authorities outside London, the Local Government Board compelled them to repay their capital expenditure in 25 years. Inside the county of London, some of the authorities had obtained their loans for 42 years; but as 42 years was quite beyond the equated period for the wearing out of the plant, he had put them all upon the Local Government Board basis of 25 years. He had in this way arrived at capital charges of 6¼ per cent., on the basis of 2¾ per cent. sinking fund, and 3½ per cent. interest. The mistake that had been made in London was decentralisation; the same mistake as was made by the gas companies many years ago. Then there was a little gas works in every little district, but a gradual amalgamation took place until there were at present only two gas works for London, one for the South and one for the North. Dealing with the power companies around London whose area the present Bill overlapped, Mr. Hammond said that the prices both of the North Metropolitan Electric Power Co. and the Kent Electric Power Co. were considerably higher than those now being proposed. On the question of diversity factor, the promoters only estimated upon 1·5, but he was inclined to believe it would be more. When the station was completed he ventured to put it at 1·66. His estimates for the renewal of plant were 60 years for buildings, 25 years for plant, 30 years for cables, and 10 years for meters. These were terms which he thought now were generally agreed upon by the electrical engineering profession. He read a Paper before the Institution of Electrical Engineers a few months ago, and these figures were debated, and it was agreed it was a proper provision to make. (ELECTRICAL ENGINEERING, Vol I., p. 759.) The estimate of the amount of horse-power available in London for conversion to electric driving was next dealt with, and Mr. Hammond pointed out that there were numerous cases of isolated generating plants which it was quite possible would be discontinued in favour of a supply from the power company if suitable rates were quoted. For instance, the Savoy Hotel was lighted with its own plant originally, but they later took supply from a company. The Hotel Cecil at present had its own plant, but there was every likelihood of the power company being able to offer sufficient inducement for it to discontinue its use. His own opinion was that the amount of machinery which the power company might hope to supply was nearer 600,000 h.p. than the 300,000 h.p. already mentioned by Mr. Parshall. He thought the protection given in the Bill to the authorised undertakers in regard to consumers up to 250 kw. was a very strong protection indeed, and secured them the small consumer, a class of business which they were particularly able to do because they were so well situated for distribution.

FRIDAY, MAY 15TH. (SIXTH DAY.)

Mr. HAMMOND'S evidence-in-chief was continued. He said the estimate of h.p. in factories in the area was based upon a Home Office return for 1904, since when no census of this character has been made. He thought it was reasonable to assume that there had been an increase in the number of factories since then. A list was then read of the companies and local authorities who made agreements or agreed clauses with the Administrative County of London in 1905. This is as follows:—Barking, Bexley, Stepney, and Beckenham Councils, Croydon and Gravesend Corporations, and the following companies:—County of London Electric Supply Co., Charing Cross and City Co., City and London Electric Lighting Co., Chelsea Electricity Supply Co., Westminster Electric Supply Corporation, St. James and Pall Mall Company, London Electric Supply Corporation, South London Electric Supply Corporation, South Metropolitan Electric Light and Power Co., Kent Electric Power Co., Empire Electric Light and Power Co., and Kensington and Knightsbridge Co.

Mr. SEYMOUR BUSHE, K.C., pointed out that no agreement

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with regard to supply was made with the Kensington and Knightsbridge Co., in fact, a clause was agreed by which the Kensington and Knightsbridge Co. was excluded from the operations of the Administrative Co.

THE CHAIRMAN: Do you want us to draw the inference, Mr. Hammond, that these companies and local authorities would make similar arrangements with you?—Some of them most certainly.

In answer to Lord Saunderson, Mr. Hammond gave some particulars of the distributing system, for which he said he was responsible. In dealing with this, he said that he had kept in mind a criticism of the committee of 1906 as to means of providing for continuity of supply. In consequence, they had provided 25 trunk cables from Barking, of which 15, each having a section of ·10 sq. in., would belong to the first stage.

LORD CROMER: You say you do not see any hostility between your company and the rival schemes, and referred to the fact that you merely want to use the companies as distributors. What I want to arrive at is whether, looking at the principles of the rival schemes, do you consider them, either from a financial or from an engineering standpoint, mutually destructive to each other?—I think it would be a calamity for both schemes to be sanctioned.

Do you think the two schemes would be impossible if they were both passed, and do you think your scheme is preferable?—It is certain that there is going to be a growth of electricity in London; for instance, the promoters are certain that the railways will want 60,000 kw. We see that annually there is a growth, and that this growth will be largely developed in consequence of lower prices. This growth will have to be provided for by new generating plant, and the amount of margin of generating plant at present available includes a certain amount of obsolete plant. Money has to be spent on this new plant, and we consider that if the burden of dealing with generation was put into the hands of a solid company, and that all the new generating plant, instead of being dotted about, was put under one roof, and dealt with by the most economical methods, then a bulk company would be able to supply to the authorised distributors that amount of extra electricity which they will require from time to time, and that therefrom the authorised distributors would be great gainers in two ways. First, they would not have to spend their money in the form of capital expenditure on a wasteful basis, and secondly, they would have the advantage of obtaining a supply at a much cheaper price than if they made it themselves; and I say there is no antagonism whatever, they should welcome this Bill. The only thing they object to is the clause about the 250-kw. consumer. We have been told more than once that there are very few consumers of this size, and what I urge is that these consumers should be properly left to the bulk company.

Let us assume that all three Bills were passed, would there still then remain the possibility of your doing business?—The only objection that strikes me is that mutual destruction would come in the way of raising capital. I take it if we were all going to the public at the same time there might be some hesitation on the part of investors as to whether their capital would be secure; but as far as the actual business part of it is concerned, I think the companies would see, if they got their Bill also, that it would be to their interests to take a supply rather than carry out their scheme.

Supposing all three Bills were passed, do you think you would still have the possibility of conducting a profitable business?—I do not think that this would tend to the best development of the capital, and eventually there would be amalgamation in the same way as the gas companies amalgamated and divided London between them.

In answer to other questions from the Committee on this point, Mr. Hammond said he thought the real issue lay between the bulk scheme and the scheme of the eight companies, and if both of these were passed there would be a great waste of capital, but he was convinced, from an engineering point of view, that the bulk scheme would be carried out, even if the other Bill were passed. Assuming the bulk scheme were passed by itself, the question of giving a cheap supply to London would depend upon the promoters getting the money.

LORD CROMER next pointed out that the capital required for the first stage was £2,600,000, and he presumed that, in addition to this, which included interest during construction, a further sum would have to be added for expenses in connection with raising the money.

Mr. HAMMOND pointed out that this was already provided for, as the interest during construction would amount to £86,000, and they had allowed £100,000.

Continuing, Mr. Hammond said that some contracts would have to be made before they went to the public for their money, but they did not think there was the slightest doubt that, as soon as the Bill became law and there was a company to deal with, a good many contracts would be entered into. Acting as he did for some of the local authorities, he could speak with confidence that many of them would prefer to take a supply in bulk rather than spend capital in putting down new machinery themselves. Further, the London County Council had been in the past, and he thought certainly would be in the future, inclined not to sanction any more money for electric lighting purposes if there was a certainty of getting energy in bulk.

Lord WELBY pointed out that £100,000 for interest during construction was rather a small sum, considering that the constructional work would be carried over a number of years.

Mr. HAMMOND pointed out that under the Bill they were only allowed to pay interest out of capital during the first four years, and the amount in the estimates had been reckoned on that basis.

Replying to Lord Welby on the question of competing schemes, Mr. Hammond mentioned the case of Newcastle, where two Provisional Orders had been granted, but the town was split up into two districts, and competition was not allowed. With regard to raising the capital, he did not think the promoters could have any objection to a clause stipulating that a certain amount must be raised within a certain time.

Lord WELBY next referred to a statement in a recent prospectus of the Newcastle Electric Supply Co., that the whole of the original system of that company had been replaced out of revenue between 1890 and 1908. Would such a rapid replacement be necessary in the future?

Mr. HAMMOND replied that the Newcastle Company started in the very early days of the electric supply business, and it was in consequence of the rapid strides made since then that their system generally had needed renewal. This contingency would not arise to anything like the same degree in the present state of electrical engineering.

Mr. FITZGERALD, at the close of these questions, stated that with regard to the other Bills, Mr. Hammond had given his personal opinion, but he wanted to make it quite clear, on behalf of the promoters—as he did in opening the Bill—that their position was that the three Bills were not inconsistent Bills. The other two Bills were not, in their opinion, in any way substitutes for this Bill; they were not, strictly speaking, competing Bills, and it was quite open to the committee to pass all three Bills.

Mr. HAMMOND'S cross-examination was then opened by Sir Ralph Littler, K.C., on behalf of the City Corporation. Mr. Hammond said the cost of the main trunk cables through the City, which would be 0·35 sq. in., was estimated at £2,000 per mile.

Mr. FREEMAN, K.C., for the London County Council, took up the question of the purchase clause, and suggested that as Mr. Hammond had taken in his estimates an equated period of twenty-five years for the life of plant, it would be only fair if the purchase of the power company's undertaking was to be the capital expenditure, less a proper amount for depreciation, as between the 25 years and the 42 years proposed in the purchase clause. He pointed out that there was no obligation upon the company to keep the plant in good repair.

Mr. HAMMOND admitted this, but said that the Bill would prevent the company from making any profit until they had made such provision. He did not agree that it would be to the interests of the company to go on with old plant rather than renew it, but was quite agreeable to there being a distinct understanding in the Bill that the plant must be maintained.

Further questioned by Mr. Freeman as to an obligation to raise a certain amount of capital in a certain time, Mr. Freeman suggested £1,000,000 in twelve months, and that a substantial commencement should be made in two years. Mr. Hammond agreed with the suggestion in principle, but would not commit himself as to the amount. He said he should not want £1,000,000 during the first twelve months.

Mr. FREEMAN then dealt with the consumer of 250 kw. and over, and suggested that provision should be made for securing the sanction of an independent authority, such as the Board of Trade, for consent to supply any such consumer.

Mr. HAMMOND retorted that he was already before the independent tribunal, and it would be inconvenient, having got powers from Parliament to supply the 250 kw. consumer, to have to ask the Board of Trade for permission to do it.

Mr. BLENNERHASSETT, K.C., also cross-examined on behalf of the Westminster City Council.

MONDAY, MAY 18TH. (SEVENTH DAY.)

Mr. HAMMOND'S cross-examination was continued by

Mr. C. A. CRIPPS, K.C., who appears for the London companies with Mr. Balfour Browne, K.C., put questions relating to the tables of capital expenditure upon the undertakings of the London companies, and took as an example the Charing Cross Co., the capital expenditure of which compared with the figure taken by Mr. Hammond in his tables was £300,000 less. Mr. Hammond said he had taken his figures from the balance-sheet of the company, and agreed that if he were wrong this alteration would vitiate all his subsequent calculations. On the question of the voltage drop in the cables, Mr. Hammond had taken 10 per cent., which Mr. Cripps said should be 20 per cent. Mr. Hammond's reply was that the 20 per cent. drop in transmission, which engineers were now used to, was because the cables were overloaded. The cables in this scheme had been calculated upon a basis of a 4 per cent. loss, and they could be arranged to work at 1 per cent. loss. If he had assumed 20 per cent. he could have used very much cheaper cables. On the question

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of load factor, Mr. Cripps argued that the estimates of the promoters had been based upon the assumption that the authorised distributors took the peak load from the power company, and consequently they got a works load factor twice as good as the existing companies. If, however, the distributors only took the day load from the power company, the result would only be half as good. Mr. Hammond agreed that the load factor would only be about half, but there would be no material difference in the profits, as the distributors would have to pay the £5 10s. per kw. whether they took a small or a large quantity of units, and if they were foolish enough to take only a small quantity it did not matter to the power company. Mr. Cripps next went to the savings to the London companies, as shown in Mr. Hammond's tables, and dealt with the following five companies, viz., Charing Cross Co., County of London Co., City of London Co., London Electric Supply Corporation, and the South Metropolitan Electric Power Co. The saving estimated to these companies by taking a supply in bulk from the power company was shown as £29,999, but Mr. Cripps said the companies had calculated that if they took their supply in the manner suggested they would make a loss of £63,110. If this were so they would not take a supply, and the power scheme would not be much good. Mr. Hammond's reply was that the fact they did not supply to a few authorised distributors made no difference at all to the prospects of the scheme; he was after the 66 authorised distributors in the area. It would take 25 years' growth, said Mr. Cripps, to reach the figures in the tables. Mr. Hammond said he was very pleased to hear this, because it showed how greatly the present companies had underestimated the power load in their area and neglected the power user. The tables of future growth were based upon the maximum plant at the disposal of the authorised distributors, which Mr. Hammond thought was the only basis of estimating the future demand, whereas Mr. Cripps held the view that this had no reference whatever in this connection. Also, said counsel, the increasing adoption of metallic filament lamps would decrease the estimates in as much as greatly decreased demand was to be anticipated. Mr. Hammond, however, held the contrary view, and said that the feeling in the industry at the present time was that the more efficient metallic filament lamps were going to create a greatly increased demand. Another point touched upon was as to the cost of generation in future, and here again Mr. Cripps said the figures of the promoters as regard the London companies were much lower than those assumed by the power company. As neither witness nor counsel could agree as to the correctness of the other's assumption, the cross-examination developed itself into Mr. Cripps putting his view of what Mr. Hammond's figures should be, and Mr. Hammond dissenting.

After this Mr. Cripps dealt with a few general matters. On the promoters' modification of the Kitson clause, it was suggested to Mr. Hammond that this allowed of competition, whereas under the original Kitson clause there was no competition without the machinery of the Board of Trade. As the Bill stood, the obligation to supply could not be enforced against the power company, yet if they did come in and compete against the authorised distributor there was still the complication of the Kitson clause, in that if the power company and the power user did not come to terms there would have to be an arbitration at the hands of the Board of Trade. Mr. Hammond said personally he saw no objection to the insertion of a clause making it obligatory upon the power company to supply all those small power consumers which the authorised distributors neglected. Such supply should be on the basis of the charges which the power company would offer the authorised distributor. Mr. Cripps next emphasised the pioneer work which had been carried out by the existing companies, with all of which Mr. Hammond agreed, but he said that if the companies would not take advantage of an offer of a cheap supply they should suffer. Asked as to why the present companies should not be permitted to carry out the larger scheme proposed in their Bill, Mr. Hammond said they were proposing to go dead against the one thing that would save London, viz., centralisation. He agreed that the main difference between the two schemes was that whereas the new company would have only one station, the existing companies had several; but this was a material difference. If the promoters of the other Bill could prove that the idea of the promoters of this one as to centralisation was wrong, then his scheme did not compare very favourably. Mr. Cripps suggested that four stations would be better than one or two, for the reason that there would be greater security of supply and that the stations would be nearer the consumers. As to the probable demand in the area of the Bill, Mr. Cripps said the companies had made a canvass, and found they were supplying about 46 per cent. of the total power installed. Mr. Hammond said he entirely disagreed with this. Mr. Cripps said the total h.p. in the County of London was 208,000 h.p., of which about half was within the companies' area. The companies supplied 47,299 h.p., which was 47 per cent. of this moiety.

The Hon. SYDNEY HOLLAND, for the Westminster and Kensington companies, first directed his cross-examination to the fact that turbines of the size proposed in this scheme had not been used in this country hitherto. He also pointed out that the Kensington Co. agreed a clause with the Administrative Co. that the area of that company should be omitted from the operations of the company. Would Mr. Hammond give them such a clause now? Mr. Hammond suggested that a clause should be submitted. Mr. Holland then went to the point that if the power company came into existence, all the local authorities and companies would find a difficulty of getting new capital during the two years which the promoters said it would take to get their scheme in working order. What would they do if the company did not get going? Mr. Hammond pointed out that in the meantime the companies had plenty of spare plant to carry them over, and they would not need new plant during the next two years. On the point of the saving to the London companies Mr. Holland argued that the only thing they would save on management, even if they took their whole supply from the power company, would be something on the salary of their engineer, owing to their undertakings being established in the way they were.

Mr. POLLOCK, K.C., for the Middlesex County Council, took the point that the competition should not be allowed between power companies, and, in view of the fact that both the North Metropolitan Electric Power Supply Co. and the Metropolitan Electric Supply Co. were both already supplying in Middlesex, that county should be cut out.

LORD LYTTON: Would you object to the new company supplying in the County of Middlesex by agreement with the existing companies.

Mr. POLLOCK: I do not know that that would be a matter for us, so far as supply is concerned, but the question of the purchase of the new company would come in and complicate the arrangements between the County Council and the existing power companies.

Mr. WEDDERBURN, for the Croydon Corporation, pointed out that in 1905, the Administrative County of London Co. agreed not to supply in Croydon without the consent of the Corporation. Would Mr. Hammond give the same clause? Mr. Hammond said to give such clauses would defeat the whole object of the Bill. He agreed there were not many factories in Croydon, but it was one of those districts where factories would undoubtedly be built if a cheap supply of electric power was available. Another point of Mr. Wedderburn's was that, assuming Croydon took the whole of its supply from the power company, instead of making a profit of over £400 per annum, they would lose £329 per annum compared with their present result. During the discussion on this, Mr. Hammond said that in the event of the whole supply at Croydon being taken from the power company, the latter would have their own men in the transforming station, and the Corporation would only require a switchboard attendant in their own station, and a man at 30s. a week would do this work quite satisfactorily.

Mr. WILLIAMS, for the Stepney Borough Council, dealt with the question of linking-up, and suggested that Stepney, Hackney, and Islington, should link up, but Mr. Hammond characterised this as a great waste of capital. Mr. Williams next attempted to bring Mr. Hammond to accept the Stepney Council's agreement with the Administrative County of London Co., but Mr. Talbot, K.C., intervened that it was not a question for Mr. Hammond to decide. The legal advisers to the promoters would consider the suggestion with every anxiety to come to terms with Stepney.

TUESDAY, MAY 19TH. (EIGHTH DAY.)

Before Mr. Hammond's cross-examination was continued, the Chairman gave a hint to Counsel for the opposition that the proceedings were being a little drawn out by the needless repetition of questions that had already been answered.

Mr. WILLIAMS then put some further questions on behalf of the Stepney Borough Council. Having gathered from Mr. Hammond that the cost of distribution as a general rule varied from 50 per cent. to 60 per cent. over the cost of generation, assuming a 75 kw. consumer, Mr. Williams put it that, under the clause in the Bill, the authorised distributor could only charge an extra 18 per cent. over the charge by the power company, and that consequently there would be a considerable loss. But Mr. Hammond replied that the cost of distribution he had mentioned related to a purely lighting undertaking. Mr. Williams was debiting one consumer with a proportion of the total cost of distribution without taking into account the diversity factor. It would be possible for the authorised distributor, by only charging the profit (one per cent. for every 10 kw. below 250 kw.) set out in the Bill, to make a profit of as much as 100 per cent. by reason of the diversity factor.

Mr. MORTEN, for West Ham Corporation, placed the 1908 figures of the Corporation electrical undertaking against those given in the tables, which are for 1907, and endeavoured to show that the basis of all the calculations was wrong. Mr. Morten also dealt with the question of carrying mains through West Ham, and pointed out that there were only two routes, viz., one over Bow Bridge and the other over the iron bridge in the Barking Road. Both these routes were already filled with mains in respect of the tramways and electric supply undertaking already in West Ham.

Mr. CAINE, for the Marylebone Borough Council, compared

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the capital cost of generation in the Marylebone works and the capital cost to the power company of generating and transmitting to the authorised distributor. Mr. Hammond admitted it might be less by the former method, but he did not consider this material, as the cost of generation was the factor to be taken into account by the authorised distributors. The question of load factor was then dealt with, and Mr. Caine's argument was that it was vital to the prospects of the power company to get high load factors, and that Mr. Hammond's assumption as to the load factor in Marylebone was much too high. The next point brought out was that the Marylebone Council had paid a considerable sum to the Metropolitan Electric Supply Co. for the prospective power demand, and yet the promoters of this Bill proposed to compete. Coming back to the diversity factor of 1·5 which had been mentioned, Mr. Hammond said he did not think this was too high, in view of the fact that the London County Council, upon its tramway system, had a diversity factor of 1·25; he thought the 1·5 taken in the estimates was not high enough, seeing what was being done in Chicago.

The Hon. EVAN CHARTERIS, for the Hampstead Borough Council, pointed out that this area was placed in the area of the Metropolitan Electric Supply Co., having been struck out of the Administrative Bill by Lord Camperdown's committee. If this Bill passed, there would be three authorities with powers to supply electric power in Hampstead. Mr. Hammond, however, refused to agree that Hampstead should be cut out of the area; he thought a wrong policy had been pursued in the past in cutting areas out of power schemes. From the position of Hampstead he thought this was the district which the power company could do the least harm to. A fact brought out in this cross-examination was that Hampstead was the first borough to initiate a period of 25 years for the repayment of loans instead of 42 years, and in the L.C.C. report for 1907 upon electricity supply in London, this was pointed to as accounting for the very favourable position of the undertaking. Mr. Charteris also dealt with the point that, as the proportion for power and heating of the total consumption in Hampstead was only 4 per cent., there was no advantage in taking a supply in bulk from the power company, in consequence of the clause limiting the price to be charged to the authorised distributor. The diversity factor in Hampstead was practically unity.

In answer to Mr. Courthope Munroe, for the St. Pancras Borough Council, Mr. Hammond said, in adopting the area scheduled and refusing to cut any authority out of the operations of the Bill, he was adopting the policy of the Select Committee of 1906, which approved the area. It was pointed out in cross-examination that the St. Pancras Council supplied 85 per cent. of the total power in the district, and that the load factors of all the power users were extremely low; also that there were only three consumers taking 250 kw.

Mr. MUNROE also appears for the Shoreditch Council, and in the course of his questions mentioned that here there was only one consumer of 250 kw. Also, that some new extensions had been carried out at £12 10s. per kw., but Mr. Hammond elicited that this did not include land, and asked Mr. Munroe to compare upon a proper basis.

Mr. LYNDEN MACASSEY, for the South Essex Water Co., asked some questions with regard to the laying of mains, and asked for all the protection which has been given to the Metropolitan Water Board under a special clause, which states that no electric main shall be laid within 6 ft. of a water main. Mr. Hammond thought this reasonable. It having been suggested by the Chairman that these matters would best be discussed on clauses, Mr. Macassey dealt with the supply of water to the generating station, and wished to know if the promoters intended to sink wells. Mr. Hammond said yes, whereupon Mr. Macassey pointed out that the total water-bearing strata for the whole of the area of the South Essex Water Co. was one square mile round the site of the Barking generating station, but Mr. Hammond would not agree to come under an obligation not to sink wells on the site of the generating station.

Mr. SNOWDEN, for the Hammersmith Borough Council, gave a few general facts with regard to the undertaking, and mentioned the Franco-British Exhibition, where the lighting was carried out by co-operation between the Borough Council and the Notting Hill Co., whereas if the whole supply was to be taken from Barking, in the event of a breakdown, the supply would be cut off. In other words, under present conditions, continuity of supply was ensured, whereas under Mr. Hammond's ideal conditions continuity would not be ensured. Mr. Hammond's comment upon a few remarks by counsel as to what is being done at Hammersmith was that the sooner Hammersmith was done away with the better.

In answer to Mr. Sanders, for the Islington Borough Council, on the question of price, Mr. Hammond said no system of charging would help Islington to make a profit on power at 1d. per unit. He contended that Islington was losing money, and that it was this undertaking more than any other in London which would be benefited by taking a supply in bulk from the power company.

In re-examination by Mr. Talbot, Mr. Hammond dealt first with the question of purchase of electrical undertakings raised by the City of Westminster, and pointed out that no purchase could take place without the consent of the Board of Trade. With regard to the high load factor which had been assumed by the promoters, he stated that this good result would be attained by aggregation. Dealing with Mr. Cripps's criticism that the capital expenditure taken in relation to certain of the London companies was too high, he maintained that as this reduction would have to be made in all his tables, the ultimate saving shown would not be affected. He could not understand the criticism of the Middlesex County Council that the proposed company wished to take the best portions of that county and leave the poorer part to the County Council, as the County Council was not the electric supply authority.

Speaking generally, Mr. Hammond said he was convinced that a great many of the authorised distributors in the County of London, who were met with the difficulty of being unable to find land for extensions, would be glad to make use of the power company for all supply after their present plant was exhausted. The Marylebone Council had complained that, having purchased the prospective power load in the district, they should be allowed to supply it; but all the power company proposed to do was to help the borough council do this, and not to compete for it. He failed to see how Hampstead could be injured by the power company, for they stated there were no power consumers there. Consequently, the power company could only supply to the authorised distributor if they desired a supply, and not otherwise.

In answer to Lord Saunderson, Mr. Hammond said that no account had been taken in their estimates for supply to tramways in the County of London, as they did not expect to do this.

Mr. HAMMOND next referred to a point that had been brought to his notice, and which had not been foreseen. It had been stated that, in the case of an authority distributing direct current only, and not wishing to lay special mains for giving an alternating current supply taken from the power company, the latter might attempt to induce the power user to take a supply of alternating current direct, on the ground that alternating current was better for power supply, and so compete with the local authority. This contingency had been quite unforeseen by the promoters, and he thought steps should be taken to remedy it.

Mr. TALBOT, K.C., for the promoters, agreed with this, and said he would venture to submit a suggestion as a way out of the difficulty.

WEDNESDAY, MAY 20TH. (NINTH DAY.)

Financial evidence was called. Sir Thomas Hugh Bell, Bart., one of the promoters, was the principal witness called. The other promoters are Mr. R. W. Blackwell, Mr. R. S. Guinness, M.P., Mr. R. Miller, Mr. G. D. Rowe, Mr. Owen Hugh Smith, Mr. W. D. Ward, Mr. V. W. Yorke, and Mr. John Young.

A full report will appear in our next issue.

Messrs. Mather & Platt's Exhibit at the Franco-British Exhibition.—We have received from Messrs. Mather & Platt, of Manchester and London, some details of the extensive exhibits which they have erected in the Machinery Hall of the Franco-British Exhibition. One of the most important of these exhibits is a twin-cylinder two-cycle gas engine, with three-phase generator, mounted on the crankshaft between the two cylinders. The speed of this set is 107 revolutions per minute, and it is rated at 800 b.h.p. output continuously, with gas supply of about 140 British thermal units per cubic foot; or, in other words, ¾-lb. of coal per h.p. hour. This design of gas engine is the most similar to a steam engine of any made; it is claimed to be equal to a steam engine in reliability, evenness of turning and certainty of starting. There are no side shafts, cams, or gear wheels, and no exhaust valves. The three-phase generator is for an output of 2,200 volts, 170 amperes, at 25 cycles per second, which, with a power factor of 0·8, is equivalent to 520 kilowatts. The firm also show a Zoelly patent steam turbine, coupled direct to a patent high-lift turbine pump. This set is designed to run at 3,000 revolutions per minute, and the turbine will develop 210 b.h.p. when supplied with steam at a pressure of 160-lbs. per square inch, and condensing. The pump will lift 1,200 gallons per minute against a total head of 400 ft. Another exhibit is a pair of patent high-lift turbine pumps direct-coupled to a direct-current steel-clad motor, placed between the two pumps. The motor runs at 1,060 revolutions per minute, and is capable of giving out 150 b.h.p. The two pumps which have each six successive chambers, through which the water passes, are connected in series, and are capable of pumping 400 gallons per minute against a total head of 720 ft., that is, each of the twelve chambers in series furnishes pressure sufficient to overcome 60 ft. This is at 1,060 revolutions per minute; at 1,450 revolutions the output would be 500 gallons per minute against 1,300 ft., and at 1,850 revolutions 600 gallons per minute against 2,000 ft. head. In addition to this plant the firm also show a large tank constructed of standard-sized cast-iron plates, with accurately-machined external or internal flanges, and several steam-driven pumps. We hope to deal more fully with these and other engineering exhibits in the Franco-British Exhibition more fully at a later date.

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ELECTROCHEMISTRY AND ELECTROMETALLURGY

ACCORDING to the *Times Engineering Supplement* there are in France a large number of factories engaged in the production of calcium carbide which are worked by hydro-electric agency, a considerable number of them being situated in the Alpine territory and some of them in the Pyrenees. The whole of the factories are worked under license from the Bullier patents, as these have been shown to be the only valid ones, consequently all the works pay royalties to the proprietors of these patents. Likewise, foreign carbide imported into France also has to pay a license. These patents expire in February, 1909, and after this the French electro-chemical product will no longer be protected against that of foreign producers, which can be manufactured at a much lower rate in certain countries, for example, Norway, where hydro-electric energy is relatively much cheaper; consequently French manufacturers will have to meet with very serious competition, which it will require all their ingenuity to counteract. It is also stated that Mr. Girod, who is well known for his success in the production of ferro-alloys by electric agency, is concerned in the putting down of a very important electric steel plant at Ugines, in Savoy. Mr. Girod intends to make steel directly in an electric furnace specially constructed from designs of his own, and in which the intermediate process of producing cast-iron will be avoided. Furthermore, he will not employ the Martin furnace which has always been used in connection with the electric furnace in steel manufacture, in order to start the reaction, which is finally completed at the higher temperature rendered possible by the use of the electric arc. Advantage will thus be gained by it being no longer needed to use gas-producers in the first stages, and the expense and trouble attendant to this part of the manufacture will be avoided. The works will comprise two 8-ton furnaces and also two 6-ton furnaces.

In the steel factory of Jacob Holzer at Unieux a 2,000-h.p. electric furnace is in course of erection, from which it is intended to produce fine qualities of steel.

Another article in the same number deals with the electrolytic copper industry. We notice from this that the opening up of new copper mining districts in Russia and Australasia has led to a demand for the erection of central electrolytic refineries, to which it is intended to send the raw copper from the various centres in these two countries. Both in Sydney, N.S.W., and also in Moscow schemes are being discussed for meeting this demand in a practical manner. In Australasia a company has been formed and named "The Electrolytic Refining & Smelting Co., Ltd." As soon as a suitable locality and site for these works has been selected building operations will begin. The company has a capital of £150,000, and the offices are situated in Sydney. The Mt. Morgan Gold Mining Co., of Queensland, has a financial interest in the new undertaking. This latter company is now producing large amounts of copper-ore, but it is relinquishing its plans for the erection of a local refinery in favour of the larger scheme. A similar scheme is being pushed forward in Russia, a company having been floated by a group of financiers interested in the industry. According to H. R. Merton the output of raw copper by the Russian mines in 1907 was 15,000 tons, as compared with 10,490 in 1906, while Australasia increased her output from 36,250 in 1906 to 41,250 tons in 1907. The rest of the article deals with subjects familiar to readers of this column.

The Rusting of Iron and Steel.—In a Paper before the Birmingham University Metallurgical Society, Mr. M. Thornton-Murray dealt with the various methods of protecting iron and steel surfaces from the corrosive action of the atmosphere and of moisture. The purely chemical theory of Calvert states that the essentials for the formation of rust are iron, oxygen, carbon dioxide and water, the latter two taking part in a preliminary reaction in which bicarbonate of iron is formed. The bicarbonate interacts with the oxygen of the air to form rust (hydrated ferric oxide), carbon dioxide, and water. The new theory of Dr. Cushman states that the action is electrolytic, and is promoted by irregularities in the metallic surface. The fact that underground pipes under the influence of earth currents tend to corrode more rapidly than others, the greater liability to corrosion of magnetised steel, and of iron or steel in contact with metals electro-negative to iron, such as lead, tin, or copper, point to a very close connection between corrosion and electrical phenomena. The presence of the magnetic oxide of iron or of particles of slag in steel lessens the resistivity to corrosion, but, on the other hand, phosphorus and silicon tend to reduce corrosion. Nickel and other steel alloying metals seem to increase the resistivity. In general, however, it is usual to coat the iron or steel with some protecting material. Tin is an excellent material for this purpose, but directly an opening is made, the corrosion is rapid, as tin is electro-negative to iron. Zinc is better, as it is, electro-positive to iron and thus tends to redeposit on the iron. It is, however, brittle and scales off easily. Electro-plating with copper, nickel, or silver is open to the same objection as was given for tin. For heavy engineering work special anti-rust paints are largely used, and for light engineering work a recently introduced process, known as the Cosbett process, is particularly suitable. In this process the iron or steel article is immersed in a hot phosphorised solution which contains an iron compound. The solution is kept at the boiling point by suitable means. The articles are immersed for three to four hours and then dried and oiled. The surface of the metal after this treatment is converted into a mixture of ferrous and ferric phosphates which has a high resistivity to corrosion and a pleasing dull black appearance.

ELECTRICAL SCIENCE

British and American

Royal Society Conversazione.—Among the exhibits of electrical interest at the conversazione of the Royal Society, held at Burlington House last week, was an interesting collection of recent apparatus shown by Prof. J. A. Fleming. This included the latest forms of his well-known cymometer and oscillation values as used for wireless telegraph receivers, and a laboratory apparatus for exhibiting certain photoelectric effects of potassium-sodium alloys. Other wireless telegraph apparatus included Mr. L. H. Walter's tantalum wave detector. In this instrument a tantalum wire point dipping into mercury forms a detector, which is comparable with the electrolytic detector at 450 miles for all but very faint signals. The sound is several times louder than with the electrolytic when the signals are not too weak, and the tone is very good in wireless telephonic transmission. The same exhibitor also showed a new signalling key for high powers, in which the difficulty of breaking the large currents is overcome by making the break (in the primary circuit of the transformer) take place beneath an aqueous electrolyte between two valve electrodes, normally separated, and actuated by a local key circuit. A model of an early form of magnetic detector was also shown. Mr. S. Cowper Coles showed samples of his new bimetallic projector reflectors (see ELECTRICAL ENGINEERING, April 9th, page 550) and some specimens of pure electrolytic iron. The Rev. F. J. Jervis Smith had on view an apparatus for generating a luminous glow in an exhausted vessel, moving in an electrostatic field and exhibiting the action of a magnetic field on the glow so produced. Other exhibits included a mercury vapour lamp for microscope work shown by Mr. J. E. Barnard, Mr. J. T. Irwin's hot wire oscillographs, and a display of various measuring instruments from the National Physical Laboratory.

New Form of Voltameter.—In the May number of the *Philosophical Magazine*, R. A. Lehfeldt gives an account of his attempts to design a gas "coulometer," or instrument for measuring coulombs by electrolysis. The usual trouble with gas voltameters is that they cannot be used accurately with high current densities. In the instrument described by the present author the two electrodes are held in a cork, which can be inserted into a sort of inverted test-tube. The test-tube has a side limb for pouring in electrolyte till the platinum electrodes are well covered, and a small-bore gas tube runs from the top of the test-tube to a manometer and a gas-measuring apparatus. The manometer is a U-tube containing olive oil, one limb being open to the atmosphere. The gas-measuring apparatus is a vessel out of which mercury can be run from a tap at the bottom. In making a measurement of a quantity of electricity the mercury was adjusted till the oil manometer showed that atmospheric pressure existed inside the apparatus, the current was passed, and mercury was run out to keep the oil manometer level. By weighing the mercury the volume of gas evolved could be estimated accurately. Of course, the temperature was kept as steady as possible by a water-jacket. The author used currents about 0·6 of an ampere, and passed quantities of the order of a thousand coulombs through the apparatus. The mercury that was run out during an experiment averaged between two and three thousand grams. The author tried a great many electrolytes at this current density, using a potentiometer and standard cell method of measuring the current passing. He found that many electrolytes give volumes of gas varying from 33 per cent. to 99 per cent. of the theoretical yield; but if solutions of sodium sulphate, of strength ten to thirty per cent., or solutions of potassium bichromate, of strength five to ten per cent., be electrolysed, almost theoretical yields are obtained. With these solutions the apparatus is reliable and rapid, the error being within one-tenth per cent.

Radioactivity of the Alkali Metals.—The so-called non-radioactive elements were carefully examined by Campbell and Wood, who found that the element potassium possesses the greatest

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radioactivity. These authors convinced themselves that the faint radioactivity they discovered was an atomic property which was carried through all the salts of potassium (see ELECTRICAL ENGINEERING, Vol. I., p. 564). Later experiments of Campbell led to the opinion that the radiation consisted of β-rays with an average velocity less than the β-rays of uranium. In a letter to *Nature* last week, J. C. McLennan and W. T. Kennedy state that they have made a close examination of the radioactivity of a large number of potassium and other salts, and find themselves unable to support Campbell's conclusions. On the contrary they have found, in the first place, that samples of potassium salts obtained from different sources exhibited widely differing degrees of radioactivity. For instance, two samples of potassium chloride which they examined differed by more than 40 per cent. in ionising power. Similar results were found with samples of potassium hydroxide, and especially with potassium cyanide. In the second place, while metallic sodium and several sodium salts did not, in their experiments, exhibit radioactivity, yet a sample of sodium chloride obtained from rock salt showed an activity comparable with that of many potassium salts. In the third place, none of the samples of lithium salts obtained and examined by the authors showed the slightest trace of radioactivity, while samples of rubidium alum and of cæsium chloride were very slightly active. Thus we have to conclude that great doubt exists as to the possession of radioactivity by the alkali metals.

Continental

An Automatic Photometer.—Most photometers are "ocular," meaning that comparisons of brightness are made by the eye. To eliminate this necessity, it has been proposed to employ a selenium cell, a bolometer, or other instrument sensitive to radiant energy. But all such instruments suffer from the drawback that their colour-sensitiveness is not the same as that of the human eye. This might be rectified by analysing the light spectroscopically and stopping down the various radiations in the requisite proportions. But, fortunately, the same result may be obtained in a much simpler manner by a screen consisting of a solution of acetate of copper. In Bulletin No. 278 of the French Physical Society, C. Fery proposes to employ such a screen for the automatic recording of luminosities. The maximum sensitiveness of the eye is at wave-length 540 mm., which is therefore the brightest region of the spectrum. It is only necessary to graduate the strength and thickness of the solution in such a manner that the recording instrument shows the maximum reading at that wave-length. Then the colour-curve is the same as that of the human eye. As a recording instrument, Boys' radiomicrometer is most suitable. It is sensitive enough to record to 0·1 to 0·4 per cent. of light transmitted by the solution, and gives a deflection of 60 mm. per candle at 1 metre.

Dysprosium more Paramagnetic than Iron.—G. Urbain claims to have proved that the first place among the paramagnetic elements belongs, not to iron, but to an element called dysprosium. This is one of the yttrium group of rare earths, and was discovered by Lecoq in 1886. Crookes only found one band in its spectrum ($\lambda=451$), but the author has succeeded in locating no less than 90 lines in the ultra-violet, of which he gives a list in the *Comptes Rendus* for May 4th. In fact, he maintains that this element is richer in lines than any element of the rare earths. He has obtained the element in a "pure" state, from which nothing else can be extracted by further fractionisation. He determined the magnetisation of its oxide, $Dy\,O_3$, by means of Curie's magnetic balance, and compared it with that of cobalt sulphate. The magnetic susceptibility of the latter is $39{\cdot}7\times10^{-6}$. That of dysprosium oxide is 290×10^{-6}. It is 12·8 times more magnetic than the magnetic iron oxide Fe_3O_4. Meyer obtained some susceptibilities almost as high with a substance called "holmium," but Urbain regards this substance not as an element, but as a mixture of yttrium, erbium, dysprosium, and some doubtful metals of the rare earths.

X-ray Test for Infant Life.—In the *Comptes Rendus* for May 4th, C. Vaillant proposes to use Roentgen rays for testing whether alleged still-born infants have lived even for a few hours after birth. From a large number of radiographs he draws the conclusion that no details of internal organs can be obtained from any still-born infants whatever, no matter how the exposure is graduated. The most pronounced effect of respiration is to bring the stomach within the range of radiography. It is the first of the internal organs to appear, and ranges in size from a pea to a large bean. The respiration of the next ten hours makes the stomach larger and more transparent. At the end of that time the large intestine begins to appear on the radiographs. When life continues for several days, but without food, the liver appears clearly, and the heart in a blurred outline. The lungs also become transparent, but that is not so certain. When the infant has been fed for several days, all the organs become more or less visible. The gases in the intestine enlarge it and favour a clear image. In all these observations the meconium plays no part. The new test should be of considerable importance for purposes of medical jurisprudence.

This year's meeting of the French Association for the Advancement of Science will take place at Clermond-Ferrand about the beginning of August. Sir William Ramsay has promised to lecture on his recent discoveries. The association's office is at 28 rue Serpente, Paris.

The First International Congress of Refrigerating Industries (*Congrès des Industries Frigorifiques*) will take place at the Grand Palais, Paris, towards the end of September. For both these meetings the French railways issue tickets at half the ordinary fares.

Institution Conversazione and Dinner.—It was announced at the Institution of Electrical Engineers on Thursday that the annual conversazione will take place on Thursday, June 25th, and the annual dinner on Thursday, October 22nd.

Central London Railway.—In our article on the extension of this station last week, we should have made it quite clear that Messrs. Balcke & Co., not only supplied the interior of the cooling tower, but that the whole tower was Messrs. Balcke & Co.'s original design.

Institution of Electrical Engineers.—The following is the result of the ballot of new members at the meeting on Thursday:—Associate Members: W. N. Cochrane, P. Cordiner, P. L. Davis, H. W. Edwards, H. A. Fleet, J. A. Fraser E. H. Rhodes, W. V. Waite. Students: H. R. Climie, I. K. Kaul, W. T. Magrath, W. Pate.

The Association of Teachers in Technical Institutions.—The second annual conference of this Association will be held in London at Whitsuntide. Papers will be read on various educational subjects on the Saturday, Monday, and Tuesday, and Wednesday, June 10th, will be devoted to an excursion.

Obituary.—At the meeting of the Institution of Electrical Engineers on Thursday Mr. W. H. Patchell, who was in the chair, announced the death of the Very Rev. Father Lafont, Professor of Physics at the St. Xavier's College, Calcutta. Mr. Patchell stated that Father Lafont was better known to them in connection with the Calcutta Local Section of the Institution of Electrical Engineers, of which he had been chairman for many years.

Telephone Charges.—An action was brought by the National Telephone Co. against G. H. Openshaw & Co., of Old Trafford, at the Salford County Court last week. The claim was for £4 for rent of apparatus, and £1 10s. for calls for this year, and 5s. 6d. for excess calls last year. Under the agreement the rent was payable in advance, and as the defendant had not paid he was cut off on February 27th. The judge decided that the company was entitled to the £4 for rent and the 5s. 6d. for excess calls last year, but not to the £1 10s., which, although generally paid as a deposit in advance, was not mentioned in the agreement as having to be paid in advance.

Damage to City Electric Light Standard.—In the Court of Appeal on Friday last the case of the City of London Electric Lighting Co. *v.* the Vanguard Motor 'Bus Co. was heard before Sir Gorell Barnes and Lord Justices Moulton and Farrell. Both parties appealed against the judgment of Mr. Justice Ridley in the King's Bench Division of the High Court. (See ELECTRICAL ENGINEERING, April 2nd, p. 507.) The jury found that there was negligence on the part of the driver on the occasion of the first accident, but that the vehicle was not a legal nuisance. Judgment was entered for the plaintiffs for £43 3s. 4d., being the amount attributable to the accident. Their lordships held that this verdict was unsatisfactory, and ordered that there should be a new trial.

Electrical Engineering in India.—A report to the Bengal Chamber of Commerce by Mr. C. E. Low, of the Industrial Survey, extracts from which are reproduced in the *Journal of the Society of Arts*, reviews the industrial situation in the Central Provinces in connection with an exhibition of the products and manufactures of the Central Provinces and Berar, which it is proposed to hold at Nagpur in November next. The question of electrical driving of cotton mills is alluded to, and it is remarked that there are four or five spinning and weaving mills of fair size in or near Nagpur, as well as the Empress Mills of Messrs. Tata. Messrs. Petit are just taking over and re-starting on a large scale another mill. The Empress Mills are already partly run by electricity. A scheme for electric lighting in Nagpur city is on foot, and, in any case, electric lighting for the Government offices cannot be long delayed.

Wireless Telegraphy.—According to an American Consular report two wireless telegraph stations have been established in the vicinity of Vancouver. One station is situated at North Vancouver, just across Burrard Inlet. The other is at Point Gray, some seven miles distant. These stations promise to be of great service to the trade between Vancouver, Puget Sound ports, and Alaska.

Experiments are being made by the United States Government to determine the possibility of installing wireless telegraphy apparatus in balloons. Balloons with receiving apparatus have already been used successfully, but owing to the risk of an ignition of gas experiments have not yet been made with transmitting apparatus on board.

The amendment to the law of 1892 relating to the telegraph system in Germany has been published. By this amendment wireless telegraphy is included, and in future no wireless telegraph installations can be erected without the consent of the Government. The law applies also to German vessels on the high seas, and regulations governing the use of installations on foreign vessels within German waters are to be framed.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published May 14th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

8,951, W. J. DAVY. An automatic switch to use in connection with small transformers for metallic filament lamps. A solenoid acting on an iron plunger is connected to one of the house mains, and also to one of the supply mains. The remaining house main is connected to the other supply main through a resistance. On closing any one lamp circuit, a current flows through the solenoid, and the plunger descends, closing a switch in the primary circuit of the transformer. The solenoid circuit is at the same time broken. An auxiliary solenoid in series with the secondary circuit keeps the plunger from rising. If all lamps are switched off, the auxiliary solenoid ceases to act, and the plunger rises, breaking the primary circuit of the transformer. Six claims, two figures.

12,139, F. J. PLANCHON. The preparation of metallic filaments for electric lamps. An alkaline solution of tungstic or molybdic acid is mixed with an aqueous or alkaline solution of an albuminoid substance, as gelatine or casein. The mixture is poured into dilute hydrochloric acid and a precipitate appears which is a compound of the tungstic or molybdic acid and the albuminoid substance. The precipitate is mixed with water to form a plastic mass, which is squirted into filaments. The filaments are reduced to purely metallic filaments in a vacuum or inert gas by raising to a high temperature by means of an electric current. Filaments prepared in this way are stated to be very regular as regards dimensions and resistance. Three claims.

15,171, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). A method of coating armature or transformer laminations with an insulating film. Gum copal is ground in water until a colloidal solution is formed. The solution should contain about 20 per cent. by weight of copal. The air-bubbles in the solution may be dispersed by adding a few drops of 10 per cent. solution of barium hydrate or chloride. This causes a precipitation of the copal, but by stirring a uniform and practically permanent suspension is again obtained. The addition of a little sodium hydrate will prevent any precipitation. The solution is then applied to the laminations by spraying, rolling, or dipping, the last-named having been found best. After draining, the plates are heated in an oven to between 100°C. and 200°C. The water is driven off, and the gum melts, forming a thin adherent coating, which does not crack if the iron is bent, and which does not easily flake off. Three claims, no figures.

16,166, J. S. HIGHFIELD. The application of the fly-wheel storage principle to the direct-current series system of power transmission, for the purpose of equalising the load on the generators when the motors are working intermittently. A control motor consisting of a series motor coupled to a heavy fly-wheel is connected in series with the main circuit. The brushes of this control motor are rocked by a series solenoid device, so arranged that on an increase of the current, the brushes are rocked into the working position, so that the motor and fly-wheel speeds up, and generates a back E.M.F. in opposition to the generator E.M.F. If the back E.M.F. of the motor at full speed is made just a little below the generator E.M.F., the speed will rise until normal line current flows. If this is impracticable, the generator E.M.F. can be reduced by the action of a governor on the control machine, which may operate a lever connected so as to increase the resistance in the generator shunt field at high speeds. If a motor on the system is suddenly started up, the line current is reduced, due to the back E.M.F. of this motor, and the brushes of the control machine are rocked round by the solenoid device to the non-working position, reducing the back E.M.F. of the control machine. If the line current is further reduced, the brushes are rocked further, so that the control machine becomes a generator and delivers energy to the system so long as the fly-wheel rotates. If the load is so prolonged that the control machine stops altogether with its brushes in the full generating position, the machine would start up in the wrong direction on an increase of line current. This result is avoided by the addition of a device to instantly rock the brushes to the non-working position on a reversal. A single control machine, with a suitable flywheel and situated in the station, will keep the current constant in the system so long as the variations are within the limits permitted by its range of speed. Five claims, one figure.

17,046, J. E. NEWMAN and L. LODGE. A method of employing electricity for stimulating vegetable growth. Rows of galvanised iron wires (about No. 20, S.W.G.) are arranged on insulators about 12 to 16 feet above the ground, and about nine yards apart. A continuous discharge to earth is obtained by connecting this network to one terminal (preferably the positive) of an induction coil, giving a pressure of 100,000 volts. Valves or rectifiers (of the Lodge type, for instance) are inserted in series, and to prevent surgings of current a choking coil also. The other terminal of the coil is connected to earth. The apparatus should be protected from lightning by a spark-gap between the network and earth. An increase in the amount of available nitrogen in the soil, and a marked increase in the crops, is obtained. Three claims, two figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1906 Patent

21,347, FELTEN & GUILLEAUME LAHMEYERWERKE AKT.-GES. Electric signalling apparatus.

1907 Patents

9,390, SIMPSON. Electric-vehicle or locomotive brakes.
9,434, MAINPRIZE. Combination fuse and switch.
10,367, COWPER-COLES. Electro-deposition of iron.
10,636, BLACK & BLACK. Electric traction installations using contact boxes.
10,650, DAWSON & BUCKHAM. Electrical apparatus for transmitting and receiving signals.
13,882, LOWDEN & WESTINGHOUSE METAL FILAMENT LAMP CO. Electric lamps.
16,051, SIEMENS BROS. DYNAMO WORKS & W. PARKER. Dynamo-electric machines.
19,378, WHITTAKER. Sanding apparatus for use with tramcars.
19,758, POOLE. Means for controlling mechanism operating rheostats.
19,855, BOYDEN. Electrical switches.
22,224, ZANDER (*Held*). Case for electric indicators.
25,961, HOSKEN. Automatic sand-valve opener for tramcars.
28,142, SIMMS MANUFACTURING CO. & ALTREE. Sparking plugs for internal-combustion engines.

1908 Patent

1,427, DE FOREST. Space telegraphy.

Complete Specifications open to Public Inspection before Acceptance.

1908 Patents

4,948, HOWARD. Alternating current transformers.
8,287, FELTEN & GUILLEAUME LAHMEYERWERKE AKT.-GES. Transporting apparatus.
8,415, NOBGGERATH. Dynamo-electric machines.
8,416, WOLFRAM-LAMPEN AKT.-GES. Incandescent filaments for electric incandescent lamps.
8,904, BOUNEAU. Electrical furnaces.
9,146, AKT.-GES BROWN, BOVERI, ET CIE. Electric transformers.
9,257, ALLGEMEINE ELEKTRICITÄTS-GES. Devices for protecting transformers, cables, and other electrical apparatus.

Applications for Amendment

Further particulars and instructions as to procedure in opposition to amendment will be found in the Official Journal of the Patent Office of May 13th.

23,942 of 1896. THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO., LTD. seek leave to amend the specification numbered as above, granted to R. BELFIELD, for "Improvements in electric switches and circuit breakers," in order to limit and to define more clearly the scope of the invention. The proposed amendment consists in striking out much of the specification, including Claims 1 to 4 and 6.

21,892 of 1904. F. M. LEWIS seeks leave to amend the specification numbered as above, for "Improvements in electric arc lamps," in order to define more clearly the scope of the invention. The proposed amendment consists in striking out Claims 3 and 5 to 8, also Figs. 1 and 3 to 6.

4,922 of 1908. C. H. STEARN and C. F. TOPHAM seek leave to amend this specification, for "Improvements in connection with electric lamps and their circuits," by including H. W. HANDCOCK and A. H. DYKES as applicants for a patent.

Expiring Patent

The following patent expires during the current week after a life of fourteen years :—

10,292 of May 28th, 1894. J. MANGER and E. MOJON. The use of an electric lamp, fitted in the case of a watch, clock, barometer, compass or similar instrument, to illuminate the dial.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ld.	10	7	7%	10½—11	-¼
Do. 4½% Cum. Pref.	10	4½	4½%	9⅝—10⅝	-⅛
Do. 6% Cum. Second Pref.	10	6	6%	10½—11	
Do. 4½% Debenture, Red.	Stock	4½	4½%	104—105	
Bromley (Kent) E.L.& Power Co., Ld.	5	⅝	5½%	4½—5	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	94—97	
Brompton & Kensington E. S. Co., Ld.	5	10	10%	6¾—7¼	-¼
Do. 7% Cum. Pref.	5	7	7%	6¾—7¼	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	99—102	+1
Ch. Cross, W. E. & City E. S. Co.	5	5	5%	3½—3¾	
Do. 4½% Cum. Pref.	5	4½	2½%	4½—4⅝	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	3¾—4¼	
Chelsea Electric Supply Co., Ltd.	5	4¼	4½%	3½—3⅝	+⅛
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9¼—10½	
Do. 6% Cum. Pref.	10	6	6%	12—13	
Do. 5% Deb. Red	Stock	5	5%	124—127	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	102—105	
City of Durham E. P. Dis. Co.	5	4	2½%	2½—3	-½
Do. 5% Pref.	5	5	5%	3¾—4¼	+½
County of London Elect. Sup. Co. Ld.	10	5	5%	7⅞—8¼	
Do. 6% Cum. Pref.	10	6	6%	10½—11¼	
Do. 4½% Deb. Red	Stock	4½	4½%	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	96—99	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3¼	—	½—1	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	63—73	+8
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4¾—5¼	
Do. 5% Cum. Pref.	5	5	5%	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½%	6¼—6¾	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	90—93	
Kensington & Knightsbridge E.L.Co.	5	10	10%	7½—8¼	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N't'ng Hill E.L. Cos. Db. Rd.	Stock	4	4%	97—101	
London Electric Supply Corporation	3	4	2½%	1—1½	
Do. 6% Pref.	5	6	6%	4¾—4¾	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6½%	4⅜—4⅞	+⅛
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—4⅝	-⅛
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E.Corp.for P.Dist.1stMt.D	100 & 500	4½	4½%	96—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	7⅜—8½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	8%	5½—6	
Do. £2 Pm.	5	8	8%	5½—6	
Do. 5% Pref. (fully paid)	5	5	5%	5⅝—5⅞	
Do. 10/- Pm.	5	5	5%	5⅜—5⅝	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11½—12½	
Oxford Electric Co., Ltd.	5	7	7%	5⅝—6⅜	
Do. 4% Deb. Red	Stock	4	4%	94—98	
St. James and Pall Mall E. L. Co. Ld.	5	10	10%	7½—8½	
Do. 7% Non-Cum. Pref.	5	7	7%	6½—7	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—⅜	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4%	2⅜—2⅝	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅝—⅞	
Do. 7% Cum. Pref.	1	7	7%	1⅞—1⅞	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5%	1—2	
Do. 5% Cum. Pref.	5	5	5%	1⅝—2¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¼—8	
Do. 4½% Cum Pref.	5	4½	4½%	4¾—5¼	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	88—91	
Central London	Stock	4	3%	77—80	+3
Do. 4% Preferred	Stock	4	4%	87—89	
Do. Deferred	Stock	4	2%	55—58	+1
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	81—84	
City and South London Cons.	Stock	2½	4½%	40—42	+1
Do. 4% Perp. Deb.	Stock	4	4%	99—102	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1896	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11s/-	¾—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4%	6—7	
Do. 4% Perp. Deb.	Stock	4	4%	87—90	
Mersey Cons.	Stock	nil	—	1—3	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	½%	44½—45½	+2½
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	75—78	
Do. 3½% Convertible Pref.	Stock	3½	3½%	73—76	
Metropolitan District	Stock	nil	—	13—14	+1½
Do. 6% Perp. Deb.	Stock	6	6%	105—110	
Do. 4% Deb.	Stock	4	4%	62—67	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pr. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co of London 5% Profit Sha. Sec. Notes	Various	5	5%	38—42	+2
Whitechapel and Bow 4% Deb.	Stock	4	4%	103—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/*	⅜—⅝	
Do. 5% Cum. Pref.	1	5	5%	¼—½	
Do. 4½% Deb. Red.	Stock	4½	4½%	86—91	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93 96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	3⅜—4½	+⅛
Do. 5% Perp. Deb.	Stock	5	5%	88—92	
Do. 4½% 2nd Deb.	Stock	4½	4½%	67—71	
City of Birmingham Trs. Co., Cm. Pf.	5	5	5%	4¼—4⅝	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	97—100	

NAME.	Amount of Share.	Dividend Paid. *= Interim. 1906	1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%	%		
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	94—97	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	¾—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	⅜—⅝	
London United Trs., Ld., Cm. Pf.	10	5	5%	6¾—7¼	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—85	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	1¼—1⅝	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	94—97	
National Elec. Construction Co. Ltd.	1	10	2/-	⅞—1⅛	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	½—1	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	4%	⅛—¼ xd	
Do. 5% Cum. Pref.	1	5	5%	⅜—½	
Do. 4½% Deb. Red	Stock	4½	4½%*	91—94 xd	-2
Provincial Tramways Co. Ltd.	10	3¾	4%	4⅞—5⅛	
Do. 6% Cum. Pref.	10	6	6%	9¼—10¼	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	6%	¾—1	
Do. 4% Deb. Red.	Stock	—	4%	76—80	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1½	
Do. 6% Cum. Pref.	5	nil	—	3½—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	56—59	+1
Do. 6% Pref. Ord.	Stock	6	30/-*	99½—101½	+1
Do. Def. Ord.	Stock	1⅜	1%	16—16½	+1½
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3¼—3½	
Do. 10% Cum. Pref.	5	10	10%	8—9	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4¼	4/-*	13½—14	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	100—102	+½
Eastern & S. African Ltd., 4½% Mt. Deb.	100	4	4%	99½—101½	+½
Do. do. (Mauritius Sub.)	25	4	4%	99—101	+½
Eastern Ext. Australasia & China	10	7	7/6	12¾—13¼	-¼
Do. 4% Mort. Deb. Perp.	Stock	4	4%	100—102	
Eastern Telegraph Co.	Stock	5¾	7%	129—134	-2
Do. 3½% Pref.	Stock	3½	3½%	83—86	-1
Do. 4% Mort. Deb.	Stock	4	4%	100—102	
G. N. Tel. Co. (Copenhagen)	10	20	20%	29—31	
Indo-European Telegraph Co. Ltd.	25	13	65/-	53—56	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅜—½	
National Telephone Co., Ltd., Pref.	Stock	6	6%	108—110	+½
Do. Deferred	Stock	5½	6%	109½—111½	+½
Do. 6% Cum. 1st Pref.	10	6	6%	10¼—12¼	
Do. 6% Cum. 2nd Pref.	10	6	6%	10½—12½	
Do. 5% 3rd Pref.	5	5	5%	5⅛—5⅜	
Do. 3½% Deb. Red	Stock	3½	3½%	98½—100½	+½
Do. 4% Deb. Red.	Stock	4	4%	101½—103½	
Western Telegraph Co., Ltd.	10	7	7%	13½—13¾	
Do. 4% Deb.	Stock	4	4%	100—102	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	6%	½—¾	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅜—3½	+⅛
Do. 6% Pref.	1	6	7½d	1⅞—1⅞ xd	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	6⅛—6⅜	
Do. 6% Cum. Pref.	5	6	6%	5⅝—6⅛	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	93—98	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—¼	-⅛
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅞	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	70—75	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	55—60	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10—11	-½
Do. 5% Cum. Pref.	5	5	5%	5⅛—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106½—108½	
Consolidated Electrical Co., Ltd.	1	3	3½%	¾—⅞	
Crompton & Co., Ltd.	3	5	5%	1⅝—1⅞	-⅛
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1⅛—1⅛	-⅛
Do. 6% Cum. Pref.	1	6	6%	1—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
Edison & Swan United "A." £3 paid	5	4½	2/6	⅝—⅞	-⅛
Do. do (fully paid)	5	4½	4/2	1⅛—2⅛	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	¼—⅜	
Do. 7% Cum. Pref.	2	7	—	1¼—1⅜	
Do. 4% 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8¼	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10¾—11¾	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—4⅝	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15¼—16¼	
Dp. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	29—31	-1
Do. 4% Deb. Bds. Red	100	4	4%	100 103	
Willans & Robinson, Ord. Shres	1	nil	5%	⅜—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3⅜ 3½	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—77	

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LOCAL NOTES

ACCRINGTON: *Lighting and Tramways.*—In his yearly budget last week, Mr. J. C. Lupton, Chairman of the Accrington Finance Committee, remarked that during the year the energies of the Council had been devoted mainly to the conversion of tramways to electric traction. That had meant that some work had been deferred, particularly highway repairs. In such cases the money had been ear-marked and placed in reserve for subsequent years. Provision had also been made for rearranging the street lighting on the main roads, consequent upon the erection of the tramway standards, and it was intended to improve the lighting greatly by fixing lights to standards and taking out a considerable number of street lamp pillars.

ALLOA: *The Electricity Undertaking.*—It was reported, at a meeting of the Town Council, that the loss on the electricity undertaking for the last five years had been £2,576. In 1907 the amount paid to the British Electric Plant Co., Alloa, for current was £1,081, and this was retailed to consumers at £1,159, showing a gross profit of £78. Deducting sinking fund and mortgage interest, the loss for the year was £573.

ARGENTINE: *Cordoba.*—The Cordoba Electric Tramway Construction Co. have, says the *Review of the River Plate*, applied to the municipality for an extension of six months in which to comply with some of the terms of their concession. They state that as soon as the concession was obtained, they took the necessary steps to float the company, but the crisis in the European Money Markets made this temporarily impossible. The company has purchased the Argentine tramway system, and has also acquired land for generating stations, having spent about $500,000. There is some local opposition to the application.

AUSTRALIA: *Water Power Plant.*—A scheme is under consideration for the lighting of Coburg and other municipalities by electricity from a water power plant on the Yarra River, near Warrandyte. According to the *Melbourne Argus*, it is estimated that, by the construction of a weir 80 ft. long and a tunnel 600 ft. long, over 1,500 h.p. would be available.

AYR: *Extension to Alloway and Prestwick.*—In view of the conditions imposed by the various local authorities, the Electric Light Committee has recommended the Council not to proceed with the scheme.

BARNES: *Tramways.*—The District Council at its last meeting discussed an offer by the promoters of the West London, Barnes & Richmond Tramways Bill with regard to street widenings. The promoters offered (*a*) to make the Council an immediate payment of £45,000 in respect of street widenings, or (*b*) that the Barnes Council should raise £75,000 for the purpose by loan, the company to guarantee the repayment of principal and interest, the Council's security to be a first charge on the entire undertaking, including the part outside their area. This proposal would provide for a road 45 ft. wide throughout the route of the tramways in the town. In reply to this offer, a resolution was moved that it be referred to the Tramways Committee to consider as to the best means of developing a service of electric trams, but the motion was rejected by 13 votes to 7.

BELFAST: *Tramways.*—At the meeting of the Tramways and Electrical Committee, on the 18th inst.—Sir Robert Anderson, Lord Mayor, presiding—a letter was read from Mr. Rodden, of the Whitewell and Cavehill Tramway Co., stating that, having considered the Council's resolution relative to the establishment of a through service between Castle Junction and Glengormely, and also the terms of the Manchester-Oldham agreement *re* the distribution of fares, they were prepared to accept in principle the Corporation's proposal. The question of details, it was suggested, could be left between the manager and a representative of the company, and this was finally decided upon.

BIRMINGHAM: *Tramway Accounts.*—The gross profits for the first complete year's working of the Corporation Tramways were announced on Tuesday to be £121,000, of which a balance of £72,000 remains after meeting capital charges, &c.

BLACKBURN: *M.E.A. Meeting.*—The Town Council have deputed Mr. Higham, Vice-Chairman of the Electricity and Tramways Committee, and Mr. P. P. Wheelwright, Electrical Engineer, to represent the Blackburn Corporation at the Nottingham Convention of the Incorporated Municipal Electrical Associations at the end of June.

BURNLEY: *Tramways.*—Mr. Harry Mozley, tramway manager, issued his annual report last week-end, in which he mentioned that the proportionate increase in receipts of previous years had not been maintained, but there was the substantial increase of 388,460 passengers, and £1,562 2s. 11½d. receipts. Parcel receipts showed a satisfactory increase of £58, and now amounted to £680 per annum. The growth in traffic had necessitated additional rolling stock, and during the year an experimental car had been constructed, and was still undergoing trials, the object being to obtain a more economical car for working special lines than the four motor equipments now in use. During the year the whole system had been cleared of corrugations, at a total cost of £615 2s. The length of rail ground was 57,700 yards, and percentage of rails corrugated 83 per cent. The cost of energy was less, owing to the reduction in the charges of the Electricity Committee from 1⅜d. to 1¼d. per unit. Double helical gears and pinions were being experimented with to lessen the noise. The depreciation fund amounted to £32,608 9s. 3d., bringing the fund up to the full annual average (£6,000 per annum) required. If profits were maintained as hoped, a substantial sum should be available for the purpose of the Corporation in future years. The question of covering the tops of the cars was receiving attention.

BURY: *Electricity Accounts.*—The units sold for lighting and power during the year ended March 31st, 1908, amounted to 1,440,659, an increase of 37·7 per cent. over the previous year. The amount supplied to the tramways has shown an increase of 27 per cent., and totalled 1,230,799 units. The profit on the year's working is expected to be £3,950, as against £2,947 for the previous year. The engineer has been instructed to prepare plans for further testing rooms, and office accommodation at the electricity works.

CHESHUNT: *Light Railway.*—The construction of the light railway at Cheshunt from the Herts county boundary to a point about 80 yards south of Queen Eleanor's Cross, Waltham Cross, is now in progress, and will shortly be completed.

CHISLEHURST: *Extension of Mains.*—The Chislehurst Electric Lighting Co. have extended their mains from Heatherbank to Summer Hill.

CLACTON: *Appointment of Electrical Inspector.*—Mr. H. E. Harrison has been appointed Electrical Inspector under the Clacton Electric Lighting Order.

DARLINGTON: *Supply to the Tramways.*—It has been decided to reduce the charge for electricity supplied to the tramway department from 1¼d. to 1⅛d. per unit.

DOVER: *Archcliffe Fort.*—The new generating station in the trenches behind Archcliffe Fort is now approaching completion.

EDINBURGH: *Leith Tramways.*—At a meeting last week of the Tramways Committee it was stated that the difficulties regarding certain clauses in the Bill relating to tramway extensions at Leith had been adjusted, and that the Bill would very shortly come before Parliament.

FOLESHILL: *Power Supply.*—The Council has approved of an agreement for the supply of power to the Newdigate Colliery Co., at 4d. per unit, with a minimum payment of £40 per annum, the contract to be binding for ten years, after which it is to be terminable at six months' notice from either side.

GLASGOW: *Tramway Undertakings.*—A report has been prepared by the Town Clerk and the tramways manager, in which is considered the relation of the tramway department to the "Common Good," the financial position of the department, and the position of the sinking fund. The report states that, as the undertaking is a part of the Common Good estate, an abstract of the revenue and expenditure is given in the balance sheet of the Common Good. The report, however, does not consider that this serves any useful purpose, and recommends its discontinuance. The total amount of borrowing powers on May 31st, 1907, was £3,100,000, since which the sum of £41,862 has been sanctioned. Additional borrowing powers will be necessary, however, as the Tramways Committee have decided to increase the number of cars and install additional machinery at the Pinkston power station. The sum borrowed from the Common Good to March 31st last year was £2,246,114, but by the operation of the sinking fund the amount outstanding is £1,679,997, which will be entirely wiped off by 1930. The capital expenditure for the same period is £3,104,060, thus showing an excess of expenditure over borrowing powers, but it does not include any portion of the expenditure of the old horse tramways, the cost of which has been entirely written off. The revenue per car mile in 1907 was 10·47d., and for the current year to date 10·46d., and it is the aim of the department to keep as near 10·5d. as possible. The depreciation and renewals fund stands at £1,079,253, which in the light of the capital of expenditure is considered about correct. On the question of sinking fund, the report recommends that the wishes of the Scotch Office in regard to sinking fund on capital temporarily borrowed from renewal and depreciation fund be acceded to, this taking effect as from June 1st, 1907.

GRIMSBY: *Electricity Accounts.*—The Borough Electrical Engineer submitted his annual report on Monday. A profit of £2,442 has been made, in spite of a temporary set-back to the revenue due to the increasing use of metallic filament lamps and the high price of coal.

HARROW: *Church Lighting.*—Electric lighting has been installed at the new Baptist Church at Harrow. The nave is lighted by 12 Osram lamps of 50 c.p. each, and in the side aisles beneath the galleries, as well as for the galleries themselves, 16 c.p. Tantalum lamps are used.

HASLINGDEN: *Tramways.*—A deputation from the Haslingden Corporation on May 15th met representatives from the Accrington Municipality with a view to arrangements being made for the running of electric cars to and from Haslingden. The Haslingden Councillors inquired whether Accrington would be willing to run its cars over the length of the line now

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being made in Haslingden borough, and, if so, on what terms for the cars and the current necessary for motive power. Accrington offered the service at 7½d. per car-mile for three months; for six months, 7¼d.; and for twelve months, 7d.; Haslingden to find its own inspectors and take the responsibility for risks to third parties. Haslingden asked if Accrington would accept for nine months the price quoted for twelve. Accrington agreed, and the deputation decided to recommend their Corporation to accept the terms.

IPSWICH: *Electricity and Tramway Accounts.*—The report of Mr. Frank Ayton, Borough Electrical Engineer, states that there has been an increase of revenue in the Electricity Department of 2½ per cent. for the year ended March 31st, as compared with the previous year, although the average price obtained per unit had declined from 4·181d. to 3·755d. The lighting connections had increased 30 per cent. and the power connections 56 per cent. The increased cost of coal is commented on, and it is mentioned that capital expenditure amounting to £1,315, mostly for extensions to mains and services, had been incurred during the year. The traffic expenses of the tramways have been reduced from 2·305d. to 2·699d. per car mile.

LLANELLY: *Provisional Order Transfer.*—The Council has decided to affix its seal to an agreement with the Llanelly and District Electric Light & Traction Co., which transfers the Council's electric lighting order to the company. A generating station is to be erected within two years.

LONDON: *Bermondsey.*—The monthly report of the units generated and sold continues to show large increases. During April, 255,163 units were generated, showing an increase of 50 per cent. over the corresponding period in 1907. The Engineer has been authorised to arrange special terms for the supply of current to the Motor Radiator Co., Tanner Street.

G.B. Surface Contact Tramways.—At the Tuesday meeting of the L.C.C., Sir John McDougall asked the Chairman of the Highways Committee whether he would present a full report on the G.B. system of traction in Whitechapel Road, before the Whitsun recess. Mr. Gordon asked whether any accident had occurred resulting in injuries to horses in the Mile End Road, and whether there had been any damage to the surface of the road by explosions. Mr. W. W. Thompson, Chairman of the Highways Committee, in reply, said that the section on the G.B. system was still in the experimental stage, and had not yet been passed by the Board of Trade, so that he could give no report before Whitsun. A horse had come into contact with a live stud, and the animal had got staggers, but without fatal result. There had also been a large escape of gas in the Mile End Road, which was the fault of the Gas Company, and the soil was impregnated with gas. Until this was overcome, it would be impossible to run any cars.

Hackney.—Twelve of the twenty-four sections of tubes on the inlet side of the Green's fuel economiser have lately been replaced at a cost of £100, but when the annual inspection and hydraulic pressure test were made it was found that it would be advisable to replace at once the remaining twelve. The inlet side will then be as good as new, and the best of the sections taken out will be used to replace sections on the outlet side at some future date. While the economiser is out of commission the coal consumption is increased by about £10 per week, and as the matter is one of urgency the Electric Lighting Committee have instructed the Engineer to proceed with the work, ordering such material from Messrs. Green & Son as is necessary. The cost of the additional work is £98.

Stepney: Electricity Accounts.—The accounts of the Borough Council's electricity undertaking for the twelve months ended March 31st show the capital outlay on the undertaking to that date to have been £287,960 10s. 1d., and that of this amount £22,888 4s. was spent during the year under review. The capital account shows the intention of the Electricity Supply Committee to write off the account the sum of £547 4s. 11d. out of last year's profits. This amount, added to that already written off, will reduce the value of the capital expenditure in the balance-sheet to £279,614 1s. 7d. The net result of the trading account shows a balance of income for the year over expenditure of £17,102 8s. 3d., and an increase in the number of units sold from 4,751,182 to 5,712,684, producing an income of £38,655 6s. 3d. This income includes the sum of £5,768 15s. 3d., in respect of public street lighting, and a further £848 1s. 8d. in respect of the sale of current to other departments of the Council. The units sold were made up as follows:—Private consumers, for lighting, ordinary charges: 274,755 units at 8d., 746,518 units at 1d.; charge to consumers with minimum annual bill of £120, 305,667 units at 6d., 1,199,782 units at 0·9d.; private consumers for power and heating, flat rate: 1,034,237 units at 1d.: alternative charges to consumers with minimum annual bill of £120, 811,168 units at ½d., and 5s. per h.p. per month demanded: private consumers in bulk for lighting, power, and heating: 22,564 units at 5d., 231,465 units at ¾d.: Council for public street lighting: 79,731 units at 6d., 1,006,797 units at 0·9d. The total income derived from all sources, minus bad debts, was £41,449 5s. The trading account shows that, compared with the previous year, the income has increased by £4,457 2s. 10d., and the expenditure by £3,280 16s. 5d. Although the expenditure has increased in total, per unit sold it has actually decreased, being 0·924d. per unit, as against 0·965d. the previous year. To the balance of income for the year over expenditure has to be added minimum guarantees, and the interest from bankers and investments, making a total of £17,480 9s. Deducting from this amount the interest paid and accrued during the year on mortgage debt, amounting to £10,075 1s. 5d., or £1,676 4s. 9d. over that of the previous year; instalments of loans, amounting to £5,207 11s., or £271 5s. 6d. over that of the previous year; and the cost of executing temporary work, amounting to £269 17s. 8d., there remains £1,927 18s. 11d. Of this last-named sum, which represents the actual surplus made during the year, the Electricity Supply Committee has decided to place £1,000 to reserve account, £200 to another reserve account for bad and doubtful debts, and to carry forward an unappropriated balance of £180 18s. 11d. The average income per unit sold for all purposes has decreased from 1·746d. to 1·624d.—a decrease of 7 per cent. The average charge made by all the companies and local authorities of London is 2·86d. per unit.

Willesden: Bulk Supply.—The Electricity Committee, after considering the report of their Chairman, the Clerk, and the Electrical Engineer upon an interview with the officials of the North Metropolitan Electric Power Supply Co., have come to the conclusion that revised terms submitted by the Company for current supplied in bulk should not be accepted. Further negotiations are proceeding.

Woolwich.—The Borough Council having informally approached the L.C.C. for sanction to a loan for the acquisition of the freehold of the Globe Lane works and adjoining property at Roff's Wharf for the purposes of the electricity undertaking, have been informed that the Finance Committee of the London County Council are prepared to recommend the Council in due course to sanction a loan for the purpose.

MANCHESTER: *Cable Box Fire.*—On Monday there was considerable excitement at the bottom of Market Street, occasioned by a short circuit in a service box in front of Cromwell Buildings. Flames and smoke were observed, and it is said that there was a slight explosion. No damage was done however; the fire brigade were in prompt attendance, but it was unnecessary to start the hose.

MUSSELBURGH: *Public Lighting.*—The National Electric Construction Co. have offered to replace the arc lamps now in use, which have given some trouble, with new lamps of a make to be approved by the Council. The Cleaning and Lighting Committee have been empowered to take advice as to a satisfactory form of lamp. The matter arose through a refusal of the Council to pay the quarterly lighting account in consequence of complaints as to the lighting.

NELSON: *Profits on Electricity Department.*—It was resolved by the Nelson Town Council on May 14th that the profits of the Electricity Department for last year, £590 0s. 8½d., be disposed of as follows:—£250 in aid of general district rate and £341 0s. 8½d. in reduction of capital indebtedness on old works.

NEWCASTLE: *Tramways.*—Mr. E. Hatton's report for the year ended March 31st records a net profit of £19,477. The total working expenses have increased from £107,318 in the previous year to £116,852. The total receipts amounted to £205,322, or an average of 11·17d. per car mile, as compared with 11·56d. for the previous year. The total car miles run were 4,411,745, as against 4,263,174.

The new line from Trafalgar Street to Market Street, described in an illustrated article in ELECTRICAL ENGINEERING, April 9th, page 552, has been inspected by Colonel von Donop, of the Board of Trade, and will be opened for traffic in a day or two.

SOUTHEND: *Electricity Accounts.*—The profit on the electricity undertaking for the past year has been £2,200, as against £946 for the previous year.

TOTTENHAM: *New Sub-station.*—The North Metropolitan Electric Power Supply Co. propose to use the "pound" in Tottenham Hale as an electricity sub-station.

YARDLEY: *Supply to the Tramways.*—An agreement has been drawn up with the City of Birmingham Tramways Co. for the purchase of the plant of the power station in the Coventry Road, Yardley, and the supply of electric energy for the working of the tramways. The Council agreed to purchase the plant at the power station at Yardley for £12,500, and to pay for any additional plant that might become necessary between the signing of the agreement and taking possession.

Dublin Local Section of the Institution of Electrical Engineers.—The following officers and committee have been elected for the ensuing session:—*Chairman:* Mr. G. F. Pilditch (Resident Engineer, Electricity Works, Rathmines). *Vice-Chairman:* Mr. W. Brown (Royal College of Science, Dublin). *Committee:* Mr. N. Hosgood (Electricity Works, Pembroke), Mr. S. T. Land, Mr. A. Moir (Post Office Telegraph, Dublin), Mr. M. Ruddle (City Electrical Engineer, Dublin), Mr. P. S. Sheardown (Electrical Engineer, Dublin United Tramways Co.), Mr. W. J. U. Sowter (Borough Electrical Engineer, Bray), Mr. W. Tatlow, Mr. R. M. Tweedy (Messrs. W. Coates & Son), Mr. A. W. Wheildon (Chief Electrical Engineer, Great Northern Railway of Ireland). *Hon. Sec.:* Mr. T. Tomlinson.

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TENDERS INVITED AND PROSPECTIVE BUSINESS

CHELTENHAM.—There was no opposition at a Local Government Board inquiry last week into an application by the Corporation for sanction to borrow £660 for the construction of a railway siding at the electricity works. At present coal has to be carted a distance of about a mile.

CROYDON.—The tramways manager has reported the necessity of replacing a tramways feeder cable, the insulation of which is in a bad conditions, with one of larger dimensions (2,450 yards of 0·5 cable), at an estimated total cost of £1,076 18s. 7d. When put in, the feeder cables were provided for a maximum service of 40 cars, but the normal service is in excess of this, and at week-ends there is a service of 60 or more. It is proposed to transfer the present positive cable to the negative side, so that this, together with the present negative cable, shall equal the new feeder in carrying capacity. At its last meeting, the Town Council adopted the recommendations of the tramways manager, which were previously endorsed by the tramways committee. Plans, specification, and estimate are to be prepared for the doubling of the single track between the Whitgift loop and the new loop recently constructed in North End. According to a report of the Borough road surveyor, the work would necessitate new track to the extent of 120 yards, which, at £4 10s. per yard, would cost £540. A surplus portion of the land required for a new electricity sub-station, which has now been erected, is to be sold, subject to protective conditions.

DARTFORD.—Tenders are invited for a surface condensing plant. Particulars from the Borough Electrical Engineer, fee £1 1s. returnable, and tenders to the Town Clerk by June 3rd.

EXETER.—An application is to be made for sanction to borrow £8,000 for extensions of mains.

FINCHLEY.—Mains are to be extended in Dudley Road and Westbury Road at a cost of £162.

GLASGOW.—A report by Mr. James Dalrymple, manager of the tramway system, deals with the question of extensions. The report recommends the construction of new lines to the extent of over 35 miles, at an estimated cost of £557,225. This will involve an annual expenditure on capital account of £55,722. A sub-committee of the tramways committee which has dealt with the report specifies a certain number of lines, which it thinks should be put in hand immediately.

GREAT NORTHERN RAILWAY CO.—Tenders are invited for stores during the twelve months from July 1st, 1908. Particulars from the Stores Superintendent, Doncaster, and tenders to the Stores Committee, King's Cross, by May 25th.

HANDSWORTH.—Tenders are invited for low-tension, lead-covered paper-insulated distributing cables. Particulars from the Electrical Engineer, and tenders to the Town Clerk by May 25th.

HORNSEY.—The Local Government Board has sanctioned the borrowing of £10,000 for the Council's electricity undertaking.

ILFORD.—Tenders are invited for surface condensing plant and cooling tower, steam and feed pipes, boiler feed pump, &c., and extensions and alterations to main switchboard. Full particulars from Mr. A. Shaw, Electrical Engineer to the Council, Electricity Works, Lea Street, Ilford, and tenders to the Chairman of the Urban District Council by June 10th. (See an advertisement this week.)

JAPAN.—A company has been formed, with a capital of £206,500, for the purpose of constructing an electric railway, 26 kilometres long, from Moji, through Kokura and Yawata to Kurosaki, as well as a branch 9 kilometres long from Kokura through Tobata to Yawata.

KILMARNOCK.—Tenders are invited for a Lancashire boiler in connection with the electricity undertaking. Full particulars from the Borough Engineer, to whom tenders by May 25th.

LONDON: *London County Council.*—The Highways Committee of the Council recommend an expenditure on capital account of £45,330 in respect of:—(1) The reconstruction on the overhead trolley system of the existing tramways from Wanless Road, via Hinton Road, Milkwood Road, Half Moon Lane, and Norwood Road, and to the existing terminus at Norwood; and (2) the construction on the same system of traction of the authorised diversion or loop lines along Herne Hill Road, Wanless Road, Poplar Walk Road, and Lowden Road. The estimate is made up as follows:—Track work, excluding rails, £35,400; overhead equipment, £6,490; cable duct and feeder pillars, £3,200; sub-station equipment, £240. The total length of tramways proposed to be dealt with is equivalent to about five miles of single track.

The Highways Committee have reported upon the purchase of the Lea Bridge, Leyton, and Walthamstow Tramways Co., within the County of London, to the extent of about three-eighths of a mile. At present the Leyton Urban District Council is working this section by horse traction, but it is now proposed that it should be converted to overhead traction, and that it should be leased to the Leyton Urban District Council until August, 1911. The terms of the lease are that the District Council shall pay to the County Council an annual rent made up as follows:—(*a*) One fifty-ninth part of the total cost of the acquisition; (*b*) one twenty-fifth part of the total cost of the reconstruction; (*c*) 3¾ per cent. on the total cost of acquisition and reconstruction for a time being unpaid by the District Council; and (*d*) one per cent. on the total cost of acquisition and reconstruction. It is therefore recommended that the sum of £6,270 be expended upon this work, excluding cars, which will be provided by the Leyton Council, as follows:—Track work, excluding rails, £5,100; overhead equipment, £1,100; cable ducts, feeder pillars, &c., £70.

Fulham.—The Electricity and Lighting Committee of the Borough Council has decided to extend mains and provide transformers, &c., at a cost of £350, in order to give an electricity supply to the Wall Papers Manufacturers, Ltd. (Osborn & Shearman Branch). The company propose, in the first place, to install two motors, aggregating from 70 to 80 h.p., at their works, and in due course they intend to install further plant. It has also been decided that cables be extended from Stevenage Road to Kenyon Street, at an estimated cost of £31 7s. 6d., and five new public lamps are to be provided, at an additional estimated cost of £15.

Stepney.—The Finance Committee of the London County Council recommend that the Council be authorised to borrow a sum of £9,500 in connection with the Blythe's Wharf generating station, repayable in 50 years. In June the Council sanctioned the borrowing of £22,000 on account of the sum of £42,150, then applied for, for the equipment of the generating station, it being estimated that the cost of the building would be £14,850. It has now been ascertained that the total expenditure will probably exceed the original sum by the amount now asked for.

Mains are to be laid in four streets in order to meet applications for supplies of electricity. The Finance Committee has decided that application be made for the borrowing of £15,375 in respect of extensions of mains.

Woolwich.—The Borough Council is to invite tenders for the supply of about 6,000 tons of coal for the year commencing June 25th. Of this amount 3,000 tons of washed nuts are required for the Plumstead Electricity Works, and 1,500 tons of rough coal for the Electricity Works at Woolwich.

NORWICH.—It is proposed to make some modifications in the boiler plant, &c., for which a loan of £25,000 was authorised last February, and apply to the Local Government Board for the additional £1,450 that will be required.

RAWTENSTALL.—Tenders are invited for the supply, delivery, and erection of a two-track booster, low-tension, direct-current, and high-tension alternating current switchboards. Full particulars from Messrs. Lacey, Sillar & Leigh, 2 Queen Anne's Gate, Westminster, S.W., and 78 King Street, Manchester; fee, £3 3s., returnable; and tenders to the Town Clerk by May 29th.

SALFORD.—The Electricity Committee invite tenders for the supply, delivery, and erection at the Frederick Road generating station of cooling towers, tanks, pumps, and pipe-work. Full particulars from Mr. V. A. H. McCowen, Borough Electrical Engineer (fee, £2 2s., returnable), and tenders to the Town Clerk by May 25th. (See an advertisement last week.)

SOFIA (BULGARIA).—Tenders are invited for the construction of an electric power station for the supply of light and power required by the Government coal mines at Pernik. Tenders will be received up to 3 p.m., on June 19th. A copy of the specification (in German), with drawings, may be examined by British contractors on application at the Commercial Intelligence Branch of the Board of Trade.

STOCKPORT.—The Tramways Committee invite tenders for automatic point controllers. Particulars from, and tenders to, the Borough Electrical Engineer.

TORQUAY.—The scheme for the erection of a new generating station at a cost of £16,000 has been rejected, and it has been decided to make alterations costing £5,000 or £6,000 to the existing station.

WALSALL.—A Local Government Board inquiry was held last Friday by Mr. W. O. Meade-King respecting an application for a loan of £4,000 for the electricity undertaking; £1,400 is required for new mains, services, and meters, and the remainder for new condensing plant, including oil separating plant and a cooling tower.

WORTHING.—Tenders are invited for the erection of an elevated barometric counter-current jet condensing plant, air and circulating pumps, and piping. Full particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by May 25th.

Post Office Employees and the Telephone Transfer.—The following general notice has been addressed to the Post Office staff:—"As the staff of the Post Office is aware, the staff of the National Telephone Co. will, with a few exceptions, be transferred to the Post Office on January 1st, 1912, and the Postmaster-General thinks it well to warn officers of all grades of the Post Office Service who may be promoted hereafter that, while every care will be taken to prevent hardship, their seniority may possibly be affected by officers transferred from the service of the National Telephone Co."

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TENDERS RECEIVED AND ACCEPTED

ABERDEEN.—The tender of the Brush Electrical Engineering Co. for the supply of extra high tension plant for the Dee village and Cults stations, at £2,485, has been accepted.

AUSTRALIA.—With reference to the tenders for telephone material called for by the Australian Commonwealth, of which notice was given in ELECTRICAL ENGINEERING, April 23rd, page 641, and subsequent issue, the following addition has been made to the list of materials to be supplied, viz. :—One common battery switchboard of nine sections in all, together with all associated frames, racks, power plant, and parts.

BELFAST.—The tender of Messrs. Watson, Gow & Co., of Glasgow, for 880 yards of cast-iron piping has been accepted by the tramway department.

BRIGHTON.—An order for 15.000 16-c.p. Tantalum lamps has been placed with Messrs. Siemens Bros.' Dynamo Works, Ltd., by the Corporation. These will be used for series burning in the majority of side streets in lieu of the carbon filament lamps.

CROYDON.—The Town Council has had under consideration a report by the Tramways Manager relative to the Quin cut-out system installed on the tramways. The report stated that the present cut-out switches were of a size adapted to the capacity of the feeder cables, which were laid down for a forty-car service. Now that an increased tractive effort is required, owing to heavier traffic loads and more frequent stops and starts, largely augmented by increased vehicular conditions, the amount of current passing through these switches is at times much greater than their capacity, and consequently they act far too frequently. The Tramways Manager recommended the acceptance of the quotation of the makers of the apparatus, the British Insulated and Helsby Cables, Ltd., at £16 per panel, for strengthening and reconstructing the various parts, the total cost per box being £69 (including labour and material), and £483, therefore, for the seven boxes.

DARTFORD.—The offer of the London Electron Co. for old tins, at the price of 15s. per ton, collected at the electricity works by the company's vans, has been recommended for acceptance.

FOLESHILL.—The tender of the Electric Trades Supply Co., Ltd., of Birmingham, for the electric installation at the Infectious Diseases Hospital, at £268 has been accepted.

GILLINGHAM.—The following tenders for coal have been recommended for acceptance :—The tender of John Hudson & Co., Ltd., for Class A (No. 2) Bowhill Single Nuts, at 15s. 9d. per ton. The tender of Messrs. Myers, Rose & Co., Ltd., for Class B best Derbyshire house screenings, at 10s. 10d. per ton, delivered in lighter alongside the borough wharves, subject to the contractors supplying the necessary trial quantity, and failing this, the tender of Messrs. F. K. Parker & Co., for Class B, at 15s. 6d. per ton delivered into the bunkers at the electric light works.

HORNSEY.—The Council received thirteen tenders for supplying and laying feeder cable from the works to Muswell Hill. The lowest price for the complete work was £5,651 9s. 2d., while an estimate submitted by the Borough Electrical Engineer for carrying out the work departmentally was £4.986 10s. It was decided to accept the tender of the Western Electric Co. for the supply of the cable at £3,322 18s. 4d., the Electrical Engineer to complete the work.

LONDON: *London County Council.*—The following tenders have been received for the manufacture, supply, and delivery of car-bodies, trucks, and electrical equipments for 175 electric cars :—Hurst, Nelson & Co., £72.450: United Electric Car Company, £79.275: Metropolitan Amalgamated Railway Carriage & Wagon Co., £80,500: Cravens, Ltd., £82.687 10s.: Gloucester Railway Carriage & Wagon Co., £83.825: Brush Electrical Engineering Co., £84.525; G. C. Milnes Voss and Co., £96.250. The tender of Hurst, Nelson & Co., Ltd., is recommended for acceptance.

Four tenders have been received for the electrical equipment and assembly of cars :—British Westinghouse Electric & Manufacturing Co., £55.587 10s., do., alternative tender (not to specification) £54.950; Dick, Kerr & Co., £59,062 10s.; Siemens Brothers Dynamo Works, £63.000: British Thomson-Houston Co., £64.750. The tender of the British Westinghouse Electric & Manufacturing Co. is recommended for acceptance.

Bermondsey.—The Borough Council has accepted the following tenders for annual supplies of coal to the Electricity Department by G. J. Cockerell & Co., for Bwllfa coal, 23s. per ton; Myers, Rose & Co., Ltd., for Exhall, Ansley Hall, Griff, Ibstock, and for Bugsworth, and for Kingsbury and Baddeley Beans, at 14s. per ton, subject to the coal being found on testing to be equal to Kingsbury Ryder Beans. There were 20 tenders for Welsh coal and 92 for Midland or Scotch coal.

Hammersmith.—In reference to the tenders for main switchgear for the Hammersmith undertaking, it was announced in our last issue that the tender of Switchgears, Ltd., had been provisionally accepted by the Electricity Committee at £2,014 10s. However, on the matter being further considered by the Borough Council, it was finally decided to accept the tender of Spagnoletti, Ltd., for the switchboard, &c., at £1,500, and the tender of Cowans, Ltd., at £316 for twenty feeder panels.

For the supply of iron flues, air heaters, and hot-air ducts required in connection with the plant extension scheme, the appended tenders have been received :—Mechan & Sons (provisionally accepted), £710; John Fraser & Sons, £969; Rosser & Russell, £1,050; Thames Ironworks, £1,350. For boiler mountings the tenders received were :—Hopkinson & Co. (provisionally accepted) : (*a*) two stop valves angles, £30; (*b*) two isolating valves, £31; (*c*) two safety valves with high and low water alarm, double dead weight, £58; (*d*) two superheater blow-down cocks, £5 6s.; (*e*) four water gauges, £18; (*f*) two steam gauges, £6 5s.; (*g*) four check valves, £13 4s.; (*h*) four feed-regulating valves, £11 12s.; (*i*) four blown-down cocks, £16 4s.; (*j*) total, £189 11s.; (*k*) fitting above to two boilers, £4. Dewrance & Co. : (*a*) £34; (*b*) £36; (*c*) £48 10s.; (*d*) £10 10s.; (*e*) £24 18s.; (*f*) £6 6s.; (*g*) £24 10s.; (*h*) £12 16s.; (*i*) £15; (*j*) £212 4s.; (*k*) no quotation. Templer & Ranoe : (*a*) £27; (*b*) £39 10s.; (*c*) £45; (*d*) £5; (*e*) £6 10s.; (*f*) £5; (*g*) £9; (*h*) £14; (*i*) £30 10s.; (*j*) £181 10s.; (*k*) no quotation.

The following tenders were received for the supply of free burning coal :—Spenser Whatley, Ltd. : Selston main seam small, (*a*) three months' contract, 11s. 5d.; (*b*) 12 months' contract, 11s. 5d. Kaye, Son & Co. : Pinxton nutty slack, (*a*) 12s. 4d., (*b*) 12s. 4d.; ditto, Pinxton pea nuts, (*a*) 14s. 1d., (*b*) 14s. 1d. Spenser Whatley, Ltd. : Selston main seam peas, (*a*) 15s. 2d., (*b*) 15s. 2d. Cory Bros. & Co. : Pewei Pyber unwashed, (*a*) 15s. 4d., (*b*) 14s. 10d. E. Foster & Co. : Mardy, (*a*) 15s. 9d., (*b*) 15s. 9d. Main Colliery Co. (accepted for *a*) : Graigola & Victoria, (*a*) 15s. 10d., (*b*) 15s. 10d. H. B. Pring : Primrose, (*a*) 15s. 11d., (*b*) 15s. 11d. Cory Bros. & Co. : Pentre, Rhondda Valley, (*a*) 16s 4d., (*b*) 15s. 10d. Speakman & Son : Corrwg Vale, (*a*) 16s. 6d., (*b*) 16s. 3d. Dinham, Fawcus & Co. : Dynnevor Duffryn, (*a*) 16s. 6d., (*b*) 16s. 6d. Hinchliffe & Co. : Sgwborwen, (*a*) 16s. 8d., (*b*) 16s. 9d. Lindsay, Blee & Co. : Moontown, (*a*) 16s. 11d., (*b*) 16s. 11d. T. A. King : Grovesend Longerwich, (*a*) 17s. 3d., (*b*) 17s.; ditto, Fernhill, (*a*) 17s., (*b*) 17s. Hinchliffe & Co. : Ynisfair, (*a*) 17s. 4d., (*b*) 17s. 4d. Waddell & Co. : Phœnix Glyncorrwg, (*a*) 18s., (*b*) 18s.

Poplar.—At the meeting of the Borough Council on the 14th inst. the following tenders were received for a 1,000-kw. turbine generating set, to replace a 200-kw. set in connection with the extension scheme provisionally approved by the Council on March 5th last : C. A. Parsons & Co., (*a*) alternator manufactured by General Electric Co., £6.283; (*b*) alternator manufactured by Bruce Peebles & Co. (accepted at £5.907 10s. without rotor), £6.365; (*c*) alternator manufactured by Siemens Bros., £6,420; (*d*) alternator manufactured by Electric Construction Co., £6.593; (*e*) alternator manufactured by Dick Kerr & Co., £6,648; (*f*) alternator manufactured by Parsons & Co., £6,901; Willans & Robinson, (*a*) £6.443 15s., (*b*) £6.498, (*c*) £6.525 10s., (*d*) £6,731, (*e*) £6.785; Richardsons Westgarth & Co., (*a*) £6,390, (*b*) £6,475, (*c*) £6.500, (*d*) £6,725, (*e*) £6.805. The Electricity Committee reported that Messrs. C. A. Parsons & Co., whose tender was the lowest, guaranteed the most economical plant, and they would make the spindle, bearings, and couplings of the new turbine interchangeable with existing plant. They also stated that various improvements had been effected in their governor gear since their turbines were installed at the Council's works, and the firm offered to bring the governor gear of the existing turbines up to the standard of their latest practice without extra charge. The Engineer advised that the order for the turbine should be placed with Messrs. Parsons & Co., having regard to saving in revenue, the lower capital cost, and the engine being practically a duplicate of existing plant. With regard to the alternator, the Engineer pointed out that if a Bruce Peebles alternator was accepted, a saving on capital expenditure of £457 10s. could be effected by utilising the spare rotor purchased by the Council for use in case of emergency. The installation of a third set of similar manufacture to the existing sets will diminish the necessity for retaining this rotor as a stand-by. The adoption of this proposal would reduce the tender of Messrs. Parsons & Co. to £5.907 10s. The Engineer reported that the turbine generator plant proposed would be capable of giving a continuous load of 1.330 kw., and an overload of 25 per cent. for three hours, and 50 per cent. for thirty minutes, and the price was a decided improvement on that paid for the last extension, when the contract price for the two sets was £13.521, and the capacity of each set was only 1,000 kw. continuous and overload of 20 per cent. The tender of Messrs. Parsons was accepted subject to the consent of the L.C.C. being obtained for the necessary loan. The following tenders were received for switchgear at the generating and sub-stations : A. W. Penrose and Co. : (*a*) generating station, £150, (*b*) south sub-station, £175, (*c*) new sub-station, £520; Ferranti, Ltd. : (*a*) £123 1s., (*b*) £181 9s., (*c*) £593 6s. 6d. (revised tender); Siemens Bros. : (*a*) £94 17s., (*b*) £115 10s., (*c*) £633 16s.; Johnson & Phillips : (*a*) £117 15s., (*b*) £166 15s.; (*c*) (accepted) £593 15s.; British Westinghouse Co. (accepted for *a* and *b*) : (*a*) £124 10s., (*b*) £213, (*c*) £706 6s.; Whipp and

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Bourne : (*a*) £125, (*b*) £215, (*c*) £730; Electric Construction Co. : (*a*) £155, (*b*) £194, (*c*) £750; Union Electric Co. : (*a*) £177, (*b*) £172, (*c*) £752 10s.; Cox Walkers : (*a*) £179, (*b*) £223, (*c*) £780; General Electric Co. : (*a*) £180, (*b*) £285, (*c*) £925. The engineer pointed out that the British Westinghouse Co. recently carried out similar work at Glengall Road sub-station in an entirely satisfactory manner, and as it was not desirable to complicate existing switchboards, he recommended that the company should be given the present contract for the Glengall Road and central stations. With regard to the switchgear to be provided at the new sub-station, the committee were informed that Messrs. Penrose and Co., whose tender was lowest, were not manufacturers of the plant to be supplied, and the engineer reported that Messrs. Johnson & Phillips, whose tender was next lowest, with the exception of an amended tender of Messrs. Ferranti, had carried out work of a high order for the L.C.C. The committee added that it was desirable that the converters to be provided at the new sub-station should be similar to those already installed for the council by Messrs. Bruce Peebles and Co. Some time ago the council agreed with the Western Electric Co. for them to supply all cables required for two years at a scheduled rate of prices. In accordance with this agreement orders are to be placed with the company for cable for High Street (Wade's Place) feeder and cable for extra high-tension feeder at £1,059 and £847 4s. respectively.

In connection with the extension scheme provisionally approved by the Council on March 5th last, the Electricity Committee have received tenders for the erection of a proposed new sub-station. These, together with the matter of the selection of a site for the sub-station, are the subject of negotiations, and a report is to be presented at an early date. Prices have also been received for the provision of a new boiler, and the committee have directed tests to be carried out with regard to the efficiency of certain types. The total estimated capital cost in respect of boiler, mains, and machinery, as revised on receipt of tenders, amounts to £20,793, as against the estimates for these items provisionally approved by the Council of £22,112. The applications for supply during the quarter ending April 30th totalled 34·128 kilowatts for lighting and 332·700 for power. Amongst the applications received were the following :—Rev. G. R. P. Preston, St. Michael's Church Hall, Bromley, 170 16-c.p. lamps and 1 15-amp. arc lamp; Venesta, Ltd., 242 Westferry Road, additional motors, 234·400 kilowatts; Spratts Patent, Ltd., Morris Road, 42·400 kilowatts; J. Stewart and Sons, Ltd., Blackwall, 24·000 kilowatts; United Asbestos Co., Ltd., Westferry Road, 20·000 kilowatts; Glengall Ironworks, Ltd., Glengall Road, 8·800 kilowatts.

Southwark.—The Electric Light Committee has received quotations from the following firms for the supply of cable : British Insulated & Helsby Cables, Ltd., (*a*) 1 mile 0·05, £260, (*b*) 1 mile 0·1, £404; Callenders Cable & Construction Co., (*a*) £305, (*b*) £450; Glover & Co., Ltd., (*a*) £245 10s., (*b*) £368 10s.; Henley's Telegraph Works Co., Ltd., (*a*) £253 10s., (*b*) £381; Johnson & Phillips, Ltd., (*a*) £242, (*b*) £365 10s.; Siemens Bros. & Co., Ltd., (*a*) £248 10s., (*b*) £369 15s.; Western Electric Co. (provisionally accepted), (*a*) £240, (*b*) £360.

Woolwich.—The Borough Council received the following tenders for 750 yards of three-core cable and 170 yards of four-core cable :—Western Electric Co. (accepted), £285; Callender's Cable and Construction Co., Ltd., £289 17s. 7d.; Johnson & Phillips, Ltd., £290 6s.; W. T. Glover & Co., Ltd., £295; British Insulated & Helsby Cables, Ltd., £294 13s.; Siemens Bros. & Co., Ltd., £295 2s. 6d.; W. T. Henley's Telegraph Works Co., Ltd., £298 2s. 6d.; St. Helens Cable & Rubber Co., £305.

NEWCASTLE-ON-TYNE.—The British Westinghouse Co. have received an order from the Newcastle-on-Tyne Electric Supply Co. for a 300 h.p. electric locomotive for hauling coal traffic from the North-Eastern Railway Co.'s sidings at Dunston to the bunkers at the power station.

The tender of the Tudor Battery Co. for storage batteries for the Manors tramway station, at £3,594, has been accepted.

RAWTENSTALL.—The Corporation Electricity Works (through Messrs. Yates & Thom, of Blackburn) have placed an order with Ed. Bennis & Co., Ltd., of Little Hulton, Bolton, for six stokers and self-cleaning compressed air furnaces for Lancashire boilers.

STOCKWELL.—The tender of Messrs. Fryer & Co., of Paddington, for electric lighting at the South-Western Hospital Ambulance Station, at £3,434. Twenty-two other tenders were received, varying from £3,700 to £5,995.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON.—Messrs. Siemens Bros. have recently fitted up two trains of the Underground Electric Railways Co. of London with tantalum lamps, the result being highly satisfactory.

WINDSOR.—The Windsor Town Council, at its last meeting, considered tenders for the public lighting of the borough, submitted by the Windsor Royal Gaslight Co. and the Windsor Electrical Installation Co., Ltd. The former firm quoted £1,193 15s. 6d. per year for lighting the town with gas for five years, 280 single burners (for ordinary standards), to be lighted from one hour after sunset to one hour before sunrise, and 58 triple burners (for large standards), to be lighted from one hour after sunset until midnight, when two burners would be extinguished, leaving one burner alight until one hour before sunrise. If the Corporation would wish to retain the existing arc lamps, the gas company would be willing to provide the 280 single lights for £931 per annum. The Windsor Electrical Installation Co. quoted £18 per annum per 8-ampere flame arc lamp, each of a nominal 2,400 c.p. of the type at present erected in the High Street, &c.; the lamps to be lighted one hour after sunset and extinguished at 11.30 p.m., after which time two lamps of 22 nominal c.p., each to burn until one hour before sunrise. For the side street lighting, £4 4s. per annum per twin 22 nominal c.p. lamp was quoted, and, if preferred, £2 5s. per standard per annum for a single 22 nominal c.p. lamp on each standard. As an alternative, current was offered at a flat rate of 2d. per unit, the Corporation to provide standards, lamps, renewals, and be responsible for maintenance. On these terms, using an 8-ampere flame arc lamp, the Corporation would obtain 2,400 nominal c.p. for 1d. per hour, and using "Tantalum" lamps, 275 nominal c.p. for 1d. per hour. The light would be distributed as follows :—29 arc lamps in main streets of 2,400 nominal c.p. each; 1 arc lamp of 500 nominal c.p.; one lamp of 400 nominal c.p.; and 284 pairs of glow lamps in side streets, each pair of 44 nominal c.p. The Town Council Lighting Committee recommended that on the expiration of the present lighting contract, the arc lamps in the main streets be maintained, at £558 per annum, and the lamps in the side streets be lighted by gas, at £931 per annum. After some discussion the Committee's recommendation for electric light in the main streets, and gas in the side streets, was adopted.

COMPANIES' MEETINGS AND REPORTS

AUCKLAND ELECTRIC TRAMWAYS.—The report for the year 1907 shows a total revenue of £140,452, compared with £132,365 for the previous year. The traffic receipts, which amounted to £137,718, show an increase of £7,381 over the previous year. After deducting all expenses chargeable to revenue, including £14,255 for interest on the debenture stock of the company, and providing for the rental and percentage of profits payable to the Auckland City Council, amounting to £3,567, and setting aside £10,000 to meet depreciation, there remains a surplus of £29,722. The expenses include expenditure on repairs and maintenance, amounting to £20,350, as compared with £16,915 during 1906. In addition the sum of £18,726 has been expended on renewals and charged to depreciation account. A large portion of the latter amount was in connection with the reconstruction of the track in Queen Street, which has now been completed. Including the amount brought forward from last account, there is an available balance of £32,824, and the directors recommend the allocation to reserve fund of £10,000, and dividends of 6 per cent. on the preference shares and the ordinary shares of £18,000, carrying forward £2,165. The sum of £2,658 is payable out of the profits of the past year as dividend on £50,000 six per cent. preference shares of £1 each, which were issued early in the year for the purpose of providing capital for additional plant and rolling stock. Nearly the whole of these shares were taken up in Auckland. The total capital expenditure during the year amounted to £71,398 6s., making the total amount expended on the tramways £664,390 14s., but only to a very slight extent did the increased expenditure become remunerative during the year. The directors therefore consider it prudent to reduce the dividend on the ordinary shares by 1 per cent., representing £3,000. The expenditure during the year included the acquisition of the necessary material for the Mount Eden, Mount Roskill, and Grey Lynn extensions, the construction of which is now in progress, the cost of a new generating set of 600 kilowatt capacity and two new boilers, which have been installed, and the purchase of large additions to the rolling stock. At the end of the year the company had 71 cars in stock, being an increase of 11 during the year. Since then the number has been further increased by the delivery of 10 cars shipped from this country, and the construction of six in Auckland, bringing the total number to 87. The company has joined the British Electrical Federation. The following statistics represent the state of affairs at December 31st, 1906 and 1907, respectively :—Miles open : route miles, 19·2 and 19·2; single line, 6·99 and 6·99; double line, 12·21 and 12·21. Number of passengers carried, 21,104,651 and 22,474,537; average receipts per passenger, 1·48d. and 1·47d.; average expenditure per passenger, 0·81d. and 0·88d.; proportion of expenses to receipts, 55 per cent. and 60 per cent.; number of cars in working, 60 and 71.

BUENOS AYRES GRAND NATIONAL TRAMWAYS.—An extraordinary meeting was held on Friday, when resolutions were passed authorising the creation of £200,000 additional five per cent. conversion debenture stock, and such further amount as

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might be necessary to provide for the redemption of £150,000 5½ per cent. preference debentures; providing for the variation of the trust deeds so as to make the 6 per cent. debentures redeemable at £105 per cent. in the event of voluntary liquidation for the purpose of reconstruction or amalgamation; and authorising the directors to vary the agreements with the Buenos Ayres New Tramway Company, Ltd., and other companies relating to the distribution of the receipts of the joint working of the tramway systems.

CALCUTTA ELECTRIC SUPPLY.—The report for the year 1907 shows that 5,487,885 units were sold during the year, an increase of nearly 20 per cent. over the sales for 1906. The gross revenue amounted to £103,360, compared with £89,242 in 1906. The working costs were £46,084, compared with £39,065 in the preceding year. This increase in working costs is due chiefly to the large increase in the cost of coal. The capital expenditure at December 31st last amounted to £604,348, an increase of £59,994 during the year. In order to meet the constantly increasing demand for electricity, the directors recently offered to the shareholders for subscription 20,000 5 per cent. preference shares of £5 each. These have all been subscribed and allotted. During the year the sum of £19,016 has been expended in the renewal of mains, and has been charged to the depreciation and renewals account. The directors being of opinion that the time had arrived when the company should manage its own business, they determined the agreement of the managing agents as at December 31st last. Offices have been opened at No. 8 Dalhousie Square, Calcutta, and Frank Rawson, Esq., C.M.G., has been appointed agent and manager of the company. Since the close of the financial year the number of applications from new consumers has largely increased. The new comprehensive license, referred to by the directors in their report of April 19th, 1905, was granted by the Government on July 31st, 1907, and by the terms of this license the company's statutory powers are continued until determined by purchase of the undertaking either by the Government or the local authority, which purchase can be effected on October 20th, 1918, or at any recurring period of ten years thereafter. The net profits for the year amount to £57,276, to which has to be added the balance brought forward from last year £4,230, and after deducting the interim dividend at the rate of 6½ per cent. per annum paid in November, 1907, and other items set out in the net revenue account, there remains an available surplus of £44,851. The directors recommend that a sum of £17,000 be placed out of the profits to the credit of the depreciation and renewals account, and that a final dividend at the rate of 9½ per cent. for the half year be declared and paid on the ordinary share capital, making, with the interim dividend, 8 per cent. for the year, the balance, £5,305, being carried forward. The meeting is to-morrow.

CALLENDER'S CABLE & CONSTRUCTION.—The report for the year ending December 31st, 1907, shows a balance (after providing for income tax) of £60,454. The balance carried forward at the end of 1906 was £56,722, and from this the extra remuneration voted to the directors in respect of 1906 has to be deducted, leaving £55,522, making a balance of £115,976. From this has to be deducted interest on debenture stock, dividend on preference shares, and appropriation for depreciation of buildings, plant, and machinery, £34,618, leaving £81,357. The directors recommend a dividend on the ordinary shares of ten per cent. per annum, free of income tax, together with a bonus of 5s. per share. The sum of £10,000 is placed to suspense account, and £45,107 carried forward. The directors are of opinion that this result, although not so favourable as that of the previous year, must, in view of the conditions which prevailed in 1907, be considered as highly satisfactory. Various causes have rendered the operations of the company difficult and less remunerative than in previous years. The almost prohibitive price of metals and the stringency of the money market are too well known to need more than casual reference. The most pronounced factor in restricting business in heavy mains has been the abnormal price of copper which prevailed in the first eight months of last year, leading to the temporary abandonment of nearly all new enterprise in electrical supply, and to the curtailment of extensions of existing networks in every direction. This was not confined to the home trade, as diminished orders were observed in almost every area throughout the world in which the company carries on its business. The continuing downward trend of the market offered no inducement to consumers to undertake new work or to fill up their deplenished cable stocks. The recent return of copper to its average price came after the season was at an end, and it may, therefore, be said that practically the whole of the company's business during the past year consisted of extensions which were absolutely necessary in connection with electrical supply stations already in existence. The subsequent stringency in the money market has delayed that improvement in business which might otherwise have been expected, and has caused difficulties in other directions, one large firm with which this company has had dealings for some years past having been forced into liquidation. Their business is in course of reorganisation, but, in order to provide against any possible loss, the directors have placed a sum of £10,000 to suspense account. The business in Germany has been consolidated, and the company has been registered under German laws, with its headquarters in Hamburg. Excellent results have already attended this step. In spite of the continued depression in every branch of engineering, the factories both at Erith and at Leigh are fairly well employed. The appliances at Erith and at the Anchor Works at Leigh have been thoroughly overhauled, with the result that the plant and machinery at both factories are in first-class order in every respect. A great improvement has been made in the working of the Anchor Company's business. The rubber trade has been much increased, and a satisfactory profit has been made on that company's operations. The directors refer with deep regret to the loss which the company has sustained, two of the members of the Board, Sir David Evans having died on August 14th, and Mr. W. O. Callender on March 14th last. The meeting is on the 21st inst.

DIESEL ENGINE.—The eighth ordinary general meeting was held last Thursday in London. Mr. C. C. Ellis, who presided, said that the past year was the best they had had. The net profit had been £20,721, as against £11,212 for the previous year. A 10 per cent. dividend was recommended, with £7,000 carried to reserve. A satisfactory feature was the varied sources from which they were receiving orders. Permission had been given to the Mirrlees Watson Co. to erect works for the manufacture of Diesel engines, and they had acquired £800 worth of shares in the Mirrlees Watson Co. He announced that they were negotiating with one of their other manufacturers for a new type of engine, which might for some purposes be more satisfactory than the existing engine.

EASTERN EXTENSION, AUSTRALASIA, & CHINA TELEGRAPH.—The sixty-ninth half-yearly ordinary general meeting was held last Wednesday. Sir John Wolfe Barry, who presided, stated that the gross revenue for the half-year under review amounted to £304,000, against £296,000 for the corresponding period of 1906, an increase of £8,000. In spite of general depression of trade in the Far East, the working expenses amounted to £154,000, against £139,000 for the corresponding period of 1906, showing an increase of £15,000. Of this increase, over £13,000 was due to cable repairs having been far more numerous during the past half-year than in 1906. They had also been obliged to spend £1,000 in respect of a claim for damages arising out of the loss of the anchor of the s.s. *Agincourt* when she fouled one of the company's cables in the Yang-tsze-Kiang. The net profit for the half-year amounted to £130,000, and, after adding £75,000 brought forward from the previous half-year, there remained an available balance of £205,000. The usual quarterly interim dividends of 2s. 6d. per share were paid during the past year, and it is now proposed to distribute a final dividend for the year of like amount, making a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution for the year 1907 of 7 per cent. 330 nautical miles of cable, mostly consisting of renewals, had been laid during the year at a cost of £28,848, and the new cable between Java and the Cocos Islands had been opened for traffic. The State-aided competition of the Pacific route was alluded to. The report and accounts were adopted.

EDMUNDSONS' ELECTRICITY.—At the adjourned meeting of first mortgage debenture holders held last Thursday to consider the authorisation of the creation of £200,000 prior lien 5 per cent. debenture stock, it was decided to issue £100,000, but the second £100,000 was not to be issued without the consent of a special committee of debenture holders, which was appointed at the meeting.

LISBON ELECTRIC TRAMWAYS.—Col. Sir Charles Euan-Smith presided at the tenth ordinary meeting last Thursday. In his speech, after referring to the assassination of the late King of Portugal, he stated that the figures remained practically the same as last year, in spite of several disadvantageous factors, including a poor harvest and political unrest. Regarding the general progress, he mentioned that during the last seven years they had converted a working loss of £14,000 to an annual profit of about £120,000. He also refuted some statements which had appeared in a circular from a Mr. Parrish. A five per cent. dividend on the ordinary shares was declared, and the retiring directors were re-elected.

MARCONI'S WIRELESS TELEGRAPH.—At an extraordinary meeting on Monday, a resolution providing for the increase of the capital by the creation of £250,000 seven per cent. cumulative participating preference shares at £1 each was unanimously adopted. It was stated that if the new capital was forthcoming the four transatlantic stations alluded to in the report would be completed by the end of the year.

PERTH ELECTRIC TRAMWAYS.—The report for 1907 shows gross receipts of £75,042, as compared with £78,543 for the previous year, while the net profit amounted to £31,177 against £35,261. The traffics for the year 1906 were favourably affected by an exhibition which was held at Perth. After payment of interest and sinking fund on the first and second debenture issues and trustees' fees for the year, there is a balance of £15,656, which is carried to profit allocation account. To this is added the balance brought forward from last year, viz., £790, making £14,446, from which has to be deducted £6,000, dividend paid on preference shares for the year, leaving a balance of £8,446. Out of this a sum of £1,500 has been

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expended on capital account in respect of new car barn, new machine shop, &c., and will be carried to reserve account of undivided profits as in former years. It is proposed to apportion the total sum of £8,446 as follows:—Reserve account—expended in extensions, &c., £1,500; cash reserve fund, £1,000; dividend on ordinary shares at 5 per cent., £5,000; carry forward, £946. Including the above-mentioned sum of £1,500, a total of £23,625 has been expended out of profits on capital account. The sum of £4,276 shown in the balance sheet as cash in the hands of the trustees has since been utilised in the redemption of £4,130 of first mortgage debenture stock, reducing the debenture debt accordingly. A contract has been entered into with the owners of the Nedlands Park Estate to operate a tramway now being built to connect with the company's system. The conditions of the contract are that the service be run at an agreed rate per car mile, and that the company participate in the profits of the land scheme if that proves to be a success. The Nedlands Park scheme embraces not only development of Nedlands Park as a building estate but provides for the establishment of a bathing station and jetty which it is believed will be largely taken advantage of by pleasure-seekers, and so increase the general traffics. The whole of the money required for the Nedlands Park tramway has been subscribed by prominent citizens of Perth. In order to fulfil the promise made to the shareholders, the directors have induced some of the large holders of preference shares to offer for sale a portion of their holding, with a view to increasing the number of preference shareholders, and thus enable an application for an official quotation to be made for the shares. The time allowed for payment for the shares expires on June 30th next, and immediately thereafter an application will be made to the Stock Exchange Committee for the quotation. The directors deeply regret to record the death of their colleague, Mr. R. C. Ogilvie, A.M.I.C.E., whose technical knowledge has been of great service to the company. The Engineer's report states that during the year the trams travelled 1,178,716 car miles, as against 1,167,763 car miles in 1906; and carried 7,790,934 passengers, as against £8,083,315 passengers in 1906. The earnings per car mile were 15·17d. in 1907, as against 15·97d. in 1906; while the expenses were 8·29d., as against 8·3d. in 1906. The expenses per cent. of earnings in 1907 were 54·7 per cent., as against 51·94 per cent. in 1906. The receipts show a decrease as compared with last year. This is due to a slight depression that has been, and is, prevailing in Perth. The meeting is to-morrow.

SOUTH STAFFORDSHIRE TRAMWAYS.—The tenth ordinary general meeting was held last Thursday under the chairmanship of Sir Ernest Spencer, when the report and accounts referred to in our last issue were adopted. The chairman referred to the improvement in the receipts, and anticipated a further increase during the present year. The final portion of the reconstructed tramways was opened in October last.

WEST AFRICAN TELEGRAPH.—The annual report states that the receipts have declined from £66,100 in the previous year to £59,200, and that the expenses have risen from £24,700 to £25,800; the dividend remains at 4 per cent., but a smaller amount is carried to reserve. The falling-off is attributable partly to diminution of Stock Exchange business in connection with West African mines.

WESTERN TELEGRAPH.—At the meeting on Wednesday last week, the report and accounts given in our last issue were adopted. Sir John Wolfe Barry, F.R.S., K.C.B., who presided, stated that whereas the receipts increased during the year by about £2,500, the total expenses decreased by £1,232. On the question of wireless telegraphy, the chairman stated that nothing had occurred to induce him to alter or modify his views as expressed on previous occasions.

Automatic Sewage Pumping Stations.—The town of Dayton, Ohio, is situated on a river which in the early spring frequently rises to a high level. At such times it is necessary to close the sewer-gates at the outfalls to prevent the river rising up into the streets and houses. The sewage is then raised and discharged above the flood-level. For this purpose three pumping stations have been constructed. According to the *Western Electrician* (Chicago), the first is equipped with two vertical Brooks submerged centrifugal pumps capable of pumping 2,500 gallons per hour, and each coupled to a three-phase 20 h.p. motor. The motors are started and stopped by oil-switch compensators, which are operated by hydraulic pistons controlled by float switches. The lift averages about 20 ft. The operation of these pumps is entirely automatic, it being only necessary to inspect them occasionally and keep the oil receptacles filled. The second station has three units, and the third station two, each consisting of a 4,500-gallon centrifugal pump coupled to a 40 h.p. three-phase motor. The operation of the plant has proved entirely satisfactory, the motors starting and stopping automatically with the rise or fall of the sewage in the pits with great regularity and smoothness. During a heavy rain recently one pump in the third station did all the work for that district, running about three minutes with idle intervals of about seven minutes. The power is taken from a public supply main at 2,000-volt 60 cycles. Upon notice of a rise in the river, the gates are closed and the current turned on to the stations.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire-bars, net c.i.f. port of arrival, quoted on Tuesday night, was £60 to £60 10s. per ton (last week £58 5s. to £58 15s. per ton).

MESSRS. ROGER DAWSON, LTD.—This firm of electrical engineers have taken extensive new showrooms in Berners Street, adjoining Oxford Street, W., which will be opened when the buildings are completed.

THE SCHORCH ELECTRICAL CO.—We are informed that Messrs. Max Scorch & Co., Ltd., Rheydt, have opened a branch which is carried on in the name of The Schorch Electrical Co., 35 Basinghall Street, London, E.C., Mr. Walter R. Rothenberg having been appointed as general manager for the business in England and Colonies.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—A. W. Bennett, electrical engineer, of Leeds, lately carrying on business under the style of Bennett & Co., has been adjudicated bankrupt. The first meeting is to be held at the Official Receiver's office, Leeds, on May 25th, and the public examination will be held on June 16th at the County Court House.

Meldrum Brothers, Ltd., patent furnace manufacturers, of Timperley, near Manchester, is to be wound up voluntarily. Mr. T. Gregory, of Manchester, is appointed liquidator.

A petition has been presented for the winding up of the Helis Cell & Accumulator Co.

The Gardner Electric Drill & Hammer Co. is to be wound up voluntarily.

Messrs. Stephen Sellon and E. M. Sellon, carrying on business as Stephen Sellon and Partners, consulting engineers, 36 Victoria Street, have dissolved partnership. Debts by Stephen Sellon, who continues under the present title.

MISCELLANEOUS CITY NOTES

ROSARIO ELECTRIC CO.—A prospectus has been published relating to a new issue of 5,000 six per cent. cumulative second preference shares of £5 each.

WALSALL ELECTRICAL CO.—Notice has been given of a petition for confirming the resolution of the company to reduce its capital from £25,000 to £20,620.

APPOINTMENTS AND PERSONAL NOTES

Applications to the number of 190 were received for the position of canvasser in the Fulham Electricity Department, and the Electricity and Lighting Committee has decided that the appointment be given to Mr. S. A. Lovick (Hither Green), who is at present employed as canvasser in the Electricity Department of the Stoke Newington Borough Council, and who has held several similar positions under other local authorities and electric supply companies.

NEW COMPANIES

ELECTRIC CONTROL.—This company was registered in Edinburgh on April 30th, with a capital of £6,000 in £1 shares, to carry on the business of electrical and mechanical engineers, and manufacturers of, and dealers in, appliances and apparatus for the generation, supply, and control of electrical power, including electric motors and breaks, &c. The subscribers are:—J. R. S. Maxwell, C. Macmillan, J. Craig, Mrs. R. Scott, Miss L. Scott, Miss R. M. Scott, H. M. Macmillan. The number of directors is not to be less than two nor more than six; the first are:—J. M. S. Maxwell, C. Macmillan, and J. Craig. Qualification, 100 shares. Remuneration as fixed by the company. Registered office, 177 Reid Street, Bridgton, Glasgow.

GLASS TELEGRAPH POLES.—H.M. Representative at Darmstadt (Mr. F. D. Harford) reports that a company has been formed at Cassel for the purpose of manufacturing glass telegraph poles. The capital is to be £90,000, which is said to be sufficient for an annual output of 60,000 poles. The patent rights cost £15,000, with a royalty of 2s. per post sold. It is stated by the company that poles of 28 ft. in length can be manufactured at a cost of 15s. (including the royalty). An experimental line of glass telegraph poles, with eleven wires, on a much frequented public highway stood the test most satisfactorily, and it is pointed out that such poles do not rot like wooden ones, nor rust and need painting like iron ones. It is further stated that broken or damaged poles can be repaired satisfactorily. Particulars of the construction, also dimensions and weights of these poles, were given in ELECTRICAL ENGINEERING, Vol. II., pp. 900 and 978.

GREYSTONES ELECTRIC LIGHT & POWER.—This company was registered in Dublin on May 8th, with a capital of £3,500 in £1 shares, to carry on the business of electrical engineers, electricians, practical engineers, contractors, &c. The subscribers are:—C. L. Matheson, A. Macaulay Fitzgibbon, A. M. Archer, A. L. Figgis, F. Batchelor, E. S. Dashwood, R. N. Tweedy. The number of directors is not to be less than three nor more than seven; the first are C. L. Matheson, H. M.

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Fitzgibbon, A. L. Figgis, F. Batchelor, A. M. Archer, E. S. Dashwood, and R. N. Tweedy. Qualification, 100 shares. Remuneration as fixed by the company. Registered office, 5 Leinster Street, Dublin.

LANGBEIN-PFANHAUSER WORKS.—This company was registered on April 25th, with a capital of £3,000 in £50 shares, to carry on in the United Kingdom and the Colonies the business of electro-metallurgists, electro-platers, electrotypers, manufacturers of and dealers in dynamo machines, electric motors, switches, and other electrical apparatus and instruments, makers, grinding and polishing machines, chemicals and electrolytic solutions, &c. The subscribers are :—W. Pfanhauser, Dr. G. Langbein, Dr. W. Pfanhauser, Dr. R. Jay, Dr. H. Kissel, O. Pfanhauser, Dr. W. Wurker. No initial public issue. The number of directors is not to be less than two nor more than three; the first are Dr. R. Jay and Dr. H. Kissell. If Dr. R. Jay ceases to be a director, the Langbein-Pfanhauser Werke Actien Gesellschaft may, so long as they are shareholders, appoint one of their own directors to fill the vacancy. Qualification (except Dr. R. Jay and such nominee), £100. Remuneration as fixed by the company.

RICHARD PAPE.—This company was registered on May 8th, with a capital of £10,000 in £1 shares, to acquire the benefit of a contract relating to an electric storage battery known as the "Fors Accumulator," together with the business of manufacturing and selling the same, carried on at 110 Strand, W.C., and Dyott Street, Oxford Street, W., to adopt an agreement with R. Pape, and to carry on the business of electrical engineers, manufacturers of, and dealers in, accumulators, storage batteries, and electrical appliances of all kinds, &c. The subscribers are :—F. J. Wood, R. Pape, W. Simpson, Miss E. M. Smith, F. Pape, T. E. Ind, G. W. Watson. No initial public issue. Table "A" mainly applies.

Tramway Strike in America.—On Friday last, over two thousand employees on the tramway system of Cleveland, Ohio, struck for higher pay. The lines have only recently been taken over by the city from private ownership. Nearly a thousand men were obtained to fill the places of the strikers and the trams were run. Several riots took place, and strikers, passengers, and police were injured.

Kent Collieries Electrical Plant.—The hearing of the case between Messrs. E. Scott & Mountain, Ltd., and the Kent Collieries Co. was resumed on Wednesday, May 6th, before Mr. Muir Mackenzie, in the Official Referee's Court, and continued on the following days. A report of the proceedings of the previous days was given on page 684 of our issue of May 7th. The following is a *résumé* of the proceedings of the last few days :—On the conclusion of the opening address for the defence, Mr. Lancaster, a director of the Kent Collieries Co., was examined by Mr. Bousfield. He stated that, previous to the breakdown, it was never suggested that more than one pump would be necessary. The water was erosive in character, and contained mineral salts, but this should not have caused breakdown. Mr. W. Thomas gave evidence to show that the tackle supplied by the defendant company was sufficient for raising and lowering the pumps. Mr. H. M. Sayers, consulting engineer to the defendant company, said that in his opinion the motors supplied were not capable of carrying the full guaranteed load. The temperatures had risen to nearly twice the usual limit. He attributed the breakdown to faulty construction and overheating. The defects in motors Nos. 1 and 2 had been overcome in motor No. 3. The pumps were now not in a state efficient enough to admit of a test being made. It was uncertain whether the breakdown of pump motors Nos. 2 and 4 was due to moisture previously in the coils or moisture drawn in from outside. With regard to the 10,000-volt test, this had been made between coil and iron only; the insulation between turns had not been tested. The presence of copper salts on the wires led him to believe that the coils had never been properly dried. With the exception of motor No. 3, the motors had not sufficient cooling surface to dissipate the heat generated. Mr. W. M. Mordey, who had tested the generating plant and one of the pumps for the defendant company, gave full particulars of the manner in which the tests were carried out. He said that whereas the specified steam consumption was 28 lb. of steam per kilowatt hour, the results of a six-hour test gave a steam consumption of 44 lb. per kw. hour on an average load of 250 kw. (the rated load). It was impossible to get the 25 per cent. overload mentioned in the specification, even with a slightly increased steam pressure. Thus, with a pressure of 108 lb. per sq. in., the maximum load obtainable was 256 kw. The maximum temperature rise of the generator was 90° Fahr. After 5½ hours' run the pump motor was too hot to run safely, and the temperature was still rising rapidly. The mean internal temperature was about 212° Fahr., and in his opinion no insulating material would stand that for long. He did not believe in asbestos insulation, as inflammable materials were used in the composition. The tests made by the plaintiffs were, he said, inaccurate and useless. In his opinion the machines were clearly overloaded, and were also not in accordance with the specifications.

PARLIAMENTARY INTELLIGENCE

LONDON POWER BILLS.—A full report of the Proceedings in Committee will be found on pp. 762 and 785-786.

DONCASTER CORPORATION BILL.—This Bill, which has been before the Police and Sanitary Committee in the House of Commons during the week, proposes by Part 3 the borrowing of £9,000, repayable in 40 years, for the construction of new tramways, the period for the construction of which is five years. There was no opposition to this part of the Bill. It was reported for third reading.

ELECTRIC LIGHTING PROVISIONAL ORDER CONFIRMATION BILL, No. 3.—This Bill, which has just passed the examiners in the House of Commons, confirms Electric Lighting Provisional Orders granted by the Board of Trade under the Electric Lighting Acts, to the Brigend Urban District Council (extension), Hendon (Messrs. Crompton & Co., amendment), Llandaff and Dinas Powis Rural District Council (amendment), Llansamlet Rural District Council, Oulton Broad Urban District Council, Sowerby Bridge Urban District Council (amendment), and Tewkesbury Corporation (amendment).

LONDON UNITED TRAMWAYS.—The Court of Referees on Wednesday last week granted the promoters of the West London, Barnes, and Richmond Tramways Bill a *locus* against the London United Tramways Bill.

METROPOLITAN DISTRICT RAILWAY.—All opposition to this Bill has now been withdrawn, and it has been referred to the Unopposed Committee.

NORTH-EAST RAILWAY.—This Bill was before the Unopposed Committee of the House of Commons on Thursday, and was ordered to be reported for third reading. It proposes an extension of time in respect of the construction of the railway authorised in 1906.

NOTTINGHAMSHIRE & DERBYSHIRE TRAMWAYS.—The Nottingham and Derbyshire Tramways Co. have introduced a late Bill which proposes to transfer to the Nottingham Corporation certain of the tramways for which powers are held by the company, and also includes powers for the construction of additional tramways by the company. The Bill came before the examiners in the House of Commons last week, and was ordered to be reported to the Standing Orders Committee owing to the Standing Orders not having been complied with in consequence of the Bill having been deposited later than the statutory time.

PROGRESS OF ELECTRICAL BILLS.—Electric Lighting Provisional Order Confirmation Bill, No. 1, was read a third time in the House of Commons last week.

The Motherwell Borough (Extension) Bill, the Wishaw Electricity Bill, and the Tramways Order Confirmation Bill, No. 2, were read a second time in the House of Lords on Thursday.

Electric Lighting Provisional Order Confirmation Bill, No. 2, was read a second time in the House of Commons on Monday.

The West London, Barnes, and Richmond Tramways Bill was read a second time in the House of Lords on Monday.

OFFICIAL ANNOUNCEMENTS AND SMALL ADVERTISEMENTS.

Official Advertisements are charged at the rate of 1/- per line (column width). Small Prepaid Advertisements of Situations Vacant and Wanted, Plant for Sale or Wanted, &c., are inserted at the rate of 1/- for the first 12 words and 3d per word afterwards. Three insertions for the price of two. Advertisements can be received up til Wednesday morning first post.

Letters should be addressed to THE KILOWATT PUBLISHING CO., LTD., 203-6, Temple Chambers, London, E.C.

TENDERS INVITED.

ILFORD URBAN DISTRICT COUNCIL.

ELECTRICITY DEPARTMENT.

THE ILFORD URBAN DISTRICT COUNCIL invite tenders for the Supply and Erection of the following Plant, and are prepared to accept Tenders subject to the Local Government Board's sanction being obtained to the necessary loan :

Contract A6. Surface Condensing Plant and Cooling Tower.
Contract A7. Steam and Feed Pipes, Boiler Feed Pump, etc.
Contract A8. Extensions and Alterations to Main Switchboard.

Copies of the Specifications, including General Conditions, Forms of Tender, &c., may be obtained on and after Monday, 25th May, 1908, on depositing a cheque for One Guinea for each Contract, with the undersigned, which sum will be refunded to *bona fide* Tenderers after the Tenders have been adjudicated on.

Extra copies of the Specification may be obtained by *bona fide* Tenderers at a charge of Ten Shillings per copy, which sum will not be refunded.

Any further information may be obtained at the Offices of Mr. Arthur Shaw, M.I.E.E., A.M.I.Mech.E., Electrical Engineer to the Council, at the Electricity Works, Ley Street, Ilford.

Tenders, sealed and marked "Tender for Contract A-, Electricity Works," to be addressed to the Chairman of the Urban District Council, Town Hall, Ilford, and to be delivered on or before 12 o'clock noon on Wednesday, the 10th June, 1908.

The Council do not bind themselves to accept the lowest or any Tender.

Town Hall, Ilford,
May, 14th, 1908.

JOHN W. BENTON.
Clerk to the Council.

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ELECTRICAL ENGINEERING

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SUMMARY

A correspondent draws our attention to the difference between the prices for ordinary cable quoted by firms belonging to the Cable Makers' Association and their foreign competitors. In the case of 3/20 V.R. cable of the 600-megohm class, for instance, the C.M.A. price is £23 8s. per mile, and the price of a foreign firm £11 17s. per mile. In 19/16 cable the difference is in about the same ratio.—We have also received a communication from Mr. E. Raymond-Barker on the relative speeds of telegraphic transmission by "wireless" methods and submarine cables. (Page 802.)

A surface-box explosion occurred in the mains of the St. James and Pall Mall Electric Co. on Saturday morning in Pall Mall, near Marlborough House. (Page 802.)

Some tests were carried out on Tuesday last on a new type of leadless insulated cable, in which the insulation consists of paper impregnated with a compound known as "Liconite." Cables in which the insulation consisted purely of this compound pressed on to the conducting core were also tested. Although the cables had been immersed for some days in water, the $\frac{3}{8}$ in. thickness of insulation withstood pressures up to 70,000 volts. Bending tests were also carried out. (Page 803.)

The Dublin and Central Ireland Electric Power Bill, which was rejected by a Committee of the House of Commons last month, was recommitted to the Committee after a short discussion in the House of Commons last week. The reason for this is that the promoters have agreed to cut out of the area the City of Dublin and the Urban Districts of Rathmines, Rathgar, and Pembroke. The name of the Bill has been altered to the Central Ireland Electric Power Bill and the capital reduced from £450,000 to £150,000. The promoters have admitted that their financial evidence on the last occasion was not strong enough, and have amended their case considerably in this respect. (Page 803.)

In evidence given by Sir Clifton Robinson before a House of Commons Committee last week, it was stated that the London United Tramways, Ltd., had been obliged to pay enormous sums for the local authorities' consents in some cases. He said that no less than £1,119,296, or over £20,000 per mile, had been paid at various times, irrespective of the cost of the construction and equipment of the lines. The particular case in point was the obtaining of wayleaves for passing over Kew Bridge. The Middlesex and Surrey County Councils demanded £1,000 each,

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and the Committee finally fixed the sum at £500 each. (Page 804.)

AT the Institution of Electrical Engineers last Thursday Mr. HUGO HIRST read a Paper on tungsten lamps, with particular reference to the osram lamp. The Paper included references to some of the more important patents, and described briefly the method of manufacture employed for the osram and "Just-Wolfram" lamp. Useful figures of life and efficiency were given, together with tables and curves. Quantitative data were also given as to the losses in the small transformers for use with 25-volt metallic filament lamps. Contrary to expectation, the discussion was hurried through so as to be completed the same evening, as a meeting for the adjourned discussion had not been arranged. Mr. HAYDN HARRISON said that incandescent gas mantles dropped 20 per cent. in candle-power after 100 hours' burning, and 40 to 50 per cent. after 500 hours, whereas tungsten lamps fell only 10 per cent. in candle-power after 1,000 hours. He also pointed out that enclosed arcs took nearer 2 than 1 watt per candle, and were, therefore, less economical than osram lamps and that street lighting with osram lamps might even be cheaper than with open arc lamps, if the cost of carboning was taken into account. Mr. B. DRAKE mentioned the breakage trouble, to which he said tantalum lamps were less subject. Dr. LOUIS BELL said that the shorter life of the tantalum lamp on alternating-current circuits was due to the frequency of heating and cooling; he had found that the life shortened at frequencies of 60 cycles and upwards, and that at 5 or 10 cycles per second it was very short. Generally, he said the life of tantalum lamps on A.C. circuits was two-thirds that on D.C. circuits. In America, tungsten lamps are largely replacing enclosed arcs. The standard sizes there are now 100, 60, and 40 watt. Mr. HANDCOCK pointed to the higher ratio of the mean horizontal to the mean spherical candle-power in the case of metal filament lamps, and thought that comparisons on the basis of horizontal candle-power were, therefore, rather unfair to the carbon lamps in which the ratio was less. Mr. A. CAMPBELL SWINTON questioned the assumption of the existence of selective emissivity. Mr. C. C. PATERSON said he did not see why the new lamps should not be standardised in candle-power instead of in watts. His experience of the gas mantle differed from that of Mr. Harrison; he found that the candle-power rose largely during the first 100 hours or so and then dropped. Nor did he attach importance to the difference between the ratios of mean horizontal and mean spherical candle-power in the carbon and metal filament lamps. It amounted to no more than 5 or 6 per cent.; the reduction factor was 0·85 or 0·86 on the one hand as against 0·7 to 0·8 on the other. Mr. T. H. LOWDEN said that the British Westinghouse Co. were now selling a 220-volt 32-c.p. lamp. Mr. WORDINGHAM deprecated the suggestions made in Messrs. Handcock & Dykes' Paper that the price of electrical energy should be raised. Mr. GASTER, Mr. J. S. RAWORTH, and the President (Col. CROMPTON) also spoke, and Mr. HIRST replied to several of the points that had been raised. (Page 805.)

THE annual report of the Stepney Electricity Department records a further diminution of working costs, which now amount to 0·93d. per unit, a figure which is brought up to 1·58d. by the inclusion of all capital charges. (Page 813.)

AN article on the Birmingham electrical fittings industry describes several interesting and artistic designs, and also includes a brief reference to the adoption of the "looping-in" system by the Admiralty. (Page 815.)

A LOCOMOTIVE caught fire in the Clapham Common station of the City and South London Railway during the small hours of Sunday morning, and some difficulty was found in obtaining access to the platform to extinguish it. The cause of the fire was not "electrical." (Page 818.)

CONSIDERABLE progress has been made with the arrangements for the Manchester Electrical Exhibition which is to be held in October. One of the features of the exhibition is to be a series of exhibits illustrating the applications of electric-power in the textile industries. We are able to publish the rules for the wiring of the stands in full. A three-phase alternating supply at 400 volts 50 cycles will be available, as well as continuous current at 200 volts for lighting and at 400 volts for power. The charge to exhibitors will be 2d. per unit for lighting and 1d. per unit for power. (Page 819.)

Under ELECTRICAL SCIENCE in the British and American Section are given the results of some experiments by T. MATHER and F. E. SMITH, comparing the Board of Trade and the National Physical Laboratory ampere-standards. A Paper read before the Royal Meteorological Society relates to the colour of lightning. An account of a new method of generating low-power alternating currents of frequencies suitable for telephonic measurements, and a note on the heat developed in thoria by its own radioactivity are also given. In the Continental Section a Paper by FÉRY, describing an improved electric pendulum, and another by SMIRNOW, in which he brings forward some general rules governing atmospheric ionisations, are abstracted. (Page 821.)

In general the use of electricity when it is employed for heating purposes in chemical processes is due to the ease with which very high temperatures can be obtained. Mr. F. T. SNYDER, however, employs it for the distillation of turpentine, not because a high temperature is required, but because it is important to regulate the temperature and not to allow it to rise much above 200° C. The process is described under ELECTROCHEMISTRY AND ELECTROMETALLURGY. A Paper on some attempts which have been made to synthesise hydrocyanic acid directly, by electrically heating carbon rods in an atmoshere of hydrogen and nitrogen, is abstracted. If such a process could be carried out cheaply, it would probably revolutionise the cyanide industry. A note on the production of aluminium shows how the output of this metal has increased during the last ten years. (Page 822.)

AMONG the patent specifications published on Thursday last is one by the FELTEN & GUILLEAUME-LAHMEYERWERKE AKT.-GES. relating to a method of signalling or selectively operating apparatus at a distance by means of electric currents of various frequencies. An improved tramway track brake is described in a specification by J. F. SIMPSON. A specification by S. O. COWPER-COLES gives particulars of an electrolyte for the electro-deposition of iron, and another by P. B. & T. H. BLACK relates to contact boxes for surface-contact systems of electric traction. The elastic support of metallic filaments is dealt with in a specification by T. S. LOWDEN and the WESTINGHOUSE METAL FILAMENT LAMP CO., and an improved winding for the commutating poles of continuous-current turbo-generators is the subject of a patent by W. PARKER and the SIEMENS BROS.' DYNAMO WORKS CO. (Page 823.)

As announced in our last issue, financial evidence in connection with the London and District Electric Power Bill was given on Wednesday last week, when Sir Hugh Bell guaranteed to be responsible for the

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raising of £250,000, and stated that he was authorised on behalf of Lord Fitzwilliam to state that he would also be responsible for a very substantial sum. On Friday, Sir Hugh Bell stated that Sir Edward Tennant had authorised him to say that he also would be responsible for capital to the extent of £100,000. In the cross-examination of the financial witnesses on the purchase clause, the London County Council indicated that it desired the terms of the Electric Lighting Act of 1888 instead of the repayment of the total capital expenditure as proposed by the promoters. Evidence from railway companies and power users in various parts of the area were called on Wednesday and Thursday, and on Friday an early adjournment was made in order that the promoters might confer with the London County Council with a view to coming to an agreement over the purchase clause. On Monday Mr. L. Maltby, a member of the firm of Messrs. Deloitte, Pender, Griffiths & Co., was called in support of the purchase clause, but serious cross-examination was postponed pending the result of the conference with the London County Council. The case for the opposition was opened on Monday, and continued over Tuesday and yesterday. The evidence from West Ham was to the effect that there were several power users of over 250 kw. in that district, and that power could be supplied at lower prices than those in the Bill. (Page 825.)

THE sale of the Bath electricity undertaking from the Corporation to a syndicate which already holds powers in the surrounding district has now been definitely decided upon. The loss on the undertaking has, however, been much reduced during the past year.—There has been considerable discussion as to the revision of tariff at Marylebone, but no alteration is to be made at present.—It is stated that negotiations are in progress for the acquisition of the Brighton Corporation Tramways by a syndicate.—The annual report shows that the power load at Burton-on-Trent now exceeds the lighting load. In spite of a rise in the cost of fuel of 33·7 per cent, an increased profit is shown. It is proposed to fit Mr. PRINGLE'S new tramcar brake to six of the cars.—Telegrams are now accepted for wireless transmission to the Channel Islands.—The Paddington Borough Council has agreed to support the Metropolitan Electric Tramways Bill for tramway extensions along Harrow Road, subject to certain conditions. (Pages 831–833.)

THE London County Council has accepted a tender of Messrs. Heenan & Froude for tramway trucks. The lowest tender, that of the Brush Co., was rejected owing to questions regarding the general conditions. In consequence of troubles experienced previously with deliveries from foreign firms, the tender of Messrs. Bolckow, Vaughan & Co. for British steel rails has been preferred to lower tenders for Continental rails. (Page 834.)

THE annual report of the American General Electric Co. records a substantial increase of business for the whole year, notwithstanding a serious falling off of orders during the last few months.—Meetings have been held during the week of several companies whose reports were given in our last issue, including Callender's Cable and Construction Co. Although this company is paying a dividend of 10 per cent. and a bonus of 5s. per share, the results are not as good as previous years, mainly owing to the variations in the price of copper and the stringency of the money market. (Page 835.)

SOME new electric drills and grinders, automatic motor-starting switches, and electric light fittings are described on pages 837 and 839.

MR. HUGO HIRST'S Paper on the osram lamp, read at the Institution of Electrical Engineers last Thursday, was an excellent *résumé* of what had been done in the manufacture of a lamp that has attained so rapid a popularity, but the discussion which followed it was to some extent a disappointment. From notes of life observations that have appeared in our columns during the last few weeks, it is evident that a large number of station engineers have these and other metal filament lamps in use and are carefully watching them, but practically no new data were given by disinterested parties. Enough has already been published, however, to show that the 100-volt metal filament lamp is a success, and that it has attained its present position during the last two or three years with a rapidity exceeding all anticipations. We have lamps of about 30 British candle-power taking $1\frac{1}{4}$ watts per candle with a life of over 1,500 hours, and lamps of 16 c.p. taking about 1·7 watts per candle, as good and reliable as the carbon filament lamps which consume some $3\frac{1}{2}$ watts per candle for a similar life. Two hundred volt metal filament lamps still present many difficulties in manufacture, however, but we are convinced that it is only a question of time before these will be overcome. The tungsten filament of the osram lamp has a diameter of only about one thousandth of an inch, and the specific resistance of the metal is so low compared with that of a carbon lamp that a 100-volt lamp must have a filament about three times the length. To produce a metal filament lamp for 200 volts, therefore, a very long filament is necessary, unless a metal with a higher specific resistance can be employed, or unless the diameter of the filament can be reduced still further, and a long filament means a high candle power. Although Mr. HIRST is not sanguine as to any great improvement in this direction at an early date, there are many workers in the field, and, in fact, one speaker in the discussion spoke of a 220-volt 32-c.p. lamp being already on the market. No sample of this lamp has yet reached us, and no announcement, so far as we know, has been made as to its reliability or its price, but, still, we feel confident that the workers at the problem are by no means disheartened, and that the minimum candle-power obtainable for a 200-volt metal filament lamp with high efficiency and reasonable life will be gradually reduced. The carbon filament lamp has already become practically a lamp employed in special circumstances only, and its use, except in small rooms, is rapidly diminishing.

THE attention of all members of the Cable Makers' Association, and also of those contractors who desire that good work should be put in and good prices paid for it, is called to a letter which we have received from a correspondent this week on the relative prices of C.M.A. and foreign cable. In two particular cases cited the price of a well-known foreign firm is almost exactly half that of the price charged by the Association firms for what is nominally the same class of cable—that known in the trade as 600-megohm. Our correspondent belongs to a well-known firm of wiring contractors who are in a position to obtain the lowest prices for material of this class, and his figures are very significant and call for explanation from cable makers. We understand, also, that the foreign firm

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in question is one of the largest Continental houses. If the cable makers in this country are keeping up their price unduly, they should be warned that this must in the long run be against their interests. On the other hand, if cable of an inferior quality is sold as of a higher grade than it really belongs to, some action should be taken to prevent it. The designation vulcanised rubber cable of the "600-megohm" class is perhaps a loose one, but it has generally been accepted by the trade in this country to imply a definite quality of high-grade vulcanised india-rubber insulation which gives an insulation resistance of at least 600 megohms per mile in the larger sizes and a correspondingly higher insulation in the smaller sizes.

URBAIN's announcement, to which we referred last week, that a metal has been found whose oxide is 12·8 times as magnetic as the corresponding iron oxide, will have been read with interest by electrical engineers bent upon reducing the weight and volume of their electrical machinery. The metal in question is dysprosium, discovered spectroscopically by Lecoq de Boisbaudran in 1886, and isolated by Urbain two years ago. Its separate identity has long been questioned, but may now be taken as completely established, since Urbain has clearly identified no less than 30 spectrum lines of the metal in the ultra-violet, and has obtained 50 grammes of it wherewith to experiment. Its atomic weight is 162·5, which places it among the rare earths between terbium and holmium. What URBAIN does not state, but what interests us particularly, is whether he has examined the magnetic properties of dysprosium in the metallic state. These should be of a somewhat remarkable character, if the promise made by the oxide is carried out. Dysprosium is obtained from a mineral called terbine. It also occurs in cerite and other such rare earth minerals. If there should be a demand for it, it should not be very difficult to discover a commercial method of producing it. At present its isolation is an exceedingly lengthy and tedious process. It is not encouraging to be told that it takes 20 fractionisations to remove its near congeners, such as holmium, and these operations take from 18 months to two years. It has been suspected for some time that other rare earths, such as erbium, are highly magnetic also. Perhaps some one among these may turn out to be the stuff we are waiting for, but for the present iron and steel are evidently not about to be displaced in dynamo and transformer manufacture.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, MAY 28TH.

Institution of Electrical Engineers.

12.30 p.m. Annual General Meeting at 92 Victoria Street, Westminster, London, S.W.

Institution of Civil Engineers.

8.30 to 11 p.m. Conversazione at the Royal Albert Hall.

Subways for Electric Cables.—According to a British Consular Report, the city of Baltimore, U.S.A., has constructed 95 miles of subways in the city, in which all lighting, power, and telegraph cables owned by companies must be placed. In some places the subways contain as many as 48 ducts. The total cost of the subways was £360,000, and after deducting from the rentals the interest on the loans and the working expenses there was a profit to the city in 1907 of £2,966. The electric lighting of the city is entirely in the hands of the Consolidated Gas, Electric Light, & Power Co. of Baltimore, which company has recently made a contract with the McCalls Ferry Power Co. for the supply of electrical energy from the large water-power station which is being built on the Susquehanna River.

CORRESPONDENCE

THE PRICE OF CABLE.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—The wide differences between the figures of a successful tenderer and those of his highest competitor, which frequently occur, are often a matter for comment in the electrical Press and elsewhere. There are many reasons for these differences, some of them perhaps hardly legitimate, but the object of this letter is to point out that cables vary in price to a degree which ought to be more publicly known, and that any consulting engineer who frames his specifications in such a way as to permit the use of either foreign or "non-association" cables, practically invites just such differences in his clients' lists of tenders.

The present C.M.A. prices compared with the current prices of a well-known foreign firm, compare as follows:—

600-Megohm Cable.

PRICES PER MILE.

	C.M.A.	Foreign.
3/20	£23 8s. 2d.	£11 17s. 6d.
19/16	£196 17s. 8d.	£107 2s. 0d.

In a contract, therefore, where the cost of the wire forms a large proportion of the total, there is room for a very wide difference in the amounts of the tenders, and those contractors who stick conscientiously to C.M.A. cable are pretty sure to be hopelessly undercut. I have just completed a Bill of Quantities for a large building in which the wire and cable amount to 36 per cent. of the whole cost: the use of foreign cable in this case would give the competing firm an advantage of nearly 18 per cent.

A remedy for this state of things is not obvious; perhaps you, Sir, or one of your contributors, may suggest one, but I would suggest that much may be done by more care in specification.

I am,

6 Dudley Road, Wimbledon. Yours faithfully,
May 26th, 1908. H. ELLIS THOMPSON.

"Wireless" and Cable Speeds.—Mr. E. Raymond-Barker sends us, just as we are going to press, a cutting from the *Morning Post* of Wednesday, May 20th, in which a passage occurs comparing wireless telegraphy speeds with speeds on submarine cables, together with a copy of a letter correcting certain statements in this article, which the editor of our contemporary has refused to insert. The statement to which Mr. Raymond-Barker takes particular exception is attributed in the article to Mr. Marconi, and is to the effect that greater speed has been attained in wireless telegraphy than can be reached even by expert operators on transatlantic cables. Mr. Raymond-Barker rightly points out that a comparison of hand speeds has nothing to do with the matter, as mechanical or automatic signalling is employed every day on transatlantic cables, and he cites speeds of 45 and 50 words per minute having been obtained on transatlantic cables, even more than 13 years ago. Such cables could be worked at nearly 100 words per minute duplex. Mr. Marconi was apparently comparing hand speeds; and, however he may have been reported, we cannot think he meant to imply that the maximum speed of wireless working is greater than the maximum speed of submarine working, for he is, of course, well acquainted with the facts of the matter.

Surface Box Explosion in Pall Mall.—At eight o'clock on Saturday morning an explosion occurred in two surface boxes in Pall Mall, in close proximity to Marlborough House, on the opposite side of the street. As usual, the Fire Brigade was summoned, but only sand and not water was directed on the cables. The Fire Brigade's report is that a "defective electric circuit" was the cause of the explosion, and it appears probable that gas in the box was ignited by a short circuit, but the St. James's and Pall Mall Electric Light Co., on whose mains the occurrence took place, will give no technical particulars at present. We are informed that the Board of Trade is investigating the matter. No personal damage was done, but a shop window was broken and some of the contents were injured.

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A NEW "LEADLESS" CABLE

ON Tuesday afternoon, at the Victoria Works, Charlton, a series of tests were carried out on a new type of leadless insulated cable. The new material from which the insulation of the cable is made is known commercially as "Liconite." This is a black, plastic substance of a bituminous character, made by a process patented by Mr. E. S. Ali Cohen, of Singapore. It is a cheap material, and has properties which render it particularly suitable for the insulation of cables. The following are some of the properties claimed:—It is unaffected by dilute acids, alkalis, oils, moisture, or electrolysis, is non-hygroscopic, resists large variations of temperature, has a high dielectric strength, is elastic and tough, and does not flow or crack. The cables exhibited were of three distinct types, in which the insulation consisted respectively of: (1) layers of paper impregnated with "Liconite"; (2) solid "Liconite Elastic," a preparation from "Liconite"; and (3) alternate layers of impregnated paper and "Liconite Elastic." A 200-yard length of cable of the first type, consisting of a 0·25 sq. in. stranded copper core insulated with 56 layers of "Liconite" impregnated paper to a thickness of $\frac{3}{8}$ in., and covered with two layers of "Liconite" tape and one layer of Hessian tape, had been immersed in water for 12 days, and withstood successfully a pressure of 32,000 volts between the core and the surrounding water for five minutes. The insulation resistance tested after nine days' immersion was 10·3 megohms per mile. A two-yard length was cut off the above cable, and bent round a drum 18 in. in diameter (12 times the diameter of the cable), three times in each direction. This piece did not break down until a pressure of 70,000 volts was reached. It is stated that this high degree of flexibility and freedom from damage due to bending is maintained throughout the life of the cable. A two-yard length of the same cable, which had been immersed with its ends bare and under water for seven days, and which before being immersed was bent round an 18 in. drum three times each way, was also subjected to the high-pressure test, and did not break down until a pressure of 70,000 volts was reached. In the manufacture of these cables, the paper is impregnated before being wound on the core, and impregnation in a vacuum chamber of the wound cable is not required. The cable is taped and braided, and, if necessary, is armoured for protection from mechanical injury. It is stated that the cost of the impregnating substance is not high, and that in consequence the cable is cheap.

A three-phase cable of the second type, in which the insulation consists of "Liconite" elastic (without paper) pressed on to the core, was also tested. Each core of this cable consisted of 19 strands of 0·085 aluminium covered with a thin layer of lead to decrease the curvature and the resultant electric stress, as proposed by Mr. O'Gorman. The diameter of the core was 0·55 in., the thickness of insulation 0·5 in., and the total diameter of the three cables laid up to 3·5 in. A 200-yard length of this cable immersed in water withstood successfully a pressure of 50,000 volts between cores for seven minutes. The third type of cable, in which the insulation consists of alternate layers of "Liconite" elastic and impregnated paper, is stated to be much preferable to the solid "Liconite" type, as decentralisation is impossible, and each layer of "Liconite" is pressed between the layers of paper forming a good mechanical job. A 40-yard length of such cable, with 0·5 in. thickness of this "reinforced" insulation withstood a pressure of 30,000 volts for five minutes.

These cables were manufactured by Messrs. Johnson & Phillips for Messrs. A. Hendrichs & Co., of Amsterdam, who own the patents for the impregnating material. An experimental plant for manufacturing these cables has been erected at Charlton.

Street Lighting in the City of London.—The City of London Engineer has issued a report with regard to experiments which, at the instance of the two City electric lighting companies, are being carried on for the purpose of comparison between the respective merits of electricity and gas for street lighting. Experimental lighting has been installed both in the main thoroughfares and side streets. The City of London Electric Lighting Co. are lighting Holborn Viaduct, Holborn, and part of the Old Bailey with 21 "Oriflamme" white or golden arcs of 1,500 actual candle-power; Farringdon Street with 18 small enclosed arcs of 500 candle-power; and Newgate Street with 10 smaller lamps, and the Charing Cross, West End & City Co. have supplied a number of centrally-hung flame lamps in Cannon Street (see ELECTRICAL ENGINEERING, Vol. II., page 693). As the high-pressure gas mains are in the whole of these thoroughfares, excepting between Holborn Circus and the corner of Gray's Inn Road, the City Engineer considers that a comparison of cost will be obtainable under very favourable conditions. For the Holborn Viaduct and Old Bailey area the existing lighting costs £390 annually, and it is stated that the proposed lighting would cost £262, as against £251 for high-pressure gas. In Farringdon Street the present cost is £312, and the cost of the proposed lighting would be £193, compared with £211 for gas. In Newgate Street a cost of £182 is at present involved, and the new scheme proposed would mean an expenditure of £95, as against £71 for high-pressure gas. Thus, for the three areas a total annual saving of £332 is anticipated compared with the present cost, and the difference in favour of gas is practically negligable.

PARLIAMENTARY INTELLIGENCE

Electricity from Peat

Central Ireland Electric Power Bill

IN the House of Commons on Thursday, on the motion of Mr. John O'Connor, it was agreed that the Dublin and Central Ireland Electric Power Bill be recommitted to the former committee, with instructions that they have power to reconsider their decision on the preamble of the Bill as reported by them to the House, except in so far as the same related to the city of Dublin, the urban districts of Rathmines and Rathgar, and Pembroke.

It will be remembered that this Bill came before a committee of the House of Commons, presided over by Mr. Luke White, on March 30th and 31st, and April 1st (ELECTRICAL ENGINEERING, April 2nd, page 503), and was rejected, presumably on account of insufficient financial evidence. We commented upon this in an editorial note in our issue for April 9th.

The Bill came before the committee again on Tuesday, when Mr. Freeman, K.C., said that the promoters had now satisfied themselves that, without the districts mentioned above, they could make the scheme perfectly remunerative, and consequently the name of the Bill had been altered to the Central Ireland Electric Power Bill. As a consequence the original capital of £450,000 with borrowing powers had been reduced to £150,000 with borrowing powers, and these were the material alterations in the Bill. The view which was laid before the Committee on the last occasion, that there were various industries which would take electricity if a supply were given in the area scheduled, had been strengthened very much during the past few weeks, particularly, in consequence of the passing of the new Patent Act, for they understood that a great deal of foreign manufacture was coming to this country, and they had the strongest possible belief that if the Bill were now passed in its present form, the undertaking would be a successful one. It was made a condition in the Bill now that before any powers could be exercised, £50,000 of capital would have to be subscribed. On the previous occasion there was no doubt that the evidence in respect of the financial support was not as full and complete as it might have been, and a certain amount of blame attached to all who were connected with the Bill, because they had a great deal more financial support behind them than appeared before the Committee. He now had a certain number of names of financial gentlemen in respect of all of whom they had received actual letters saying that they were prepared to give substantial support to the Bill. These were Mr. W. Geoghan, a director of the Great Southern and Western Railway Company of Ireland, who had subscribed £1,000 to the preliminary expenses and was willing to subscribe more if desired; Mr. Samuel Geoghan, a director and shareholder of the Irish Industries Co., who had subscribed £1,700 to preliminary expenses and would take a substantial interest in the concern; Mr. Griffiths, of Rathmines Castle, Engineer to the Dublin Docks Board, and a shareholder in various industrial concerns, who had subscribed £1,000 towards preliminary expenses; and other subscribers had found portions of the preliminary expenses, so that altogether £5,626 had been found in this way. In such a comparatively small matter as this was now, he thought this was a substantial guarantee that the capital would be found; in fact, one of the subscribers, who had also promised to take an interest in the company, had taken the trouble to go over to Germany and see the peat process in operation there before giving a decision. The only opponents to the Bill now were the Dublin Corporation, who wanted some protection with regard to their property outside the city boundary, which was perfectly reasonable, and the Alliance and Dublin Gas Company, whose position had not altered since the Bill was last before the Committee, namely, one of competition.

Sir RALPH LITTLER, K.C., for the Alliance and Dublin Gas Co., protested most strongly against the Committee re-opening the case for the Bill, as it was wholly without precedent in Parliamentary practice. What the promoters were asking was to amend their financial evidence, it having been insufficient on the previous occasion, and he would like to know where petitioners against Bills would be in the future if such a precedent were to be set up; he ventured to suggest that there would be an end to all established Parliamentary practice. He also had to complain that it was usual, when seeking permission to recommit a Bill, to consult all parties, including the petitioners against it, but in this case his clients had not been consulted.

The CHAIRMAN pointed out that Parliament had decided that there should be a new trial.

Sir RALPH LITTLER stated that in his view the recommendation to the Committee was that they should have power to reconsider their decision, and he asked the Committee not to go into the merits of the Bill again for the reasons he had stated.

The CHAIRMAN thought the Committee would be acting wrongly if they decided simply to reject the Bill once more, and thought they were bound to hear evidence.

Sir RALPH LITTLER said that in view of this decision, and the fact that his clients had had no time to prepare their case

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against the Bill in its altered form, he must withdraw from any discussion on the matter at the present stage.

Evidence having been called with regard to finance, the preamble of the Bill was found proved, and it was ordered to be reported for third reading.

London United Tramways Bill

Tramways over Kew Bridge

THIS Bill was before a Committee of the House of Commons, presided over by Mr. D. A. Thomas, last week. The Bill proposed to confer powers upon the London United Tramways, Ltd., for constructing tramways and widening and altering streets and roads, and for other purposes, but there was only one part of the Bill opposed, viz., a proposed tramway, three furlongs in length, over Kew Bridge. The object of this line, said Mr. Balfour Browne, K.C., who appeared for the promoters with the Hon. J. D. Fitzgerald, K.C., Mr. Lewis Coward, K.C., the Hon. Evan Charteris, and Mr. Lynden Macassey, was to connect the electrical system of the company on the north of the river Thames with the horse service between Kew and Richmond on the south side, when the latter system would be reconstructed. The Middlesex and Surrey County Councils, however, opposed, because the tramway company would not agree to pay to each of them £1,000 per annum wayleave for the use of the bridge. As a matter of fact, the authorities in question refused their consent to the company's proposal on these grounds, but the Standing Orders Committee decided that the Bill should go forward. Sir Clifton Robinson, the managing director and engineer of the London United Tramways Co., gave evidence, and said there would be no difficulty in constructing a double line of tramways across Kew Bridge, as there would be 11 ft. on either side of a double line down the centre. Sir Clifton was very emphatic about the manner in which the local authorities had treated the London United Tramway Co., in the past, and handed in an abstract of his evidence before the Royal Commission on London Traffic, in which he showed the various sums in which the company had been mulcted at various times. This, he said, amounted to £1,119,296, or over £20,000 per mile, irrespective of the cost of construction and equipment of the lines. The Committee eventually found the preamble of the Bill proved, but as the parties were unable to agree as to the amount of the wayleave which should be paid, the Committee fixed it at £500 per annum each, to the Middlesex and Surrey County Councils.

BRISTOL TRAMWAYS.—This Bill was before the Unopposed Committee of the House of Lords on Wednesday, and was reported for third reading.

LONDON ELECTRIC POWER BILLS.—A full report of the proceedings before Lord Cromer's Committee will be found on pages 825 to 831.

LONDON UNITED TRAMWAYS BILL.—A report of the proceedings before the House of Commons Committee, which considered this Bill last week, will be found elsewhere in this issue.

RADIOTELEGRAPHIC CONVENTION.—In the House of Commons on Monday, Sir Edward Sassoon asked the Under-Secretary of State for India whether any expression of opinion had been received from the Government of India as to the provisions of the Berlin Convention on Wireless Telegraphy; if so, whether they desired to participate in them; and, if not, would they be allowed to contract out. Mr. Buchanan replied that the Government of India has expressed their wish to adhere to the Berlin Convention on its ratification by his Majesty's Government.

THE G.B. SURFACE CONTACT SYSTEM.—In the House of Commons on Monday Mr. B. S. Straus asked the President of the Board of Trade whether he is aware of the danger to horses and human beings owing to the defective state of the stud system which the London County Council Tramways Committee has put down on the section between Aldgate and Bow; whether he was aware that accidents of a serious character have already occurred; and would he say what action he proposed to take for the safety of the public. In reply Mr. Churchill stated that on the section in question, which is not yet completed, two accidents, one to a man and one to a horse, have been reported by the police as having occurred through contact with a defective stud while the track was being tested. Fortunately neither accident seemed to have been of a serious character. Before the lines are brought into use for traffic, an inspection would be held and the Board's officers would require to be satisfied that all proper precautions have been taken. He was informed by the County Council that any necessary tests of the system in the meantime would be carried out when the traffic was very light, or at night.

PROGRESS OF ELECTRICAL BILLS.—The North-East London Railway Bill was read a third time in the House of Commons on Thursday, and a first time in the House of Lords on Friday.

The Nottinghamshire and Derbyshire Tramways Bill was read a first time in the House of Commons on Thursday.

Electric Lighting Provisional Order Confirmation Bill No. 3 and the Leeds Corporation Bill were read a second time in the House of Lords on Wednesday last week.

The Wolverhamption Corporation Bill was read a third time in the House of Commons on Monday.

King's College, London (Transfer) Bill was read a second time in the House of Commons on Monday.

Electric Lighting Provisional Order Confirmation Bill No. 1 was read a third time, and passed in the House of Commons on Monday.

WIRELESS TELEGRAPHY IN INDIA.—In answer to a question by Mr. Rees in the House of Commons on Thursday, Mr. Buchanan stated that no communication by wireless telegraphy has yet been established between India and any other British possession, but wireless communication was at present working between Diamond Island and Port Blair, and between Saugor Island and the pilot steamer at the Sanhead.

The Berlin Wireless Telegraph Convention.—It is announced that the Canadian Government has definitely decided to ratify the Berlin wireless telegraph convention of 1906.

Telegraph Traffic.—The cable between England and Gurnsey ceased to operate on the 20th instant, but was again put into working order on the 25th instant. We have to announce the interruption of the cable between Gibraltar and Tangier on the 22nd instant, and also of the cable between Pera and the Dardanelles. It is stated, however, that communication over the latter cable has only been stopped for the purpose of carrying out some repairs. Floods are responsible for the interruption of the Fao route, and the via Hanekin line was down in two places between Diarbekir and Bagdad, and Alep and Bagdad, but the latter line was again in working order on the 21st instant. The Compagnie Française des Cables Télégraphiques succeeded in effecting a repair of their cable between Martinique and Guadeloupe on the 21st instant, the interruption having lasted since the 8th instant. The interrupted cable between the Dardanelles and Constantinople was repaired on May 26th, while on the same day the telegraphic service between Constantinople and Rome was stopped. Owing to the "Trawlers" incidents (see page 818 of this issue), some delay exists on the lines of the Commercial Cable Co.

Newcastle Local Section of the Institution of Electrical Engineers.—The annual general meeting was held on Friday. The following officers and council for the ensuing session were elected:—*Chairman*, Mr. A. T. E. Drummond (District Manager National Telephone Co., Newcastle); *Vice-chairman*, Mr. W. D. Hunter (Managing Director, Newcastle and District Electric Lighting Co.); *Past Chairmen*: Prof. W. M. Thornton (Armstrong College), Mr. H. L. Rixley (Newcastle-on-Tyne Electric Supply Co.), and Mr. J. Pigg (North-Eastern Railway). *Committee*: Mr. J. H. Holmes (Messrs. J. H. Holmes and Co.), Mr. G. G. Stoney (Messrs. C. A. Parsons and Co.), Mr. G. Ralph (Messrs. J. H. Holmes and Co.), Mr. C. S. Vesey-Brown, Mr. A. S. Blackman (Borough Electrical Engineer, Sunderland), Mr. C. Turnbull (Borough Electrical Engineer, Tynemouth), Mr. F. Tremain (Superintending Engineer, G.P.O., Newcastle), Mr. J. A. Anderson, Mr. E. Fawssett, Mr. H. W. Clathier (Messrs. Reyrolle and Co.), Mr. H. Henderson (North-Eastern Railway), Mr. T. M. Clague, Mr. W. T. Dalton (Corporation Tramways, Newcastle), Mr. A. H. Law, and Mr. G. S. Whitmore. *Hon. Sec.*: Mr. C. S. Faraday Proctor (Edison-Swan United Electric Light Co.). *Hon. Treasurer*: Mr. W. A. Clatworthy.

Electric Tunnel Railways for the Berlin Mails.—According to *Engineering*, the German postal authorities intend to connect the general letter post-office in the Königstrasse of Berlin by special tunnels with the post-offices at the chief railway stations, which will be coupled by a circle line. The line to the Potsdamer Bahnhof is being built as an experiment. The double-track tunnel is to be immediately under the pavement, and is to have a width of 6 ft. and a height of 30 in.; a depressed footpath is to be provided between the two tracks, so that a man can walk through the tunnel; but there will be no attendants on the trains. The tracks are to have a gauge of 16 in. Each train is to consist of one motor-car and four trailers, the latter long enough to take a large mail-sack. All the cars, including the locomotive, will run on two axles; the locomotive will have a coupling in front and rear. The roof of the car is to be arranged to open on each side. The power is to be derived from three-phase currents of low voltage, taken up by trolley-arms of 6 ft. length from two lines. Trains are to follow one another at intervals of 1·5 minutes.

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OSRAM LAMPS

Paper by Mr. Hugo Hirst

IN a Paper read before the Institution of Electrical Engineers last Thursday, Mr. Hugo Hirst (Managing Director of the General Electric Co.) gave some useful information with regard to osram lamps.

He commenced with a short historical sketch, pointing out that the early metallic filament lamps, made long before the Edison or the Swan carbon filaments were invented, were never a commercial success, because the melting-point of platinum is only slightly higher than that temperature to which it has to be raised for the economical production of light. In consequence, the slightest increase in the voltage was sufficient to melt the filament. In 1881 the carbon filament lamp came to the front and stopped the researches and experiments in connection with the perfection of the then existing metallic filament lamps. It was only after a lapse of nine years that the next American patent dealing with a new metallic filament lamp made its appearance—this was the Poland patent No. 432,710, of 1890, for the iridium lamp. The author referred next to the researches of Auer von Welsbach, and his invention of the gas mantle and the osmium lamp. The quiet peculiar radiation of the incandescent gas mantle, which consists of thorium oxide containing 1 per cent. of cerium oxide, has been, he said, the subject of numerous researches which have furthered the purely theoretical knowledge of radiation. Very careful experiments, especially the now famous investigations of Lummer, have shown that bodies exist which at the same temperature radiate as light a larger percentage of the supplied energy than the so-called "black bodies." The Welsbach mantle owes its high efficiency to this property.

The osmium lamp was the first commercial metallic filament lamp, invented by Auer von Welsbach in 1898, and it was put on the market in the following years. Its regular commercial supply commenced in 1902. In this lamp the filament is made of metallic osmium, which has a considerably lower specific resistance than carbon. The osmium lamp consumed 1½ watts per candle-power, and had a useful life of over 1,000 hours, with scarcely any decrease in candle-power during that period. At first the osmium lamps could only be produced for 37 volts, which necessitated the connection of three lamps in series on a 110-volt circuit. The lamps were very fragile, and had to be burned in a perpendicular position. Their cost was about ten times that of a carbon lamp, due largely to the limited quantities of osmium available. This did not prevent millions of these lamps being manufactured, but it was evident that it would be impossible to produce them in the quantities required to supply all Europe, which would need between 30 and 40 million lamps per year. During the following three years the osmium lamp was further improved and made available up to 77 volts, enabling two in series to be used for 110 volts, and three in series for 220 volts.

The Tungsten Lamp Patents.

After a short reference to tantalum lamps, Mr. Hirst came to the patent, applied for in 1904 by Drs. Just and Hanaman,* for incandescent bodies consisting of pure tungsten. This, he said, is the first English patent describing the manufacture of pure tungsten filaments—all previous inventors had failed to produce metallic bodies from this element which were free from oxides, carbon, or carbides.

The second claim of their patent reads :—"Process for the manufacture of incandescent bodies in accordance with Claim 1, characterised by the fact that tungsten or molybdenum or compounds of these metals are mixed with organic binding media, formed and carbonised, whereupon the carbon is chemically eliminated, substantially as described."

Quite independently of these inventors, the Deutsche Gasglühlicht Aktiengesellschaft (the Auer Company) applied for a patent† which covers a process for the manufacture of pure tungsten filaments. In 1906 and 1907 a large number of British patents were granted both to the Deutsche Gasglühlicht Aktiengesellschaft and to Drs. Just and Hanaman, which describe further improvements in the manufacture of tungsten filaments.

The two patents above mentioned cover what is known as the "paste" process of producing tungsten filaments—another method called the "coating" process was protected by Drs. Just and Hanaman in their British patent No. 11,949 of 1905.

These Mr. Hirst regards as the fundamental patents protecting the processes according to which tungsten filaments can be manufactured commercially at the present time, but he mentioned also a few patents by some other inventors :—

Heany (American patent No. 859,585) proposes to use an alloy of tungsten with titanium.

* British patent No 28,899, 1904.
† British patent No. 19,379, 1905.

Kuzel (British patent No. 28,154 of 1904) suggests the manufacture of glowing bodies from colloidal metals.

British Thomson-Houston Company (British patent No. 18,749 of 1906 and subsequent patents) describes the manufacture of filaments of tungsten with the help of volatile metals or alloys, chiefly amalgams, which could be drawn into wire.

Zerning (British patent No. 2,554 of 1906) claims the use of hydrogen and nitrogen compounds of tungsten as the materials from which to construct tungsten filaments.

"As far as I know," Mr. Hirst added, the hydrogenous compounds of tungsten have never been described by a chemist, and from the information I have been able to obtain the statement of Sir Henry Roscoe still stands. In his famous work, 'Elements of Chemistry,' he refers to the treatment by Berzelius of tungsten trioxide in a current of hydrogen. I understand that the result of the experiments of this famous scientist, which were confirmed by his French contemporary, Moissan, was the production of nothing by pure tungsten powder without any trace of hydrogenous compound being formed. As Zerning's experiments were directed towards the same object, it would denote a wonderful achievement if he should have produced a result which is not described in any scientific work, and which the above eminent authorities found to be impossible. The nitrogenous compounds are well known, and it is proved that they cannot exist at the high temperature at which the filaments have to be burned. The patent description is not very clear, but indicates that Zerning intends to make use of the 'paste' process thus producing filaments containing probably carbon or carbide."

After a careful consideration of all the patents on the subject, the author maintains that of the multitude of processes that have been applied for and tried since the first application of the Deutsche Gasglühlicht Aktiengesellschaft and the Just and Hanaman patents, these two alone have during the last two years produced to the world commercial and useful lamps. It has been ascertained, he says, that all metallic filaments burning at a consumption of one watt per candle have been made with tungsten filaments. If ever so small percentages of other substances are added to the tungsten, the economy and useful life of lamps with such filaments suffer immediately.

Manufacture of the "Osram" Lamp.

"Osram" is the name under which the Auer Company introduced the first commercial tungsten metal filament lamp. The osram lamp is manufactured by the "paste" process, the principle of which consists in preparing from solid substances, such as the metals themselves in the most finely divided form, a paste with binding or stiffening agents such as the gums, dextrin, and other similar bodies. Such a mass has the consistency of putty, and is then squirted through a very fine orifice in a diamond, with a pressure of several tons per square inch. The result of the squirting operation is that one obtains a somewhat moist thread, which, however, has enough coherence to be formed into filaments that do not break while being dried.

The filaments are first heated under exclusion of air and then possess sufficient strength to be held in metal clamps. They are then subjected to the passage of an electric current which raises them to a high temperature, causing the filaments to sinter. The process of sintering is carried out in gases which chemically attack all the constituents of the binding agent, without the metal being affected, so that eventually a filament of pure metal remains. This filament is dense and homogeneous, but being obtained by a sintering process it is different in structure from the still denser metal which would be obtained from a melted mass.

The difference of the filament of the osram lamp, which is pure tungsten metal, from the filament of the osmium lamp, shows itself by the following characteristics. Owing to the higher melting-point of tungsten, an osram filament will stand a temperature at least 100° C. higher than the osmium filament. Their specific resistance and resistance coefficients differ, and there is considerable difference in their radiation properties. The colour of the osram filament is a steel to a silver grey, whilst the osmium filament has a bluish-grey appearance.

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When preparing osram filaments for lamps of 120 volts, 22 to 27 c.p., burning at an efficiency of about 1·1 watts per candle-power, taking 0·2 to 0·25 amperes, the diameter of the filaments is 0·03 mm. The jet from which this filament is squirted is, of course, much larger. The diameter of the jet at point of issue from the diamond is about 0·055 mm. The thread, after being squirted, shrinks to 0·050 mm. when dried. After it has been heated to a red heat under exclusion of air, it becomes a very porous filament, with a diameter of 0·045 mm. When this is sintered by the passage of an electric current, which raises it to the brightest white heat, its length is reduced, and it finally shrinks down to a diameter of 0·030 mm. The shrinkage is caused by the removal of the carbon and other material forming the organic binding medium, which originally amounted to 84 per cent. of the volume of the paste. It follows that, during the whole process, 84 per cent. of the original volume must disappear, and the shrinkage corresponds to a linear contraction of 55 per cent. It is easy to alter the amount of shrinkage by selecting suitable proportions of the binding medium or by adding volatile substances which disappear on heating.

During this heating process the filament is fastened in clamps and placed in globes or other arrangements containing certain gases. The heating is effected by the electric current to a gradually increasing amount, and while the thread decreases in length and diameter, it at the same time allows the passage of increased current. This is due to the sintering of the particles and also to the filament being freed from carbon, which even in minute quantities increases its resistance. The process is controlled by the operator, who has a voltmeter and ammeter to guide him. The current increases rapidly at first, but reaches a constant value within a few minutes. This is common to all sintering processes, and the same phenomena are observed with osmium, iridium, or molybdenum filaments. The filament so obtained is elastic but brittle. The osram thread, 0·03 mm. diameter, can be bent into a loop of about one centimetre diameter without breaking. After this bending it returns to its original form.

Each filament is fastened on to its leading-in wires without the application of any paste. The end of the leading-in wire is melted down to a small globule by means of an electric arc. This globule holds the filament securely, and the resistance from the passage of the current from the leading-in wire to the filament is negligible.

The evacuation of the lamp is carried out in the same way as with carbon filament lamps. Any process, mechanical or chemical, is suitable, but it is found that any traces of the gases occluded in the tungsten filament escape much more slowly than in the case of the carbon filament. The result is that the evacuation process requires a longer time with the osram than with the carbon filament lamp.

The other method of constructing tungsten filaments was developed by Drs. Just and Hanaman simultaneously with, but quite independently of, the Deutsche Gasglühlicht Aktiengesellschaft. Their lamp was introduced commercially under the name "Just-Wolfram." They use what is known as the "coating process," as described in the British patents 11,949 of 1905 and 3,684 of 1906. Ordinary carbon filaments of very small diameter, 0·02 to 0·06 mm., are raised to a bright red heat by means of an electric current in an atmosphere of volatile tungsten compounds in the presence of hydrogen. The compounds most used are the chlorides and oxychlorides of tungsten. The heat of the filament causes the hydrogen to reduce the volatile metallic compounds, depositing the metal in homogeneous condition on the carbon filament. A later patent discloses a process whereby three or more filaments are coated in series at one operation.

After the filaments have been coated in this way, they are submitted to the action of an electric current in an atmosphere of highly rarefied inert gas, such as, for example, hydrogen at a pressure of about 20 mm., until they show the clearest white incandescence. This process causes the carbon to combine with the tungsten surrounding it, forming a carbide. This change is so complete that in the resulting filament the cross-section is tubular, and no carbon can be distinguished under a microscope at the point of fracture. The filaments so obtained containing carbon (mostly as carbide) present a glittering white metallic appearance.

In the next process they are raised to a high temperature through the passage of an electric current while they are surrounded by a mixture of hydrogen and a little steam. This causes the carbon to be oxidised by the same reactions which go on in the water-gas process. The carbon may, however, be eliminated by any other method which gives a resulting filament entirely free from carbon.

Drs. Just and Hanaman have also obtained patents* protecting their process of mounting the tungsten filaments to the leading-in wires. This is effected by means of a paste consisting of finely divided tungsten metal mixed with coal-tar or gum. These paste mounts are dried and finally made red hot by any suitable means before the filament is heated in the bulb.

The finished filaments made by this process have a light grey silvery appearance and a little smoother surface than those made by other methods; in fact, they most nearly approach the appearance of a drawn wire. The tungsten or osram lamps produced by either of the above-described processes have identically the same characteristics.

It has been proved that these lamps will burn for from 1,000 to 2,000 hours with a consumption of about 1 watt per Hefner candle-power, without any appreciable falling off in the candle-power. Of all the metals which have been experimented with up to now, the author says, only pure tungsten has such a life.

In economy, the result is also better than has been obtained with other filaments, thus the osmium filament takes 1·5 watts and the tantalum 1·7 watts for direct current, and somewhat more for alternating.

Output, Efficiency, and Temperature Coefficient.

In the following comparisons between the osram and carbon lamps the author has adopted the Hefner candle-power in every case.† At the present, he says, it is found next to impossible to try to standardise metallic filament lamps in candle-power; it would make the lamp commercially impracticable.

The following figures give a comparison between the energy taken and power radiated from the surfaces of osram and carbon filaments:—The filament of a 25-c.p. osram lamp, consuming per mean horizontal candle-power 1·1 watts, has a total surface of about 50 sq. mm., which equals per candle-power 2 sq. mm., or per watt of supplied energy, 1·8 sq. mm. A good surfaced carbon filament consumes per mean horizontal candle-power 3·5 watts, which equals per candle-power 5·5 sq. mm., or per watt of supplied energy 1·57 sq. mm. It results, therefore, that 1 sq. mm. surface of osram filament gives 0·5 c.p., and consumes 0·55 watt; 1 sq. mm. surface of carbon filament gives 0·182 c.p., and consumes 0·63 watt.

Returning to the much-discussed question of selective emissivity, the Paper says:—It will be seen from the above figures that the osram filament radiates only 87 per cent. of the energy radiated by an equal surface of the carbon filament, but gives 275 per cent. of the light given by the carbon filament. If the kind of radiation were the same in both cases, the carbon

* British patent 9,349 of 1906.

† A Hefner candle is 0·88 of a standard British candle, so that one watt per Hefner c.p. corresponds to 1·14 watt per British c.p.

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filament ought to get hotter than the osram filament by about 60° C., because of the higher total radiation per unit of surface. On the other hand, considering the greater light emanating from the osram filament, its temperature ought to exceed that of the carbon filament by about 200° C. These contradictory conclusions show clearly how different is the radiating power of the osram filament as compared with the carbon filament. The latter behaves much more like the "black body" of the radiation theory. From approximate calculations the temperature of an osram filament burning at 1·1 watts per candle-power is about 250° C. higher than that of a carbon filament burning at 3·5 watts per candle-power. If a carbon filament were to be overrun to such an extent as to consume only 1·1 watts per candle-power, its temperature would then have to be raised by 360° C. The favourable radiating properties of the osram filament, therefore, mean that its temperature is 100° lower than that of a carbon filament of the same efficiency. If it were not possessed of this radiating property it would have to be burnt at an efficiency of 1·5 to 1·6 watts per candle-power, in order that it might have the same life it actually possesses at 1·1 watts per candle-power.

A further favourable property possessed by all tungsten filaments is their high positive temperature coefficient of electrical resistance. If one takes the resistance of carbon, tantalum, osmium, and tungsten filaments at ordinary temperatures, the resistances at those temperatures which, in a vacuum, correspond to 1·5 watts per candle will be as follows:—

For a carbon filament, 0·55 of the original.
For a tantalum filament, 5·70 times.
For an osmium filament, 8·50 times.
For a tungsten filament, 11·00 times.

At temperatures of about 2,200° C. absolute, each increase of temperature of 10° increases the resistance of a tungsten filament about 0·45 per cent. If the pressure is raised from 100 to 104·5 volts, the current

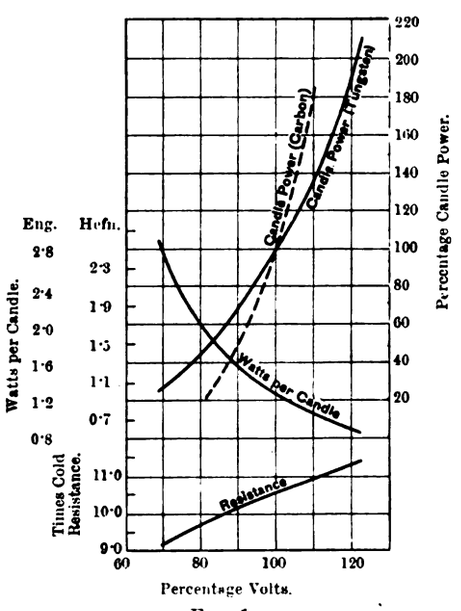


FIG. 1.

rises from 1 to 1·027 amperes. For a carbon filament the amount of the increase would be from 1 to 1·05 amperes. The total energy supplied, therefore, rises in the former case about 7·3 per cent., and in the latter about 9·7 per cent. Near the normal conditions the light of a carbon filament lamp rises and falls with the 6·3 power, that of a tungsten filament lamp with the 3·6 power, of the voltage.

Mr. Hirst is of opinion that the latter differences are too great to be explained by the increase of energy caused by the change of pressure. The small changes in the light of the osram lamp, as compared with a carbon lamp for the same change of voltage, can, he thinks, only be completely explained by the supposition that with a change of energy the radiated light is altered in a different way with the two lamps. Near the normal efficiency, the light of a carbon lamp changes with the third power of the energy, whilst such change for an osram lamp progresses with 2·5 power of the energy. These proportions have a very important practical consequence, which is clearly shown by the accompanying curve (Fig. 1) and Table I.

Table I.

	Osram.	Carbon.
Increase of light due to 10 per cent. increase in voltage	36 per cent.	84 per cent.
Decrease of light due to 6 per cent. decrease of voltage	21 ,,	34 ,,

High-voltage Lamps.

High-voltage metallic filaments of the osram type have recently been put upon the market, manufactured both by the D.G.A. and the Just-Hanaman processes. Tests have shown that the average life of a 1-watt per c.p. lamp seems to be between 800 and 1,000 hours. During this period there is said to be no appreciable drop in candle-power, and the lamps have shown themselves to be equally good as the low-voltage osram or Just lamps. These high-voltage lamps, made for from 200 to 250 volts, require double the number of filaments used in the low-voltage lamps. It is evident, therefore, that they cannot be produced for small candle-power. Up to the present 40- to 50-c.p. is about the lowest unit that has been obtained in a commercial lamp, and, Mr. Hirst says, some extraordinary development or discovery will have to be made before that candle-power can be largely reduced.

The Use of 110-volt Lamps on 220-volt Circuits.

To meet the demand for lamps to burn in series, elaborate arrangements have been made at the Osram Works for testing lamps that will run in series. They are tested to one-hundredth of an ampere, and sorted out in from five to seven series numbers according to the type of lamp and carefully marked, and the reference numbers (ranging from, say, 28 to 38, which are marked on the caps of all lamps. singled out for series burning) practically mean the consumption of current is 0·28, 0·29, 0·30, 0·31, &c., of an ampere.

The Effect of Metallic Filament Lamps on Supply Systems.

Mr. Hirst predicts that the introduction of the new lamps will probably mean an increase of 100 per cent. in the unit adopted for electric light. Sixteen-c.p. carbon lamps will be replaced by 25 to 35 watt tungsten lamps, and those places in which a low illumination is desired will still be supplied with carbon filament lamps of 2½, 5, and perhaps 8 c.p. As it is not practicable at present to make osram lamps for 110-volt circuits of a lower candle-power than 25, it is likely that in small rooms greater illumination will have to be used. Where larger spaces have to be lighted, it is easily possible to obtain the present illumination by using fewer lamps, but he thinks that, with the cheaper light, the general tendency will be towards higher illumination. Station engineers will find that the increased load from new consumers will more than make up for the decreased consumption of existing ones.

Price, Breakages, and Blackening.

As has been the case with so many new inventions, so the tungsten lamp on its introduction had to run the gauntlet of many reproaches on the part of the more conservative elements in our profession. Burning in vertical position up to now has had to be insisted upon by the manufacturers, but lamps can now be supplied to burn in any position. The price of these lamps is for the moment a trifle higher, but before many months the author believes that they will be supplied at the same price as the others. The price itself is naturally held up as a disadvantage, especially when a consumer is displacing old lamps for new ones. The outlay then appears serious, but Table II. is given to show that the saving in current for given illumination rapidly wipes off this expenditure.

Much has been made of the brittleness of the metallic filament and of the percentage of breakage in certain

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instances. From the moment it was understood how to pack the osram lamp, however, the author states that the breakage in bulk has been a negligible quantity. It now only affects the supply of the lamps in small parcels of one half-dozen to one dozen. This problem is now being dealt with, with every prospect of an early success.

Another point about which there has been considerable outcry is the blackening of individual bulbs which occasionally occurs. It is at present thought that this blackening is due to some extent to the great sensitiveness of the filament to small changes in vacuum. Other theories exist as to the cause of this, but what for the moment mainly interests the users is that if a lamp is going to blacken it usually happens at a very early period of its life, when the makers are prepared to deal with the matter generously. It is quite different in this respect to a carbon lamp, in which a blackened bulb means as a rule that the lamp has been kept on circuit for an indefinite period, far exceeding its useful life.

Life Tests.

The samples of osram lamps, tests of which are recorded in the tables and diagrams, were selected at efficiencies corresponding to the limits of sorting, that is, 1·0 to 1·25 watts per Hefner candle-power, so that they represent the lowest and highest efficiency at present on the market.

Test I. on Table II. and Fig. 2 was made by Faraday House on an ordinary commercial lighting circuit, alternating current, with a variation of voltage of about 3 per cent. each way. Twelve lamps were tested, and nine gave a life of 2,000 hours, with a 20 per cent. drop in candle-power. The first failure took place at 900 hours, the other two failures following between 1,200 and 1,400 hours. The cost of lighting with such lamps comes out at the very low figure, including renewals, of 5¾d. per 1,000 c.p.-hours.

Tests II. and IIa. in Table II. are other examples of osram lamps burnt at a slightly lower efficiency, and after 1,500 hours' use the drop in candle-power only amounted to 11 per cent. This test was continued to 3,350 hours, when nine lamps were still good. Their average candle-power was then 70 per cent. of the initial candle-power. It is interesting to note from this test that it pays to run these lamps to a point when the candle-power has dropped 30 per cent., as will be seen from the table.

The test No. V. (Fig. 3) of tungsten lamps made by the Just-Hanaman process shows that these lamps are quite as good as the osram. The test was only carried to 1,000 hours, but it is quite possible that the lamp could have lasted up to 2,000 hours or more, with a proportionate reduction in the cost of renewals. After the 1,000 hours the drop in candle-power was exceedingly small, amounting to only 3 per cent.

The tantalum tests, No. VI. on Fig. 4, Mr. Hirst says, give a much less favourable result than the above

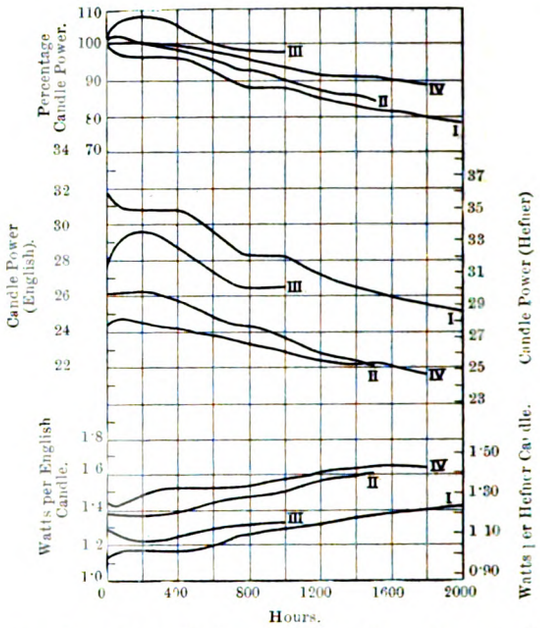


Fig. 2.—"Osram" Average Life Test Curves, &c.

figures. The test is on a direct-current circuit, and the cost per thousand candle-hours works out at 9½d., or 73 per cent. more than the osram lamp.

The carbon filament lamp results, test No. VII. on Fig. 5, were selected from a large number of tests, and represent the average English-made lamp. A comparison of the figures in the last column of Table II. shows that the total saving from the use of osram lamps over carbon lamps when equal voltages are compared is 60 per cent.

Test No. VIII. in Table II. shows the trials of high-voltage tungsten lamps, which were made on an

Table II.

Life Test Results.

No. of test.	Type.	Cost per lamp.	Tested by	Starting		Efficiency in W./C.P.	Number of lamps.	Duration of test.	Average useful life.	Mean efficiency.	Average C.P. hours.	Cost per 1,000 C.P.-hours.		
				Watts.	C.P.							Renewals.	Energy at 4d. per unit.	Total.
	Low Voltage.													
		d.						Hours.	Hours.	W./C P.		d.	d.	d.
I.	Osram ...	48	Faraday House	35·7	36·3	0·99	12	2,000	1,520	1·12	48,700	0·98	4·48	5·46
II.	,, ...	48	Westminster Testing Laboratory	35·8	29·7	1·22	12	1,500	1,360	1 29	36,600	1·31	5·16	6·47
IIa.*	,, ...	48					12	3,350	2,850	1·42	70,800	0·67	5·68	6·35
III.	,, ...	48	T. R. Charlottenburg..	34·7	31·0	1·12	?	1,000	1,000	1·11	31,100	1·54	4·44	5·98
IV.	,, ...	48	Robertson, E. L., Ltd.	35·0	27·7	1·26	6	1,800	1,720	1·36	45,600	1·06	5· 4	6·50
V.	Wolfram ..	48	,, ,,	38·0	30·7	1·24	2	1,000	1,000	1·27	28,900	1 66	5·08	6·74
VI.	Tantalum..	33	Westminster T. L. ...	39·1	22·0	1·78	6	1,000	700	1·84	15,000	2·19	7·36	9·55
VII.	Carbon ...	12	——	59·0	18·7	3·15	10	1,000	1,000	3·25	18,000	0·67	13·00	13·67
	High Voltage.													
VIII.	Wolfram ...	90	Robertson E. L., Ltd.	63·4	53·7	1·18	10	880	720	1·12	42,500	2·12	4·48	6·60
IX.	Carbon ...	12	——	68·0	18·9	3·6	10	1,000	1,000	3·95	18,200	0·66	15·80	16·46

Note.—For the purpose of comparison *all* the above results have been expressed in terms of the "Hefner" unit of candle-power.

* This is a continuation of Test II. to 3,350 hours to show that it pays to burn Osram lamps to the limit of life.

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ordinary alternating-current lighting circuit, 50 cycles, with a voltage variation of 5 per cent., most of the variation being upwards. The figures show that, even

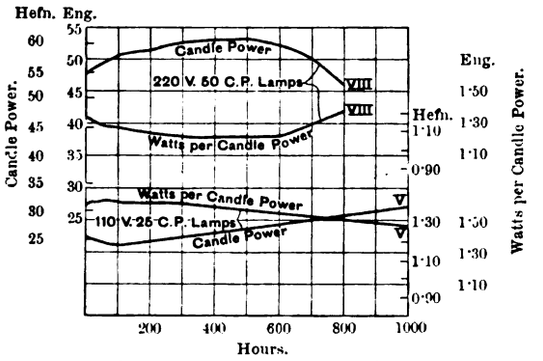


FIG. 3.—"JUST-WOLFRAM."

paying 7s. 6d. for these 65-watt lamps, there is a saving of over 60 per cent. over the average high-voltage carbon lamp (test No. IX. on Fig. 5) when all the factors of

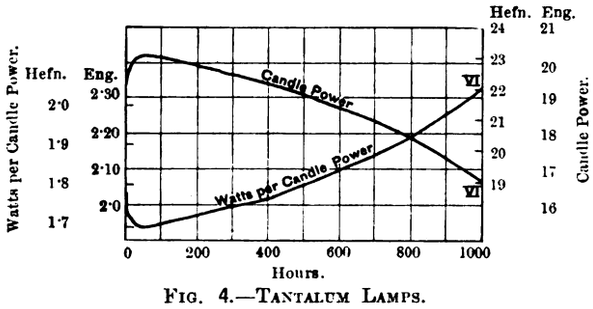


FIG. 4.—TANTALUM LAMPS.

the cost are considered. In all of the above examples the price of current has been taken as 4d. per unit.

As an instance of the life of osram lamps for public

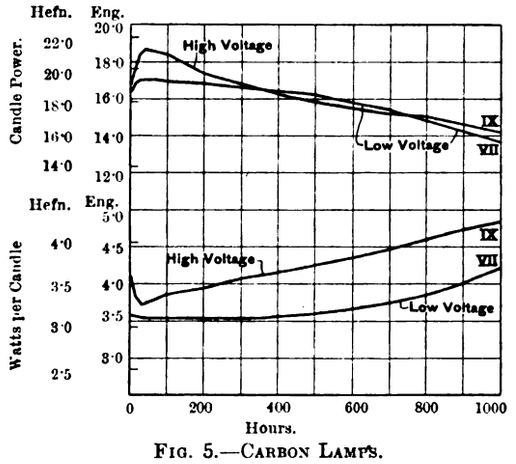


FIG. 5.—CARBON LAMPS.

lighting, the following figures showing the life of the lamps installed in the streets of Canterbury, which have been kindly furnished by the Borough Engineer, Mr. C. A. Blascheck, are given:—

LIFE OF OSRAM LAMPS ERECTED IN THE STREETS, MARCH, 1908.

St. George's Place. Post.	Lamps in open. Hours burning.	St. George's Place. Post.	Lamps in open. Hours burning.
No. 37	1,357	No. 41	*2,434
	*2,434		*2,434
No. 38	1,971	No. 42	1,665
	2,036		*2,434
	93	No. 63	974
No. 39	*2,434		2
	*2,434		*2,434
No. 40	1,779		
	*2,434	Total—16 lamps ...	29,349

Average hours = 1,834.

Dover Street and Oaten Hill. Post.	(Lanterns enclosing the lamps.) Hours burning.	Dover Street and Oaten Hill. Post.	(Lanterns enclosing the lamps.) Hours burning.
No. 179	1,402	No. 206	2,315
	1,500		*2,464
No. 180	484	No. 207	712
	*2,464		800
No. 181	829		639
	*2,464		1,068
No. 182	*2,464	No. 208	430
	*2,464		736
No. 183	*2,464		736
	*2,464		1,960
No. 184	*2,464		1,403
	*2,464	No. 255	*2,464
No. 185	*2,464		*2,464
	*2,464		
No. 205	*2,464	Total—29 lamps ..	51,974
	*2,464		

Average hours = 1,792.

NOTE.—Those marked * are still burning, therefore the actual average life on completion of test will be considerably higher.

25-volt Lamps Used with Transformers.

The following is an abstract of the remainder of the Paper, which deals with 25-volt osram lamps and house transformers. Osram lamps for 25-volt circuits have been standardised for both 10 and 16 c.p. These lamps consume respectively 10 and 16 watts, and for this consumption give the same candle-power as the ordinary carbon filament lamps taking 40 and 60 watts. For use with these lamps, transformers have been constructed the iron loss on which is as low as 5 watts on a transformer designed for 300 watts output. Table III. shows the units taken per year by this and two other transformers of a larger size to overcome iron losses:—

Table III.

Details of Iron Losses of Small Transformers.

Output of transformer in watts.	Number of 16 c.p. osram lamps alight at one time.	No load.	Iron losses.	Units taken per year.	Cost per year at 4d. per unit.
		Watts.	Percentage.		£ s. d.
300	19	5	1·67	44	0 14 8
750	47	10	1·33	88	1 9 4
1,500	94	17	1·13	149	2 9 8

The cost per year at 4d. per unit is given in the last column.

The copper losses in these transformers are not large, and only occur when the lamps are being used. The total loss in the copper of the transformer, and in the wires between the transformer and the lamps, will not be appreciably higher than the copper losses in the cables alone when carbon lamps are used.

Table IV. shows the financial results from the use of these 25-volt 16-c.p. osram lamps in a private house requiring 25 lamps. It is assumed that the smallest size of transformer in the preceding table will suffice, as 19 lamps alight at one time is about the extreme maximum load in such a house. The total saving in current shown in the last column varies with the number of hours the lamps are in use; at 500 hours' use the saving in current is £6 4s. 9d. on a yearly bill of £9 10s. when carbon lamps are used. The current account is thus reduced 65 per cent., but the bill for lamp renewals will be somewhat higher.

Table IV.

Annual Costs for Current on an Installation of 25 16-*c.p. Lamps, of which* 19 *are Burning at one Time.*

(16-watt Osram Lamp *v.* 60-watt Carbon Lamp.)

No. of hours per annum at maximum load.	Maximum load in watts. Osram lamps.	Maximum load in watts. Carbon lamps.	Units used per annum with Osram lamps. Osram lamps.	Units used per annum with Osram lamps. Transformer.	Units used per annum with Osram lamps. Total.	Units used for Carbon lamps.	Cost of current at 4d. per unit. Osram lamps.	Cost of current at 4d. per unit. Carbon lamps.	Cost of current at 4d. per unit. Saving.
							£ s. d.	£ s. d.	£ s. d.
300	304	1,140	91	44	135	342	2 5 0	5 14 0	3 9 0
400	304	1,140	122	44	166	456	2 15 3	7 12 0	4 16 9
500	304	1,140	152	44	196	570	3 5 3	9 10 0	6 4 9
600	304	1,140	182	44	226	684	3 15 3	11 8 0	7 12 9
700	304	1,140	213	44	257	798	4 6 6	13 8 0	9 1 6
800	304	1,140	243	44	287	812	4 15 6	15 4 0	10 8 6

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Table V. shows the complete balance sheet obtained by adding the cost of current to the lamp renewal charges for both carbon and osram lamps.

Table V.

No. of hours per annum of maximum load.	Osram lamps.		Carbon lamps.		Total.		Total saving with Osram.
	Current.	Lamp renewals.	Current.	Lamp renewals.	Osram lamps.	Carbon lamps.	
	£ s. d.	£ s. d.	£ s. d.	s. d.	£ s. d.	£ s. d.	£ s. d.	%
300	2 5 0	1 10 0	5 14 0	7 1	3 15 0	6 1 1	2 6 1	38
400	2 15 3	2 0 0	7 12 0	9 6	4 15 3	8 1 6	3 6 3	41
500	3 5 3	2 10 0	9 10 0	11 10	5 15 3	10 1 10	4 6 7	43
600	3 15 3	3 0 0	11 8 0	13 3	6 15 3	12 1 3	5 6 0	44
700	4 5 6	3 10 0	13 6 0	16 7	7 15 6	12 2 7	6 7 1	45
800	4 15 6	4 0 0	15 4 0	19 0	8 15 6	16 3 0	7 7 6	45½

A formula is given for calculating the comparative cost of osram and carbon lamps if the copper losses are also taken into account.

Using the following symbols :—

a = Open circuit loss in watts.
b = Number of lamps.
c = Candle-power.
d = Cost per unit.
e = Average hours of running per year.
f = Copper loss on average load.

The cost of lighting with osram lamps per year works out at—

$$8{\cdot}76\,a\,d + \frac{b\,c\,e\,d}{1{,}000} + \frac{f\,e\,d}{1{,}000}$$

The yearly cost of lighting with carbon filament lamps as against this works out to be—

$$3{\cdot}5\,\frac{b\,c\,e\,d}{1{,}000}$$

This under the assumption of an efficiency of 1 watt per Hefner candle for the osram lamp and 3·5 watts for the carbon filament lamp.

The saving in running cost, therefore, is per year—

$$3{\cdot}5\,\frac{b\,c\,e\,d}{1{,}000} - 8{\cdot}76\,a\,d - \frac{b\,c\,e\,d}{1{,}000} - \frac{f\,e\,d}{1{,}000}$$
$$= d\left(\frac{2{\cdot}5\,b\,c\,e - f\,e}{1{,}000} - 8{\cdot}76\,a\right).$$

Taking the cost of an actual installation with 25 16-c.p. lamps as an example, and assuming $a=5$, $f=12$ (to be on the safe side the maximum copper loss has been taken, not the average), d=4d., and e=1,000, the saving works out to £15 14s. 9d. on a total of £23 6s. 8d., equivalent to a *saving of* 67·4 *per cent.*

Without transforming down, but taking the smallest obtainable candle-power, namely, 28-watt osrams (against 16-c.p. carbon lamps), the saving would have been £11 13s. 4d., equal to 50 per cent. Taking further into consideration the cost of renewals and the additional cost of the transformer, as the latter costs £2 2s., and a 5-years' life may be assumed, the annual charge for this is 9s. The cost of renewals for osram lamps (25×3s.) is £3 15s., and the cost of renewals for carbon lamps (25×1s. 3d.) is £1 11s. 3d., so that the actual saving is therefore £15 14s. 9d., less £2 12s. 9d. = £13 2s., which is equivalent to 56·2 per cent.

In some cases the iron losses have been found so small that they will not keep the meter running, and it is therefore suggested that those supply engineers who wish to make use of osram lamps to extend their private-house load should themselves supply these small transformers and charge the consumers a slight increase per unit to cover the iron losses, and also the capital expenditure involved.

There is another large field for these low voltage lamps in connection with isolated plants for the supply of country houses, workshops, &c. Where small units of light are quite sufficient, the cost of the generating plant can be reduced very largely as the output required falls in the ratio of the efficiency of the filaments used in the lamps. Thus the maximum load in any given case falls in the ratio of 3½ to 1, and neither the factory inspector from the Home Office nor the fire insurance company claims that supply at 25 volts is dangerous.

DISCUSSION.

Mr. Haydn T. Harrison, who opened the discussion, referred first to the fact that the gas mantle differed in a most important feature from the metallic filament lamp, namely, that in the first 100 hours of burning the candle power dropped 20 per cent., and after 500 hours burning it dropped from 40 to 50 per cent., whereas the tungsten lamp had the peculiarity that in 1,000 hours it dropped less than 10 per cent. in candle power. He next called attention to a patent taken out by the British Thomson-Houston Co. (No. 16,530, of 1907), and published in Electrical Engineering of May 14th last, in which it was said that when tungsten was heated to a temperature below that of oxidisation in the atmosphere, it was ductile, and could be drawn down. The filaments now made were not drawn, but if tungsten was ductile at a temperature below oxidisation, of course there might be considerable possibility in this particular idea. He believed it was only in patent form at the present moment, but probably Mr. Hirst would know more about it. Later on in the Paper Mr. Hirst said that elaborate arrangements had been made for testing lamps to one-hundredth of an ampere, but as the lamps only took 0·3 of an ampere this was rather a large percentage, and the corresponding percentage difference in volts would be greater than the difference in current on account of the temperature coefficient. Between 0·31 and 0·29 was a difference of over 6 per cent., and the voltage difference would be between 8 and 10 per cent. Nearly every ammeter or instrument in a lamp factory would work within closer limits than that, and he thought there must be a clerical error in the Paper. He had had a great deal to do with both street and private illumination, and he found that the big units of light were appreciated. If they took an economical large unit of light they could afford to diffuse it, and he supposed one of the greatest disadvantages in incandescent electric lighting was the high intrinsic brilliancy of the filaments themselves. With Osram lamps he, personally, had never used them in a house unless they had been frosted or put in globes, with the filaments not visible. They could not afford to do this with carbon lamps at 4 watts per candle, but with 1 watt per candle they could. All the way through the Paper Mr. Hirst had used a comparison between Osram lamps and other incandescent electric lamps and gas lamps. He did not know whether many people had realised that the fact that the Osram lamp was giving a light at one watt per candle, took it into a much bigger region than that. The enclosed arc lamp took nearer two watts per candle than 1 watt per candle. The open type arc lamp, the nearly horizontal rays of which were the most important for street lighting, was also taking over one watt per candle, and it therefore came to a comparison of the cost of renewals and the cost of labour and carbons. He had worked it out that where big units were required, say, from 500 to 600 c.p., it was more economical to use a group of Osram lamps giving this candle-power because the cost of carbons and labour in an arc lamp was considerably higher than the cost of lamp renewals as given in the Paper. In connection with the reference in the Paper to Canterbury, where a large number of lamps were mentioned as having lasted 2,434 hours, he might mention that a big percentage of these lamps were still burning last Saturday, and that brought the average life of all the lamps referred to in the Paper in connection with the streets of Canterbury to over 2,000 hours.

Mr. B. Drake (Messrs. Drake & Gorham) said that he had had the honour of being associated with Mr. Hirst in connection with the introduction of the Nernst electric lamp. It had been a very troublesome problem, and it must have been a great relief to Mr. Hirst, after the difficulties encountered there, to be able to sail in smoother waters. The advent of the metallic filament lamp at this period of the electrical industry was most welcome, at any rate, to those connected with private plants. The difficulty up to the present had been that electric light had been so expensive, and that although it was admitted to be the best, people would go in for competitive forms of lighting. He thoroughly agreed with the previous speaker that the engineers in charge should use their endeavours to get people to use their light in a more rational way. The ordinary pendant with a clear filament should be replaced by a lamp of two or three times the candle-power with a shade put on the underside instead of above. With regard to the name of these lamps, Mr. Mordey had suggested "wire lamp"; this would apply more to the tantalum than to any other lamp, and he preferred the suggestion, "metal lamp." The great difficulty with these lamps had been to get them to the consumer; they were so brittle. Mr. Hirst's company had overcome this in a practical way in bulk, so much so that when lamps were sent in their casings, the breakages were only about 2 per cent. With the tantalum lamp, which was much stronger, no special precautions were necessary, and it was probably for this reason that the tantalum lamp had been most favoured up to the present. Certain phenomena in connection with these lamps had been brought to his notice, which perhaps some of those present might be able to explain. There was a general feeling that metal lamps had a longer life in winter than in summer. Whether this was so he did not know, but he had been told it many times by users. Could it be due to temperature? Others had stated that in streets they noticed the lamp when exposed to snow lasted much less time. Possibly this might be due to the greater number of times the lamps were switched on in the winter than during the summer, or it might be the temperature. Tantalum lamps had a much longer life on alternating currents with low frequency than high frequency. This seemed to point to the fact that breakages were due to molecular vibration, which

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was borne out by the fact that they usually broke in several places. With regard to competitive forms of lighting, he had had to compete recently in private installations with two forms of lighting, viz., acetylene and petrol gas. The former was preferred on account of its colour; it was said to be the closest approach to sunlight of any form of artificial lighting; but the cost of working was high; it came to 2·2d. per 1,000 c.p. hours. Petrol gas seemed to vary according to the price of petrol in the district and the veracity of the salesman; it was anything from 1·3d. per 1,000 c.p. upwards. This was enough to show that the metal lamp had again put us in the running, and although from a central station point of view it might be looked upon as a drawback at present, he was quite sure it would benefit the industry in the end.

Dr. LOUIS BELL (Edison Illuminating Co., of Boston) said that there were many metallic filament lamps in use in America at the present time. At first came the tantalum lamp, which was received with open arms and a great deal of enthusiasm, but it was very promptly pushed aside by the tungsten lamp as soon as this came in. The reason for this was that a very large number of distributing circuits in America were alternating current, and the tantalum lamp had a shorter life on this circuit—from his own experience about two-thirds that with direct current. In connection with what Mr. Drake had said, his experience was that tantalum lamps worked badly both at high frequencies and at very low frequencies. He had experimented on the cause of failure in life of these lamps on alternating-current circuits very considerably, and the facts seemed to be these, namely, that the faulting of the filaments was due to the continuous heating and cooling rather than anything else. The heating and cooling, of course, took place more rapidly as the frequency rose, but at the lower frequencies the temperature change was more complete, as the filament had time to cool. As a result, after having carried out a large number of experiments at all sorts of frequencies, he had found that at 60 cycles and above—particularly above—the life was very materially limited, whilst on the other hand, at a very low frequency, say 5 or 10 cycles, the lamps could hardly be put in fast enough to keep them alight. Following the tantalum lamp came the tungsten lamp, at first in the form of the imported lamps, and mostly made on the Just-Hanaman process, and some on the Auer process. These latter were taken up by the General Electric Co. of America, which now produced most of the lamps in use there. The lamp which was first put on the market was a 100-watt 80-c.p. lamp. They were working there at 1¼ watts per English candle. He thought the watts per candle ratings were mostly based on the Hefner unit. The large lamps were most welcome, because they enabled them for the first time to have a successful substitute for the extremely uneconomical enclosed arc lamp, which they were in the habit of using. Enclosed arcs at 80 volts at the arc, worked on a 120-volt circuit, were about as striking an example of lack of economy as could well be found, and the high candle-power incandescent lamps had been most welcome. Manufacturers had been very slow to put out the lower candle-power lamps, but importation of German lamps had forced them to it, and the standard lamps now put out were 100 watts, 60 watts, and 40 watts. These were substantially like the Osram lamps in their general character; the life was excellent, and, save for the fragility in shipment, the success of the lamp was, on the whole, thoroughly good. In making many life tests of them he had noticed that the specific emissivity seemed to change during the life of the lamp, so that it was quite a common thing in testing a batch, and getting life curves, to find individual lamps, and sometimes nearly all the group, rising in candle-power after they had fallen 10 or 12 per cent., and eventually breaking after a very long life. One question uppermost in their minds now was the most economical efficiency at which to run these lamps. At one watt per English candle, most of the experiments indicated that the lamp was being overrun. At 1½ watts the life was admirable, and in the small candle-power lamps of 40 watts and below it would probably pay to run at this somewhat reduced efficiency. Casually he had heard several rumours which he hoped to investigate during the course of the next few weeks on the Continent. One of them was that our German friends, who had passed on so many good things in lighting, had up their sleeves carefully concealed a lamp which would run at half a watt per Hefner, or something of that sort. With regard to the use of these higher candle-power lamps, he wished to endorse most heartily the suggestion made that they should always be used either in such a position that they were fairly without the field of vision, so that the eye would be shielded by the brow from direct radiation, or else that they should be used behind diffusing shades. In American practice tungsten lamps were never used except under one of these conditions, and the company with whose practice he was most familiar, namely, the Edison Illuminating Co., of Boston, was putting out a great many of these lamps, every one half frosted, and, moreover, they put above that a shade which had deep skirts nearly to the top of the lamp, and in every case where the lamp was to be installed fairly within the field of vision the shade was sand-blasted or etched, so that the light was completely diffused so far as the observer's eye was concerned. The intrinsic brilliancy of these lamps was between 1,000 and 2,000 c.p. per square inch, and the effect upon the eye was terrific. These new illuminants must be treated this way, or else the eyesight would suffer. As a rule most of the American central stations furnished renewals, and in that way they were able to control the output of these lamps. These renewals were put out to the customer not free, but at a small renewal charge which was really less than the cost of the lamp, but which was enough to make the customer and the station share the benefit of the smaller consumption of energy, and he thought no American central station manager had the slightest fear of the use of metallic filament lamps. One witty friend of his referred to these troubles as merely the growing pains of the industry, which he thought a fair characterisation. One other leading central station manager in America had told him bluntly quite recently that he proposed to put out these tungsten lamps free, and added—a result which he knew to be the fact already—that every time he had reduced his price to the consumer he had increased his net profits. He thought that if the matter was met in that spirit these new lamps were going to be a boon to the industry all over the world.

Mr. H. W. HANDCOCK (Messrs. Handcock and Dykes) complained of the confusion that arose owing to the arbitrary use of the Hefner or British standard with their very different values. Another point was the present method of measuring the candle-power of lamps. If the mean horizontal candle-power were taken, he was not sure that it was fair to the carbon filament. In the case of the metallic filament, practically the whole of the illumination was horizontal. It was true that this had advantages for street lighting and disadvantages for room lighting, in certain cases, but if they took the horizontal measurement for metallic filament lamps and compared that with the horizontal measurement for carbon filaments, without due regard to the mean spherical value, clearly, if the results obtained were worked out in watts per candle-power, the tendency was to reduce the watts per candle for the metallic filaments as compared with the carbon filaments. As an instance of this, he thought it would be found that if they took an ordinary 8 c.p. lamp in the horizontal position and compared this with the illumination obtained from a metallic filament 50 watt lamp, immediately under the lamp, in that position the 30 watt carbon lamp was giving considerably higher illumination than the 50 watt metallic filament. It illustrated the difficulties due to taking all measurements in the horizontal plane. He thought they might with advantage lay more stress on the benefits that accrued to the central station as regarded the less sensitiveness of the new lamp to variations in voltage, and on the fact that the candle power of the metallic filament lamp was so well sustained as compared with the carbon filament. A minor point, on the other hand, was that something a little bit in advance of the present arrangements in portable lamps was required if metallic filament lamps were to be used. The portable lamp was an important factor in the ordinary dwelling house, and for this purpose they must have either a 25-volt osram lamp, or revert to the carbon filament lamp. Referring to the effect of the more efficient lamp in reducing the central station load, he mentioned the offer which the author had recently said he had made to the London stations to supply lamps to them, to let them distribute the lamps and have control of the distribution. His own opinion was that from the business point of view the author was so absolutely right that the central stations, when they passed that offer, missed a golden opportunity.

Mr. A. A. CAMPBELL SWINTON said that without calling into question the statement made by the author that it had been shown that bodies existed which at the same temperature radiated as light a larger percentage of the supplied energy than the so-called black bodies, he wished to suggest that it was not at the present moment proved that the Welsbach burner owed its high efficiency to this property, as the author had stated. Experiments had been made—he forgot for the moment by whom—in which a mantle made of the Welsbach mixture—namely, 2 per cent. of ceria and 98 per cent. of thoria—was heated up in a furnace. At the same time, in the same furnace, mantles made of pure thoria were heated, and it was found that they gave exactly the same amount of light. He would also refer to a paper of his own read some years ago before the Royal Society, where the same experiment was tried, the two mantles being heated by means of kathode rays in a vacuum, and again the same result was obtained. In the incandescent gas mantle it was well known that the 2 per cent. additional ceria enormously increased the amount of light, whereas in the experiment he had referred to, the addition of the ceria made no difference whatever, or, at any rate, no difference that was ascertainable. This went to show, he thought, that it was not a question of emissivity, but probably a question of chemical action, which took place only when these bodies were heated by a flame. He only wished to mention the matter because he thought it undesirable that a question about which there was still a considerable amount of controversy should be referred to as a settled matter.

Mr. C. C. PATERSON (National Physical Laboratory), referring to the author's statement that it was next to impossible to try to standardise metallic filament lamps by candle power, said he did not see why this should not be done, at least from the consumer's point of view, whatever might be the view of the makers. Carbon filament lamps had been standardised by candle

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power, and surely, if they could standardise a lamp which varied in candle power as the sixth power of the voltage, they ought to be able to do so with a lamp which varied only as the cube or fourth power. They bought lamps to give candle power and not to consume watts, whatever the central station man might say. He was sorry to see Mr. Hirst expressing so many results in Hefner candles. We had a British candle, which was a pertectly substantiated one, and was used in America and France, and why should we hark back to the Hefner, which was used in Germany and was not generally understood here. At the same time, in the curves, he was pleased to see Mr. Hirst had put in English units as well. He had been looking at a number of test-sheets that day, and noticed the same difference between the initial performance of osram lamps as was shown in Mr. Hirst's diagrams. Some seemed to rise largeiy in the initial stage, as Test No. 3 at the Reichsanstalt; others dropped almost at the beginning without any rise. He would like to know if Mr. Hirst could give a reason for this. It would be very interesting to get some idea as to the total output of lamps in Great Britain; how many million lamps were made during the year and consumed, and how many did Mr. Hirst think it was possible to replace with metallic filament lamps within the next four or five years? He did not know whether that was too difficult a question to ask, but one would like to get some idea as to what was the probable output of carbon filament lamps in the near future. Mr. Harrison had made one remark as regards gas mantle tests, namely, that the gas mantle fell off very much from the beginning; he must say that this had not been his experience. He had found when testing in the ordinary way without any special laboratory conditions that they rose very largely during the first hundred hours or so, but after 150 hours they began to drop. Referring to Mr. Handcock's point with regard to the distribution of light, that the candle-power was always measured in the horizontal position, he really did not think this put carbon lamps at such a disadvantage. Of course, there was some disadvantage, but not more than 5 to 6 per cent. difference. The reduction factor for metallic filament lamps was about 0·7 or 0·8, *i.e.*, a reduction from the mean horizontal to the mean spherical. For the carbon lamps, it was 0·85 or 0·86.

Mr. T. H. LOWDEN (The Lowden Electric Lamp Co.) said that there was only one paragraph in the Paper which he wanted to quarrel with, viz., "Up to the present 40-50 candle-power is about the lowest unit obtained in a commercial lamp, and some extraordinary development or discovery will have to be made before that candle-power can be greatly reduced." He absolutely denied that statement. The British Westinghouse Co. at the present moment were selling a 220-volt 32 candle-power lamp; it could be bought on the market, and he had very good reason to know that in a short time high-voltage 25 candle-power tungsten filament lamps would be on the market, and would be a stock line. Mr. Hirst had referred to the blackening of lamps, and thought that this might possibly be caused by the vacuum not being what it should be. He knew for a fact that any lamp which was not properly exhausted would blacken immediately, and he had never yet met a lamp which would blacken if it were properly exhausted. There was a good deal of credit due to the people who had invented these metal filament lamps, but there was a good deal more to be done besides just making the filament. If the lamp were not made properly there was going to be trouble, and he was sure Mr. Hirst and Mr. Wilson would appreciate this.

Mr. C. H. WORDINGHAM said he would like to record his conviction that the metallic filament lamp was a blessing, and only a blessing, to the electrical industry. He had not an opportunity to speak upon the last Paper on this subject, but he did think that to hear central station engineers talking about raising the prices to keep out their best friends was painful in the extreme. The people to get revenue from were the people using gas, and the only possibility of getting them was by some such epoch-making invention as this, which cut the consumption down to one-third. Only those who had run a central station knew how impossible it was to get consumers unless they were told that they were to be charged a low price. There was a remarkable field for them, for they had not yet anything like a decent proportion of the possible consumers, and he was positive that the metallic filament lamp would enable them to take up this field. His only other remark was that he thought inventors might devote their attention to doing for the Osram lamp what they had done for the Welsbach mantle, and that was to invent a simple and useful anti-vibration holder.

Mr. L. GASTER, referring to Mr. Hirst's remark that he would treat people liberally in the matter of blackened lamps, asked if it was his intention to change them over the counter; or what did he mean by liberally. Another point was the condition of lamps when they reached the consumer. Out of one batch of 24 that reached him, 20 were broken. These were not osram lamps, however, but another metal filament lamp. That these lamps were fragile there was no doubt, and he thought that the more the user was impressed with the fragility the better. In this connection he referred to the German prescription which was sent out with the lamps. This stated that the lamp must not be dusted with a dry cloth, because it produced an electrostatic discharge and broke the filament, and recommended that when the lamps were dusted, the cloth should be damped. The patent question was also another important matter, and as consumers they ought to know to what extent they were likely to meet with trouble later on.

Mr. J. S. RAWORTH said he remembered the time when they paid 25s. for carbon filament lamps, and when the box was opened half of them were broken. Therefore he wished to say to Mr. Hirst that even if there was a little fragility in his new lamps he need not be downhearted about it, because that had been cured with regard to the carbon lamp, and no doubt it would be cured with regard to the osram lamp. He was rather annoyed that Mr. Drake should say that they did not use their lamps with sufficient intelligence, but at the same time he thought this was partly true. In his own drawing-room he had six lamps which had been there for ten years. If, however, he thought that the lamps were using more current all the time, then he would have them down to-morrow, even if he had to send for the gasfitter to do it. Twenty-five years ago, when the Swan lamp had come out, he had read a Paper before one of the scientific societies of Manchester upon the electric light of the future, and pointed out that for every ton of coal they were then burning under their boilers to produce electric light, only half a pound of it eventually appeared in the shape of light. He had forgotten how he had obtained the data for this calculation—it might have been by weighing glow-worms. The fact remained that they had been going on for 25 years, and had been burning three times as much coal under their boilers as they ought to have done, and when previous speakers spoke of giving the carbon filament lamp a chance, his answer was that it had no chance. The manager to one of the largest lamp factors in this country came to him the other day and said that he must have a metallic filament lamp because he could not sell carbon lamps. This was a very good reason, and he did not think there was a better one in the world.

The PRESIDENT (Colonel CROMPTON) said he was sorry they had not heard any speakers on the side of the supply companies, but he thought Mr. Wordingham was a little hard in his utterances in this respect. Perhaps, however, Mr. Wordingham was not aware that there were many cases of supply companies where gas did not compete at all, and where they had got all the consumers they could get. Therefore any reduction meant practically the loss of their dividends, and, secondly, that any money that would be spent during the next few years on replacing lamps in the houses would be very largely taken out of the consumer's bills for energy. How much that would be checked by the natural conservatism of the English householder, who hated to see the wiremen inside the house and to see any changes made, they did not know. It would for a certainty, in the case of stations which supplied the better class houses, undoubtedly be a very anxious time, and it was a curious thing that this, which was undoubtedly one of the greatest improvements which had taken place in the art of illumination, would cause such great anxiety to people who had put their capital into the illumination business.

Mr. HIRST, in his reply, thanked the speakers for the very kind manner in which the Paper had been received. Throughout he had been trying to keep the manufacturer in the foreground and the trader in the background; but by the questions that had been put to him and the points that had been raised it was not his fault if he had to answer a few questions in his capacity of trader. Both Mr. Gaster and other speakers had put questions to him which he could only answer in the same way as had been indicated by Dr. Louis Bell. We were not very well organised in this country for introducing a new delicate scientific thing. In America and in Germany the manufacturers were also the central station engineers; they were also traders in direct contact with the consumer, and they could bring out a new thing from beginning to end. In England they had to deal with a different state of things, and that was why they met difficulties which were not encountered in other countries. It was why he suggested some time ago that central station engineers should take this matter up. They had answered that they could not fall out with the contractors. Surely if anybody could not afford to fall out with the contractors it was the lamp makers. He would like to sell shades as suggested by Dr. Louis Bell, for he had various ideas intended to overcome this difficulty of fierce light; but the lamp maker could not get at the consumer. They had told the contractors that the lamps broke if they were treated roughly or if they were put in holders which jerked when the lamp was switched on. They had told them that they would not burn upside down, or that they would not burn in one position or another position, but how few contractors were organised to let the consumer know this? The same thing applied to series running, and even central station engineers at the beginning did not take the maker seriously. It was quite true, as Mr. Gaster had stated, that he had promised to be liberal with black lamps. So far as he knew he had been liberal, and all the leading contractors would bear him out in this, but how many small contractors were there who, when they exchanged lamps, thought it better business not to exchange them with the customers? He did not say this in any unkind way; the small contractors treated it as a matter of business, and the lamp makers had no power to control it. As regards series running he thought one-

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hundredth of an ampere was correct, and considering the little difference a few per cent. made in the life of a metallic filament lamp, and considering the experience they had had of these tests, he thought they were quite justified in sticking to this standard. Series running had proved a success from the moment it had been understood how to pair lamps properly. If he said that series burning would have to continue because he was afraid that no lower candle-power high-voltage lamp would come into the market at an early period, he said so because of what he knew of the manufacture of these lamps. He knew that it would require twice the length of filament for a 200-volt lamp than for a 100-volt lamp, and he failed to see with present methods how they could get a smaller unit of light. If, however, there were other methods, he thought it would take some considerable time before they were introduced, and in stating this as his own opinion he wished the Institution to understand that it was no use thinking that in a month, or in two months, or in six months, or in twelve months, these lamps would be a marketable thing. Their firm on the Continent, which made millions of these lamps, had at present no idea how a lamp could be commercially made with the lower unit. He had himself seen a 25-candle-power 200-volt lamp, but the price would not be a commercial one at all. On the question of breakage, he could only say that there were exaggerated ideas of this. His company first introduced a 5 per cent. breakage allowance for all who used these lamps, and recently they had offered to exchange any lamps that were broken. He did not know of a single instance in which the user had taken advantage of this offer. This, after all, was the best proof that the breakage could not be so terrible, and he believed that the breakage had been due more to carelessness in handling the lamps when they arrived than to breakage in actual transit. With regard to Mr. Handcock's remark as to why he used Hefner candle-power, he did this for the simple reason that the lamps came from countries in which Hefner candle-powers were generally used. He had no doubt that in course of time all these lamps would be dealt with in English candle-powers, although he personally must say that if he could prevent these lamps being sold on candle-power he would like to do so. He would like to sell the lamps by watts, as Mr. Bell had stated they sold them in America, where the standard sizes were 100, 60, and 40 watts.

Dr. BELL said they were rated in watts, but the candle-power was distinct from the rating. They were sold to run at 1¼ watts per English candle.

Mr. HIRST said he thought they would have a very good case when the Standards Committee came to deal with this matter, of trying to stick out for watts. Continuing his reply, he said he would not go through the whole list of speakers, but would promise everybody a full reply in the *Journal*. With regard to Mr. Campbell Swinton's remark, the statement had not been made on the strength of his own experiments. The information had been given him by the inventors of the gas mantle themselves, who had been working on this theory, and as collector of the information he thought it wise to give it to the meeting.

On the motion of the President, a vote of thanks was accorded Mr. Hirst for his Paper.

STEPNEY ELECTRICITY SUPPLY ACCOUNTS

THE report of Mr. W. C. P. Tapper, engineer and manager to the Electricity Department of the Borough of Stepney, for the year ended March 31st last shows an increase of net profit of £753 over that of the previous year, in spite of a decrease of 7 per cent. in the revenue per unit, this latter being 1·62d. per unit against 1·74d. last year. It is interesting to compare these figures with the average charge made by all the companies and Local Authorities of London, viz., 2·88d. per unit. The increases in the maximum load and the units sold are shown in the tables below. With regard to the use of metal filament lamps, Mr. Tapper reports as follows:—

The outstanding feature of the year, from the lighting point of view, has been the adoption by a very large proportion of the consumers of the new metallic filament lamps. These lamps mark an enormous advance in the utilisation of electrical energy for lighting purposes, the saving in energy per candle-power being from 50 per cent. to 75 per cent. of that taken by the carbon filament lamp, according to the type adopted. The new lamp results in as great an economy in the use of electricity as that effected in the consumption of gas by the introduction of the gas mantle, and at the extremely low prices ruling in Stepney to long-hour users electricity is undoubtedly cheaper than gas for equal candle-power. To the use of these lamps must be attributed the reduced increase in the sales for lighting purposes, in spite of the very much larger number of lamps connected.

The following table shows the number of units generated and sold for various purposes during the last two years with other interesting figures:—

Units sold and generated—	Year ended Mar. 31, 1907.	Year ended Mar. 31, 1908.
Units sold for private lighting ...	2,528,228	2,793,026
,, ,, power	1,229,000	1,833,130
,, ,, public lighting ...	993,954	1,086,528
Total units sold	**4,751,182**	**5,712,684**
Units used on works	158,434	184,591
,, in distribution	368,282	541,317
Total units generated ...	**5,277,898**	**6,438,592**
Connections (equivalent in 8 c.p. carbon lamps) —		
Private lighting	12,685	16,390
Power	19,636	41,776
Public lighting	448	282
	32,769	58,448
Plant capacity of station at end of year	3,720 kw.	3,720 kw.
Maximum supply demanded ...	2,414 kw.	2,831 kw.
Load factor	17·5 %	21·1 %

The units used in distribution will, of course, go up from year to year, but the opening of the Blyth's Wharf Station will materially check the rate of increase, as it will reduce the heavy transmission losses occasioned by supplying the eastern end of the borough from Osborn Street.

The following figures, calculated from the revenue account, give an analysis of the costs in pence per unit sold with the corresponding figures for the previous year (see ELECTRICAL ENGINEERING, Vol. I., page 830):—

COSTS PER UNIT SOLD.

Generating costs—	Year ended Mar. 31, 1907.	Year ended Mar. 31, 1908
Coal	0·34d.	0·39d.
Steam from dust destructor ...	0·14	0·10
Oil, waste, water, and stores ...	0·03	0·03
Wages	0·11	0·10
Repairs and maintenance	0·06	0·04
Distributing costs *—		
Wages, repairs, and maintenance	0·04	0·04
Total works cost	**0·72**	**0·70**
Management charges, &c.—		
Rents, rates, and taxes	0·09	0·08
Salaries and wages	0·11	0·11
Stationary, insurances, legal and establishment charges	0·06	0·06
Total cost per unit sold (excluding capital charges) ...	**0·98**	**0·93**
Interest and repayment of loans	0·62	0·62
Cost of temporary work written off	0·02	0·02
Total cost per unit sold (including capital charges) ...	**1·72**	**1·58**

The total working expenses, as analysed above, were £24,347 (including maintenance to public lamps), and the receipts from all sources amounted to £48,827. Of the balance thus given, interest and repayment of loans absorbed £15,282, and £270 was written off as cost of temporary work, leaving a surplus of £1,928. The balance carried forward from the previous year was £2,467. Of the £3,395 thus produced, £547 was written off for various purposes, and £1,200 was carried to reserve, so that £2,946 was finally carried forward to the next account.

* Attendance and repairs to public lamps is not included in the distribution costs as given above, but amounted to £2,004 or about 0·4d. per unit sold for public lighting for 1907, and £2,355 for 1908.

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With regard to the cost of fuel, Mr. Tapper writes as follows in the report:—

The accumulation of an exceptionally large stock of coal due to the threatened coal strike in the early part of the winter, together with the slightly higher coal prices obtaining during the year, and the necessity for the more extended use of the turbines, running non-condensing during the past winter, have unfortunately left their mark upon the coal bill. The quantity of coal used during the year has been 12,514 tons, 2,441 tons being Welsh coal (large and small) purchased at an average price of 19s. 5d. per ton, and 10,073 tons bituminous small coal, the average price of which was 13s. 8d. per ton.

The following figures will be of interest, viz.:—

	1906-7.		1907-8.	
	Coal.	Destructor steam.	Coal.	Destructor steam.
Units generated ...	3,945,643	1,332,255	5,050,037	1,388,555
Total cost of fuel ...	£6,651	£2,507	£9,247	£2,314
Average cost per unit generated	0·405d.	0·451d.	0·439d.	0·400d.

It will be seen that a slight increase in the fuel cost per unit is recorded. This has, however, been more than covered by reductions in other directions, bringing the total cost down by approximately 8 per cent.

The following table shows the capital expenditure under different headings up to March 31st, 1908:—

	£.	£ per kw.
Land	22,650	6·1
Buildings	60,344	16·2
Machinery	58,985	15·9
Accumulators	2,565	0·7
Mains	111,554	30·0
House services	12,006	3·2
Meters and demand indicators ...	7,502	2·0
Electrical instruments	2,948	0·8
Tools	896	0·2
Other items	8,510	2 3
	£287,960	£77·4
Deduct amount written off out of profits	8,346	2·2
	£279,614	£75·2

Institution of Electrical Engineers.—The following is the result of the ballot for new members at the meeting on Thursday: *Associate Members*—T. C. Baillie, J. S. St. G. Cooper, W. H. Frazer, J. Lustgarten, L. C. Morris; *Students*—J. Brander, E. A. Corbin, H. Cross, S. H. Crow, F. De Lautour, J. J. Fitzsimons, F. J. Gibson, C. Higgins, A. Hutt, A. Lee, T. B. Richardson, F. J. Stevenson, H. P. P. Trimingham, F. R. D. Wickham.

Canadian Electrical Association.—The eighteenth Annual Convention of this Association will be held in Toronto on June 10th, 11th, and 12th next. Several Papers on power transmission and distribution are to be read and discussed. One Paper is of a legal nature, and deals with contracts, with special reference to the sale and purchase of power and the drawing up of specifications and purchase of machinery.

Metropolitan District Railway.—Last week the running of a nine-car train from Barking to the City was commenced. It is claimed that this forms the longest multiple unit train in the world. The train is 450 ft. long, and carries 1,000 passengers. Five motor-cars and four trailers are used. At Whitechapel the train is uncoupled and divided into two of four and five cars respectively, which proceed separately, as the platforms of the stations further west are not of sufficient length to accommodate nine cars.

State Monopoly of Electricity Supply in Belgium.—According to the *Elektrotechnische Zeitschrift*, the Belgian Government has granted concessions for large power-stations in Brussels, Charleroi, Antwerp, and Ostend, for a period of 25 years. At the end of this period, the whole of the transmission and distribution cable network becomes the property of the State, which also reserves the right of superintending and acquiring the power-stations. The four stations are large enough to supply nearly the whole of Belgium, and arrangements are provided whereby the four separate systems can be linked up together if necessary. The stations are guaranteed the supply for the State railways, and for other State purposes, on terms not exceeding those of other competing supply authorities. Municipalities are allowed to enter into contracts for supply for periods of not more than 18 years.

THE "METALIK" INCANDESCENT LAMP

On page 767 of our last issue, in the course of an article on metal filament lamps for street lighting, reference was made to the satisfactory results which have been obtained at Croydon with "Metalik" lamps, which have been in use since the end of January for street lighting. We are now able to give a few particulars of this promising type of lamp, which has been put on the market in this country by G. M. Boddy & Co., incandescent lamp manufacturers, Newington Works, Liverpool. In addition to the favourable results reported by Mr. A. C. Cramb, of Croydon, we understand that at Bradford an average life of 1,407 hours has been obtained, and that on another corporation system, lamps are reported to be still unblackened which have been burning 1,356 hours. Other places where the lamps are in use include Hoylake, where a life of over 1,000 hours is also reported, Liverpool, Waterloo, Sheffield, and Wallasy, and great progress has been made since the first introduction of the lamp last year.

The efficiency of the lamp is approximately 1¼ watts per c.p., and at present lamps are made in the following sizes:—50 volts, 25 c.p.; 75 to 130 volts, 32 c.p. and 50 c.p.; 100 to 130 volts, 100 c.p.; and 200 to 250 volts, 50 and 100 c.p. A 24-volt 10-c.p. lamp, specially suited for train lighting, is also being introduced. Although the lamps have their filaments anchored in such a manner that it is possible to use them both in the case of high and low voltages, in practically any angular position, they are usually most successful if fixed in a downward vertical position. The filaments are manufactured under a special chemical process, of which we are unable at present to give full particulars, and the makers claim that they are of a tougher nature than any other metal filament, although quite as efficient.

The standard lamps have mostly been made hitherto in the usual elongated bulb, but recently it has been found possible to make the filaments shorter and more rigid, and a new type has been brought out with a smaller sized bulb, specially suitable for chandelier and ornamental fittings. This form includes 32-c.p. lamps for voltages from 70 to 130 volts. Although of slightly higher price, the lamps have found much favour, especially in Paris, where large numbers are already in use, and we understand that during the last few days an order for 250 of these has been received for fixing in chandeliers in a church in England. The high-voltage 50-c.p. lamps are also now made with spherical bulbs, which we understand are preferred by many corporation engineers for street lighting, for various reasons.

Electrically Propelled Commercial Vehicles.—The lorries manufactured by the Siemens-Schuckert Werke are provided with batteries of lead cells, manufactured by the Akkumulatorenfabrik A.-G., of Berlin. The battery, which is placed under a hood in front of the driver, consists of 40 cells, and has a capacity of 244 ampere-hours at a five-hour discharge rate. A two-ton lorry with this battery will travel 27 miles on one charge. The motor is a 7 h.p. series motor, geared to the back wheels through differential gearing. All gear wheels are of nickel-steel, and run in oil. The efficiency of the motor varies between 80 and 85 per cent. The wheel of the band-brake situated on the motor shaft is constructed in the form of a fan to assist in cooling the motor. An omnibus with the above equipment is capable of carrying sixteen passengers.

Arc-Lamp Electrodes.—A Paper, read by A. B. Cornwell before the American Institute of Electrical Engineers, and reported in a recent issue of the *Western Electrician*, contains some interesting information concerning arc-lamp electrodes. Electrodes were grouped into three classes: (1) carbon electrodes, (2) impregnated carbon electrodes, and (3) electrodes of metallic oxides and of metals. Carbon electrodes will maintain a steady arc on alternating-current circuits at a low voltage. The one-half-inch carbon is most generally used, but experiments show that five-sixteenth-inch carbons have a higher efficiency, whiter light, and hold a steadier arc. The expense of trimming, however, is increased with the smaller carbon. A few of the minerals used for impregnating electrodes of the second class are silicates, chlorates, phosphates, and boric acid to reduce combustion, magnesia and borates of soda and potash to increase the conductivity, and salts of calcium and phosphates to increase the luminosity. The proportion of minerals sometimes reaches as high as 7 per cent. In the third class the electrodes are made up of metallic oxides, such as magnetite and hematite; titanium oxide possesses good luminiferous properties, but is a bad conductor. In the magnetite arc-lamp the negative electrode contains oxides of magnetite, titanium, and chromium. The positive electrode is usually a metal, copper having been used to some extent. The life of a magnetite electrode is about 175 hours to about 120 hours for the carbon. A magnetite arc requires no inner globe. It can be operated off direct-current circuits or off alternating-current circuits with a mercury rectifier.

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THE BIRMINGHAM ELECTRICAL FITTINGS INDUSTRY

MANY of our readers will doubtless be interested to have some account of the present condition of the fittings industry, and as Birmingham is the chief centre for this branch of manufacture, we propose to give the results of our investigations in this city. Several reasons combine to render Birmingham specially adapted for this class of work. Birmingham brassworkers have always displayed enterprise and foresight in adapting themselves to new conditions, and at the advent of electric light took up the manufacture of electroliers and other fittings to such purpose as to obtain a practical monopoly of this trade. Rolling mill and tube works abound in the neighbourhood, and provide the sheets and tubes for conversion into fittings of every description. The glassware for use in connection with fittings is also produced largely in the district.

A large proportion of the fittings turned out are of the machine-made description, the parts being stampings rather than castings, spinnings rather than hand-



Fig. 1.—Birmingham Guild of Handicraft : Table Standard.

raised or hammered work. At the present time, however, it is noticed that there is a distinct tendency towards the introduction of a more artistic fitting, into the production of which individual skill enters to a considerable extent. The Municipal School of Art has recently started a special class for brassworkers, and it is to be anticipated that the craftsmen trained in this manner will exercise a beneficial effect in the industry. At the same time it should be pointed out that the power to improve the type and design of fittings rests almost entirely with the head of the firm, and there appears to be considerable need for an art class in metal work for the benefit of the employer as well as the employee.

Whilst on this subject it should be pointed out that the Guilds of Handicraft are exerting a good influence on the design and manufacture of electrical fixtures. The Birmingnam Guild of Handicraft set before themselves a high artistic standard and steadfastly refuse to undertake work which does not conform to this standard. This firm takes every year one or two apprentices who have been through the complete course at the Municipal School of Art, and has now a staff of workers with both artistic perception and technical skill. Practically the whole of the work turned out by this firm is hand-made, and it is significant of the demand for this type of fitting that several orders have been received from the United States. It may be

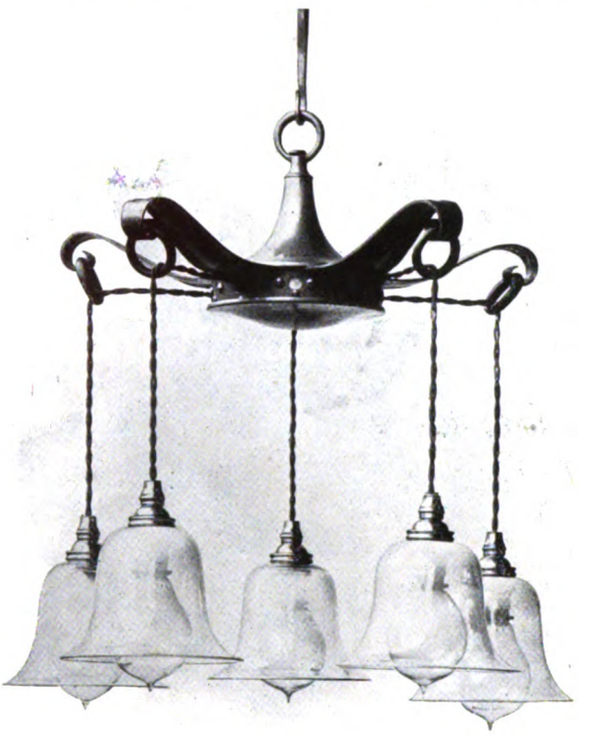


Fig. 2.—Birmingham Guild of Handicraft : 5-light Fitting.

mentioned that the Guild was created by the Kyrle Society with the object of providing work for metal workers and others who were in need, and reached by gradual steps its present semi-commercial status.

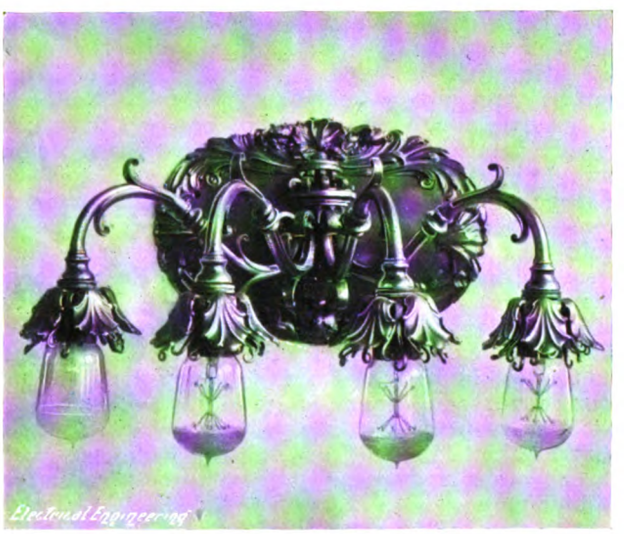


Fig. 3.—Fittings with Tantalum Lamps made by the Bromsgrove Guild of Applied Arts.

Another guild which is carrying out highly artistic work at the present time is the Bromsgrove Guild of Applied Arts, which was founded some seven years ago by Mr. Gilbert with the express object of reviving the class of work for which the eighteenth and earlier cen-

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turies were famous, work which bore the mark of the feeling and care taken in its execution, in contrast to the machine-made repetition work, which was the

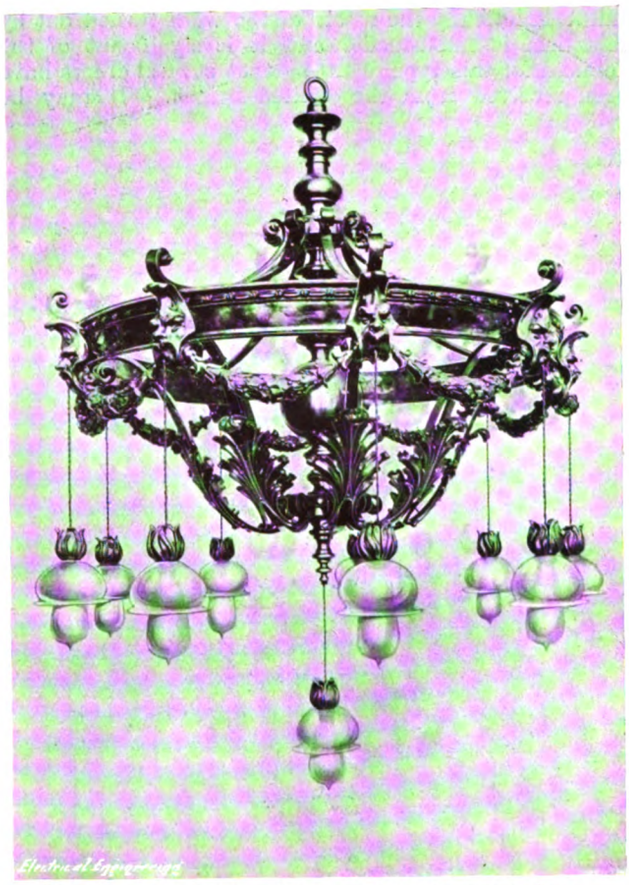


Fig. 4.—Electrolier made by the Bromsgrove Guild of Applied Arts.

natural outcome of the vast development of machinery in the Victorian era. This guild is located at Bromsgrove in the centre of one of the prettiest rural districts in mid-England.

Before describing the specialities of various firms we may mention that during our visit of inspection of some of the shops we noticed that a new system of insulation has recently been adopted by the Admiralty for fittings to be used on board ship. Instead of earthenware, or other fragile material, mica or micanite is employed, one object being to employ a thoroughly reliable insulating material, and to avoid risk of fracture during the firing of guns. Switches, plugs, fuse, distribution, and main switchboards were in process of construction on these lines. The larger boards are built up of angle iron, the live parts being insulated from the frame by sleeves or washers of micanite: in the case of switches and plugs, the bodies of which are of brass, discs of micanite are inserted to act as an insulating lining. The Admiralty has also recently taken up the loop-in method of wiring for ship work, and this has caused considerable alterations of ceiling roses, &c., on account of the larger number of glands necessary for the additional leads. These glands are of circular section, with grooves slotted in the periphery for tightening purposes.

General Electric Co.—As would naturally be expected in the case of the firm which is responsible for the introduction of the Osram lamp, a considerable amount of attention has been devoted to fittings specially adapted for use with this peculiarly shaped bulb. Although a series adaptor is a cheap and convenient method of utilising the Osram lamp where the voltage is too high for single lamps, nothing whatever can be said in its praise as an *objet d'art*, and some of the recently designed fittings produced by this company are a great advance in this respect. Mill fittings, pendants, bulkhead and ceiling fixtures have all been modified to meet the altered conditions, and naturally the shades and globes have also come in for revision.

On account of the less satisfactory working of Osram lamps of high voltage in any other position than the vertical, the company are at present getting out a new design of swivelling ball socket to get over the difficulty. This socket consists of two half-spheres held together by a bead, and so arranged as not to damage the insulation of the conductors.

A novelty is now being put on the market under the title of "Easyphix," which may be said to resemble the well-known child's toy, "Mechanics Made Easy." The basis of the fixture is a spinning in the shape of a flat ring, in the periphery of

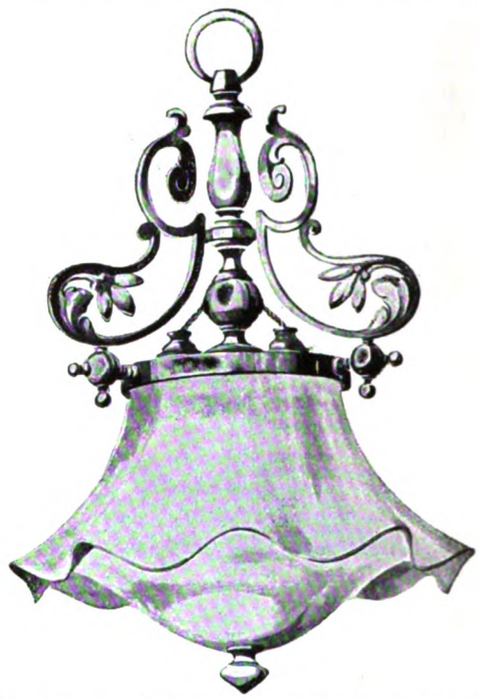


Fig. 5.—General Electric Co.: New Pendant for two Osram Lamps.

which there are sixty holes. In these holes are fixed a greater or less number of arms of various designs, so that the fitting can be used at will for 2, 3, 4, 5, 6, 10, 12, or 20 lights. The figure 60 was selected as affording the greatest number of permutations of convenient size. One of these fittings is illustrated on the opposite page.

Stampings and spinnings enter very extensively into the make-up of fittings, as they are much more cheaply produced than castings when made in large quantities, but a large amount of casting is done, more especially in connection with the smaller parts.

C. J. Thursfield & Co.—This old-established but comparatively little-known firm devote their attention largely to the manufacture of fittings to special designs which are for the most part of substantial construction. The parts are mainly castings which are finished almost entirely by handwork, and it is interesting to note that the firm does its own casting. A considerable number of fittings have been supplied for the Indian market, and some massive fittings have been supplied for Government buildings. As an indication of the care taken by this firm to study the wishes of their customers, it may be mentioned that a special line of what a Britisher would style unduly ornate fittings has been developed to suit the Oriental taste of the Indian, who is not satisfied with the more plain fittings used for the most part in England.

Verity's, Ltd.—This firm have a good supply of orders, and are busy in all departments. In the fittings line more artistic and elaborate designs are in demand, and these necessitate a greater amount of handwork than the cheap style of article. An improved type of electrolier was seen, in which the arms, instead of being screwed direct into the central ball, are fixed in a ring of substantial design, and the ball is divided along its horizontal diameter beneath the ring, so that by the loosening of a vertical screwed rod the bottom half may be removed, and the wiring carried out with great ease. This obviates the trouble often experienced in wiring the old type of fixture. Another interesting item is a tilting shade carrier for cord pendants, which is capable of adjustment in two planes, so that the direction of the light can be varied with facility.

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This is on new lines, and is a great advance on previous designs.

Another new development by this firm is an improved type of suspension chain, consisting of a ring with four projecting pins 90° apart, on opposite pairs of which are fixed links. This invention is due to Mr. Smith, and its object is to provide a safe and convenient method of running the flexible conductor. The conductor is threaded through the rings, and is consequently not subject to the same liability to injury as with the ordinary type of chain.



Fig. 6.—General Electric Co.: "Easyphix" Fitting (10 lights).

Fig. 7.—Verity's, Ltd.: Electrolier with Split Ball for easy wiring.

Fig. 8.—Verity's, Ltd.: Tilting Shade Carrier for Cord Pendant.

J. H. Tucker & Co.—This firm found that its quarters in the heart of Birmingham did not allow of sufficient room for the necessary extension of their business, and taking the bull by the horns have moved out into what a year or two ago were open fields. Here they have unlimited room for future extensions, have first-rate shops designed without regard to restrictions of space, with the advantage of much better natural lighting than is possible in a crowded city area, and much more healthy conditions for their employés, who are, for the most part, women and girls. To indicate one economy effected we may mention that the amount of artificial light required is reduced by two hours per diem. Messrs. Tucker's are shortly bringing out a new catalogue embodying the recent improvements in the design of their manufactures. Among these may be mentioned an improved construction of tumbler switch, in which the necessity for putting a strain on the insulating bush is done away with (Fig. 9), and a double contact is employed (Fig. 10), acting on both sides of the switch blade, and adjusting itself much more easily than the single contact, which only acts on one side of the blade. This arrangement avoids the possibility of there being bad connection with consequent sparking. A large number of the parts of the switches, &c., are turned out by automatic turret lathes, but the majority of the stamping is done by hand.

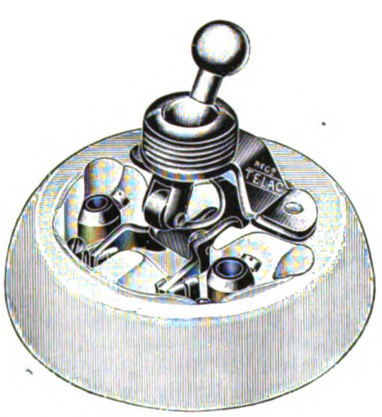


Fig. 9.—J. H. Tucker: Tumbler Switch down, showing Roller Action.

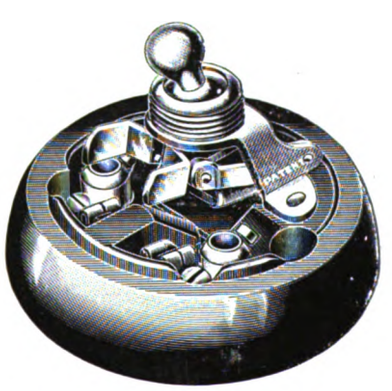


Fig. 10.—J. H. Tucker's Tumbler Switch, with Double Contact.

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F. and C. Osler, Ltd.—It may not be generally known that this firm were originally manufacturers solely of glassware. When electric light came into vogue, a demand arose for electroliers of the cut crystal type, and the firm gradually took up

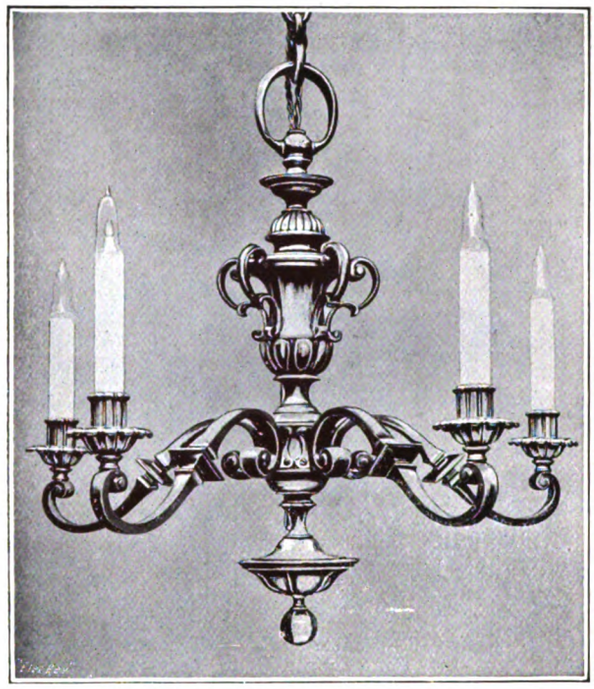


Fig. 11.—Osler & Co. : Candle Fitting, Georgian Style.

metal work. It may be remarked that the fact of the firm producing both the glass and the metal ware greatly facilitates the production of artistic fittings. One example which came before our notice was a small pendant with gunmetal frame,

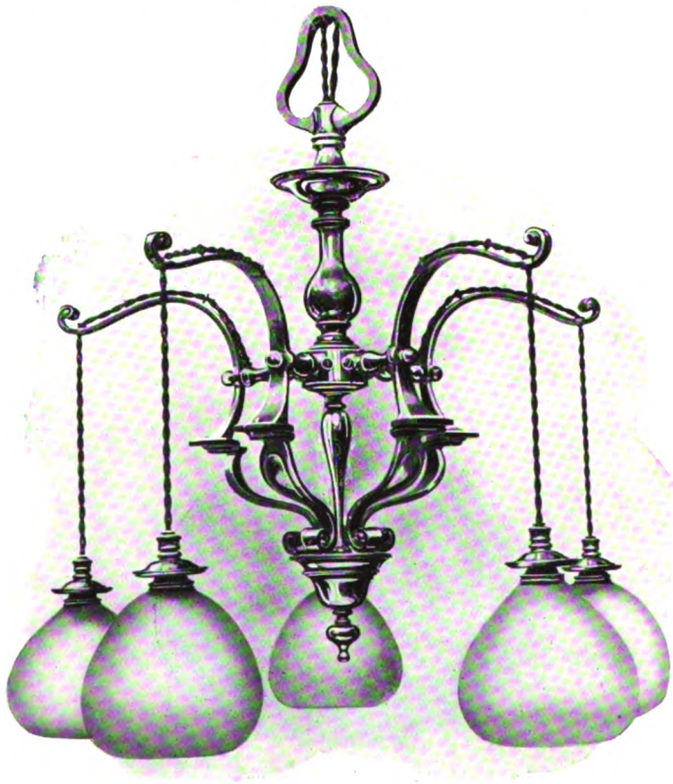


Fig. 12.—Osler & Co. : 5-light Fitting, Georgian Style.

into which the glass globe had been blown whilst still in plastic condition.

The class of fitting for which this firm is now justly famous is the 18th century or Georgian style, which has been evolved by Mr. Herbert Pepper after long and careful study of the architecture, furniture, and decorative art of this period. They may be said to hold the same position in regard to electric light fittings that Sheraton and Chippendale do to furniture, and if it is borne in mind that there were no examples of such work extant for the designer to reproduce and imitate, it must be acknowledged that great credit is due to this firm for its creation of this style of fitting. Other styles produced are the Adams and Dutch.

During a tour of the works, the point which strikes one most forcibly is the large amount of manual skill exercised. Most of the processes are carried out by hand in contrast to the automatic machine methods used to such a large degree at the present time. The price of a cut glass dish for bulk-head or ceiling fitting is seen to be perfectly reasonable when the time and skill necessary for its production is taken into account. The grooves are first ground out roughly by a steel wheel with fine sand as the triturant, next smoothed up by a stone, and finally polished by a wood wheel. The amount of care, skill, and patience necessary to do this must be seen to be properly appreciated.

FIRE ON THE CITY AND SOUTH LONDON RAILWAY

A FIRE occurred in the Clapham Common Station of the City & South London Railway on Sunday morning under somewhat peculiar circumstances. On Saturday night the last locomotive was left in the station as usual, and everything was shut down, including the generating station, at a quarter-past twelve. The station is only opened at half-past eleven a.m. on Sunday morning, as there would be practically no City traffic on that morning, and the line is not working, but at seven o'clock smoke was seen to be issuing from the top of the station. The alarm was given, and fire engines and fire escapes arrived on the scene. The firemen experienced some difficulty in getting down to the platforms, owing to the dense smoke that was rising, but finally, by using smoke helmets, they succeeded in descending to the platform. There they found that the locomotive already mentioned was in flames, and it was only a matter of a few minutes to extinguish it.

In a report, which appeared in the *Times* on Monday morning, it was stated that the fire was probably the result of "the current having short-circuited," and mention is also made of "the hazardous task of shifting the engine motor out of the way of the other rolling stock." Needless to say, it is quite impossible for the fire to have been electrically caused, as the current was entirely switched off and the generating station had been actually shut down since the previous night. It is thought that the fire may have been due to the emergency oil lamp having been left burning and in some way setting fire to something, or else that a match or cigarette end had been left in the cab of the locomotive near a box in which waste, &c., is kept. The watchman, who was below at 3 o'clock in the morning had reported that all was well.

Although the locomotive was of steel construction, the fire had done considerable damage, as all the cables and casing had been burnt out, and there is very little of the controller left.

Damage to Cables by Trawlers.—A Reuter telegram reports that the Commercial Cable Company has made representations to the State Department at Washington, requesting diplomatic correspondence with Great Britain on account of damage done by English fishing trawlers to the American submarine cables between America and Europe. The Commercial Cable Company states that during the past three months it has been put to an expense of over $100,000 in repairing its cables within fifty miles of the Irish coast on account of these fishing trawlers, two and even three of the cables having been injured and broken at a time. The interruptions affect not only communication between Europe and America, but also between Great Britain and Canada, and, consequently, between Great Britain and Australia.

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THE MANCHESTER ELECTRICAL EXHIBITION

A GOOD deal of progress is being made in the arrangements for the Electrical Exhibition, which is to be held in Manchester in October next. At the last meeting of the Committee, held in the Electricity Department of the Town Hall, Manchester, on Tuesday, May 12th, applications and inquiries for space from some 130 would-be exhibitors were dealt with, and a very large number of allotments were made. Since that date applications and allotments are being dealt with as received, and there are ample indications to prove that the Exhibition will be thoroughly supported by all branches of the industry. A number of interesting exhibits of machinery in operation have already been arranged for by combinations of the principal motor manufacturers and the makers of textile machinery, machine tools, and the like. As already announced, the Exhibition is receiving the support not only of the Manchester and Salford Corporations, but of some thirty adjoining towns and the Lancashire Electric Power Co., which is in itself a strong indication as to the importance which is attached to it. It will undoubtedly serve as a great impetus to the industry.

The electrical trade generally must not underrate the importance of the Exhibition, as it is their own, being run by themselves and for trade benefit only; and as Manchester is known to be the centre of one of the greatest manufacturing districts in the world, the far-reaching effect of such an Exhibition is bound to bring beneficial results to all taking part in it.

A further meeting of the Committee was held in the Town Hall, Manchester, on Tuesday last, when a number of important applications for special exhibits, which it is considered are likely to be particularly attractive, were arranged for.

Supply of Current.

Electricity for exhibitors' stalls will be supplied by the exhibition to each stand at 2d. per unit for lighting, and 1d. per unit for power. The supply will be (*a*) three-phase alternating 50 periods at 400 volts, and (*b*) continuous current at 200 volts for lighting, and 400 volts for power. (For 3½ h.p. motors and below this power 200 volt continuous current may be used.) Alternating current lighting supplies will be furnished at 240 volts, *i.e.*, the voltage between either phase, and the star point. Exhibitors must arrange to balance up their lighting equally between the three circuits, where three circuits are taken to one stand.

Wiring Rules.

The necessary meters, main fuses and main switches, at a rental varying from one to two guineas, according to capacity, will be provided by the exhibition authorities. The exhibitor must provide suitable space on his stand, and a board on which the above can be mounted. The connection of the supply-leads to the main switchboard will be carried out by a duly authorised firm on behalf of the exhibition. Exhibitors will be required at their own cost to wire their stands generally in accordance with the regulations of the Manchester Corporation and to the following details.

The exhibition reserves the right through their Consulting Engineers, Messrs. Pearce & McCowen, members of the I.E.E., to refuse to connect any stand which does not comply with the above regulations or conditions herein set forth; and for the purpose of ascertaining that their regulations are complied with, their Consulting Engineers shall have the right to examine the wiring and connections to each and every stand; and in the event of any disagreement, the matter to be referred to the Hon. Consulting Electrical Engineer, Mr. S. G. Castle Russell. The exhibition also reserves the right to limit the supply to any consumer.

Distribution Boards and Local Circuits.—The supply to each stand from the main switchboard must be sub-divided into circuits and controlled by D.P. fuse boards, to be supplied by the exhibitor. The fuses are to be of the bridge or other approved enclosed type; the terminals and bus-bars are to be efficiently mounted on porcelain or slate bases, and contained in boxes lined with asbestos sheets and amply divided between opposite poles. No incandescent lamp circuit shall exceed four amperes, and no other single circuit 15 amperes, without first obtaining the approval in writing of the Consulting Engineers. Branch switches, if used, shall be of the tumbler type, high pressure pattern to carry four amperes. Arc lamp circuits must be controlled by D.P. fuses and linked switches. Motor circuits must be controlled through D.P. fuses, linked D.P. switches, and mounted in metal cases. All switches with projecting handles must be so protected that they cannot be actuated accidentally. Enclosed type starting switches and resistances must also be supplied, the latter being provided with "maximum" and "no-voltage" releases.

Conductors.—No bare conductors allowed. All conductors shall be of tinned copper, and shall be so proportioned to the work that the current density shall not exceed a ratio of 800 amperes to the square inch. All conductors, except flexible cords, shall be insulated with pure and vulcanised rubber, taped, braided, and compounded, and have an insulation resistance of not less than 1,000 megohms per mile. Flexible cord shall be insulated with pure or vulcanised rubber, and covered with stout silk, cotton, or other approved braiding. Its use must be restricted to pendants and portable appliances approved by the Consulting Engineers. Wires and cables shall be adequately and firmly fixed, and in all cases where wires are within reach of the public they must be enclosed in wood casing or other approved covering. All joints must be covered with pure rubber and proof tape. On circuits to carry more than four amperes, clamped joints must be used.

Protection of Conductors. Unencased conductors must be out of reach of the public, securely supported on insulators, run in such a position as to be reasonably free from any interference that might otherwise cause them to be damaged, and tappings must be made by insulated conductors other than flexible, with properly taped joints. Unencased conductors must not be in contact with bunting, gauze, cloth, or other covering material. "Fairyland" strips are allowed, but unless holders are fitted with metal backs, must be securely mounted on Uralite or similar board or insulators out of reach of the public. No. "E.L.B." flexible strip or boards will be allowed unless in iron cases with glass fronts. Wiring at the back of wood sign boards must be encased. Wood casings with batten holders will be allowed. Exhibitors proposing any system of lighting not included in the above will please send full particulars to the manager forthwith, for consideration, as otherwise it may not be possible to connect their stands.

Celluloid.—No imitation candles, shades, or other accessories made in celluloid will be allowed on fittings connected to the supply or to accumulators.

Metal Tubing.—If metal tubing be used, both lead and return wires must be in the same tube, screw jointed, and earthed, unless exemption be granted by the Consulting Engineers.

Local Switches.—All switches must be of quick action, ample dimensions and "break," and without intermediate position between "on" and "off." They must be placed out of reach of the public, and must not be placed beneath counters or in show cases, but preferably mounted and protected as distribution boards.

Show Cases.—These must not be lighted from the inside.

Arc Lamps.—Not more than six arc lamps shall be simultaneously in use on one stand, and the supply for any one arc lamp shall not exceed 15 amperes by 55 volts, 7¼ amperes by 110 volts, or 4 amperes by 220 volts. No naked arcs will be allowed. Arc lamps must be enclosed with one or more globes, and ash trays, if provided, must be efficient. The outer globe must be protected with wire netting if deemed necessary by the Consulting Engineers. The lamps must be suspended on insulators by steel wire or hooks, *not* by the conductors. The connecting cables must be suitably protected from contact with inflammable material. External resistances must be in fire-proof cases, and must be mounted at least 12 ins. horizontally and 18 ins. vertically from woodwork or other inflammable material. Each series of arc lamps must be controlled through D.P. cut-outs and linked switches.

Electric Motors.—Motors exceeding ¼ h.p. must be of the "totally enclosed" or "ventilated enclosed" type, and must be mounted on sheet-iron trays to catch oil. In the latter type the ventilated openings in the motor must be covered with metallic gauze. The starting currents of any motors and the number of steps on the starter must conform to the standard regulations of the Manchester Corporation. If the starting current of any motor be excessive in the opinion of the Consulting Engineers, they reserve to themselves the right to determine certain times for starting up, or alternatively, to request the exhibitor to provide an improved type of starter. For three-phase motors, squirrel cage wound rotors will be allowed up to 40 h.p. Above this the slip ring type of rotor, or some other means of starting, must be provided, to be approved in writing by the Engineers.

Transformers and Accumulators.—Neither live transformers nor accumulators will be allowed unless special permission be granted by the Consulting Engineers.

Stand Roofing.—If and where stands may be covered on the top, the roofing must be of solid construction, otherwise the stand will not be connected.

Contractors.—The names of proposed contractors other than those on the Corporation's registered list must be submitted to the exhibition manager for approval by the Consulting Engineers, and all stands must be ready for connecting up at least 72 hours before the opening of the exhibition.

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CATALOGUES AND PAMPHLETS RECEIVED

ARC LAMPS AND ACCESSORIES.—Two new leaflets are to hand from Mr. G. Braulik, of 217 and 218 Upper Thames Street. One of these deals with a new semi-enclosed continuous-current arc lamp, known as the "Aster Eclipse," intended to take the place of small flame arc for interior lighting, and the other describes several forms of ratchet winches for lowering arc lamps.

CRANE CONTROLLERS.—A new list from Messrs. Siemens Brothers Dynamo Works, Ltd. gives illustrations and full particulars of a complete series of crane controllers, embracing a number of patterns for continuous and alternating currents. These controllers are of a simple and substantial drum type with magnetic blow out. The contact fingers are of hard-drawn copper of a special hinged design pressed against the panel by a stout flat steel spring. No combustible material is used in the construction of the drum. A large number of different forms of hand wheels and levers can be fitted, including the convenient universal arrangement for working two controllers by the movement of the same handle in different planes. The resistances can be attached to the controllers, arranged in separate cases. Special care is used in the graduation of the various steps. Both the continuous and alternating-current controllers can be arranged for various different combinations of forward, reverse, free running, and braking positions. A complete series of spare parts is listed, and very full information is given of the different forms of controller available. A frontispiece shows a 1-ton crane fitted with Siemens motors and controllers recently erected at Tower Bridge Wharf.

ELECTRIC FANS.—Particulars of a variety of forms of continuous-current "Stellite" fans are given in a new list just issued by the Electric and Ordnance Accessories Co., Ltd., of Stellite Works, Aston, Birmingham. These fans are British made, and are designed to pass the tests of the British Admiralty. The "A. P." pattern combines in itself the distinctive features of the desk, trunnion and bracket types, and is thus equally suitable for use on table, floor, desk, wall or ceiling. The frame consists of an ornamental cast-iron pedestal, with a gimbal ring of the same material. The pedestal is fitted with rubber feet to absorb vibration, and to prevent damage to polished surfaces. The gimbal has brass fittings. The field cores are cast in one piece with the motor body. The commutator is of hard drawn copper, and the slots of the armature are carefully lined with insulating material. Double silk covered high conductivity copper wire is used for the armature and field windings, and before and after taping all coils are impregnated under vacuum with an insulating compound, and the armature bearings, of phosphor bronze, are fitted with wickfeed lubricators. The starting switch and speed regulator are fitted inside the base, the resistance consisting of wire coils wound on non-hygroscopic porcelain. Spring catches ensure the switch being left central on the respective stops. In addition to this universal type, ordinary pedestal fans, cabin fans, and porthole fans are listed. With the exception of the "cabin fans," which are intended for rooms with low ceilings and have two horizontal blades with 26 in. or 36 in. sweeps, all these fans are made in the 12 in. and 16 in. sizes, driven by what is described as a 1/16 h.p. motor. The motor for the larger cabin fan is an $\frac{1}{8}$ h.p.

ELECTRIC LIFTS.—A pamphlet from the Electric Construction Co., Ltd., of Wolverhampton, describes their different types of passenger and goods lifts. These can be obtained with either "drum" or "friction" drive, and with hand-rope, car-switch, or press-button control. The motors are specially designed for lift work, and are coupled to the winding drums through worm and worm-wheel reduction gear. Illustrations of some of the standard types of continuous-current and three-phase alternating-current control switchgear are given.

SMALL MOTORS, CRANES, AND TRACTION EQUIPMENTS.—Several new pamphlets have recently been issued by the Oerlikon Co., of Zurich. One of these gives an interesting description, with numerous views, of the departments of the works where small motors are manufactured. These shops have recently been considerably extended. Illustrations of a number of types of the machines manufactured are also given. The other two pamphlets give a very good idea of the large amount of work the firm is doing in the direction of electric cranes and heavy traction, by lengthy lists of contracts carried out, and excellent illustrations of some typical examples of plant supplied, and views of railways equipped.

STEAM TRAPS.—A leaflet from W. Geipel & Co., of Vulcan Works, St. Thomas's Street, S.E., gives particulars of the latest forms of the well-known Geipel "Rapidity" steam trap, including both the ordinary and special Admiralty types.

SWITCHGEAR, TESTING APPARATUS, &c.—A set of lists is to hand from Messrs. Morris and Lister, of Carlton Works, Coventry. Illustrations are given of complete switchboards for various purposes, and particulars are contained of a number of items of switchboard equipment, which the company specialise in, including quick-break knife switches, tubular porcelain switch fuses, thermal excess current alarms, ironclad switches, and a new form of thermal overload circuit breaker. In the last-mentioned piece of apparatus, two contact blocks are fixed rigidly to, but insulated from, the switch arm. They are connected electrically by two parallel strips of suitable metal, each fitted with a steel catch piece. When the switch is closed, the strips are sprung apart over a fixed catch, and the full rated current does not loose the catch. Overload causes the strips to move apart, and the circuit breaker flies off under the action of a spring. The testing apparatus dealt with includes Messrs. Morris and Lister's well-known eddy current brake for testing small motors, and a series of specially designed choking coils for testing alternating plant on inductive loads, on the lines described in Messrs. Morcom and Morris's recent paper before the Birmingham Local Section of the Institution of Electrical Engineers.

PORTABLE LAMP WITH PRIMARY BATTERY.—The New Ignition Syndicate, Ltd., of Canal Bridge, Old Kent Road, have sent us pamphlets relating to a portable lamp with a primary battery, and have also showed us a specimen of it. The lamp is intended for emergency use, &c., and consists of a wooden box containing the battery, with the lamp fixed on the front. The battery used is a single-fluid one, and when the box is in its ordinary upright position, the plates are out of the liquid. To ignite the lamp, the box is simply inverted. The zinc is removable for replacement, and forms part of a watertight stopper. Two sizes are used, one containing a single cell, and the other containing two cells. The latter measures 6 in. by 3½ in. by 7 in. high, and weighs 5¼ lb. when charged. Metal filament lamps are used. It is stated that one charge suffices to light the lamp for six consecutive hours in the small pattern, and ten consecutive hours in the two-cell pattern.

TWO-WAY SWITCHES, &c.—A new leaflet from A. P. Lundberg and Son describes the construction and applications of this firm's well-known "Marvel" switch, by which a large number of systems of control of several lamps from one or more points can be effected (see ELECTRICAL ENGINEERING, Vol. II., p. 624).

WIRELESS TELEGRAPHY.—Several new publications have been issued by Marconi's Wireless Telegraph Co. These comprise reprints of Mr. Marconi's lectures, given recently before the Royal Institution and the Liverpool Chamber of Commerce, and a pamphlet entitled "Ten Years of the Marconi System of Wireless Telegraphy." This contains a historical account of the development of the Marconi system, from the experiments of Mr. Marconi in 1895, founded on the work of Hertz, Branly, and Lodge. The forms of coherers and other apparatus used in the earlier stations are described, and the simpler forms of "syntonic" and duplex transmission are explained by means of diagrams. The now familiar history of the perfection of transatlantic wireless communication is recounted, and an illustration is given of the Marconi magnetic detector. A good many of the historical details have recently been given in our columns in connection with the company's annual report.

Post Office Underground Telegraphs.—In a reply to a memorial from the Associated Chambers of Commerce, the Postmaster-General stated that the extension of the underground system is progressing as rapidly as possible. The line to Cornwall, which is of importance in connection with the submarine cables, is approaching completion. Work on the Newcastle-Leeds line and the main underground line to the north is being pushed on as quickly as possible, and the line from Edinburgh to Glasgow is nearly complete.

Automatic Transformer Switch for Metallic Filament Lamp Circuits.—Mr. W. J. Davy, of Arc Lamps, Ltd., has a new automatic switch for metallic filament lamp transformer circuits, in the stages of commercial development at present, and has a specimen of the apparatus under trial, so that it may be expected to be placed on the market at no very distant date. The switch is combined with the transformer, and a feature of it is that no alteration is made to the existing wiring, and one lamp switched on or the last lamp switched off will automatically cut the transformer in or out as the case may be. A brief reference to the patent was made in our last issue.

Manufacture of Metallic Filament Lamps.—According to *L'Electricien*, a method for the electrolytic manufacture of metallic filaments has been recently patented. The method consists in electrolytically depositing a skin of osmium-iridium alloy on an ordinary carbon filament. The filament is made the cathode, and the electrolyte is a solution of potassium osmiate with a small amount of iridium chloride. The carbon core is vaporised by raising the whole to a very high temperature by means of an electric current. The resulting osmium-iridium filament is stated to be strong and ductile.

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ELECTRICAL SCIENCE

British and American

Comparison of the Board of Trade Ampere-Standard-Balance with the Ayrton-Jones Current-Weigher.—During the last few years a new current weigher, designed at the Central Technical College, has been constructed at the National Physical Laboratory with a precision not previously obtained in any instrument for the absolute determination of current. When the Board of Trade ampere balance was set up and verified in 1894, the platinum weight used with the instrument was adjusted so that a current which deposited silver at the rate of 1·118 milligrammes per second produced, on reversal, a change of force equal to the weight of the platinum. At that period such a current was believed to represent the ideal ampere with a fair degree of accuracy. T. Mather and F. E. Smith read before the Royal Society, on March 26th, an account of their experiments to compare these two instruments. The comparison was carried out by the aid of cadmium cells and resistances used as secondary standards of current; for example, if a current be passed through a resistance, and the strength of the current be adjusted until the P.D. between the terminals of the resistance is equal to the E.M.F. of a standard cell, then, when the cell and the coil are at given temperatures, a perfectly definite current must be passing through the coil. If the current be determined in absolute measure by means of a current weigher, the combination of cell and resistance is standardised, and can be used subsequently as a secondary standard of current. Knowing the relations between E.M.F. and temperature for the cell, and between resistance and temperature for the coil, the current required to produce equality of P.D. and E.M.F. at any given temperature can be found. The authors in this way standardised certain combinations of cells and resistance by means of the Ayrton-Jones weigher at Bushy, and then these were taken by hand to the Board of Trade Laboratory at Whitehall. Two slightly different methods of using the Board of Trade balance were employed, and the mean of six independent comparisons carried out on three successive days show that currents, as measured by the Whitehall balance, are about 0·053 per cent. higher than their values in terms of the Bushy balance. That is, the Board of Trade ampere is about 1/30 per cent. smaller than 1/10 of the C.G.S. unit of current as determined by the National Physical Laboratory current-weigher. Further, the recent determination of the electro-chemical equivalent of silver at Bushy, taken with the above result, shows that the Board of Trade ampere is equal to the international ampere, as defined by silver deposit, within one part in 10,000. In an appendix to the Paper the authors deduce from the above, and from certain previous measurements at the National Physical Laboratory on standard cells, that the E.M.F. at 20° C. of the normal cadmium cell is 1·0186, Board of Trade volts, and that the E.M.F. at 15° C. of the normal Clark cell is 1·4330 Board of Trade volts. The former is in good agreement with the value 1·0186 volts published by the Reichsanstalt, and the latter is in good agreement with the value 1·4329 determined by A. P. Trotter at the Board of Trade Laboratory in 1904.

The Colour of Lightning.—At the first afternoon meeting of the Royal Meteorological Society on May 20th, Mr. Spencer C. Russell read a Paper on "Observations on the Colour of Lightning, made at Epsom, 1903 to 1907." The author gave results of observations of fork lightning made during 57 thunderstorms, and 78 observations of sheet lightning. It appears that in fork lightning red is the colour of the most frequent occurrence, and this is followed closely by blue, the least frequent colours being orange and green. White is of the greatest frequence in sheet lightning, red and yellow being next. It seems that the presence of hail, when occurring in association with a thunderstorm, is intimately connected with blue lightning.

Production of Small Alternating Currents for Telephonic Measurements.—At the Physical Society meeting last Friday, B. S. Cohen read a Paper on the above subject. For telephonic measurements alternating currents of frequency ranging from 100 to 2,000 per second are of great service, and the output of the apparatus need be only about one watt. A variety of methods have been proposed and used, such as small alternators, humming telephones, and vibrating wire interrupters. The author's new device may be classed as an improvement of the vibrating wire method. This method in its ordinary form consists of a stretched metal wire carrying a tongue dipping into mercury. The current through the mercury and the wire energises a magnet, which is so arranged as to draw the tongue out of the mercury. The consequent stoppage of the current allows the contact with the mercury to be remade; and, of course, the frequency of the interruptions is mainly determined by the natural period of the wire. It is found very difficult to construct a vibrating wire which will run steadily at above a frequency of 300 per second; the output is also small, and the frequency cannot be varied much. In order to overcome these difficulties the author arranges that the interruptions made by the vibrations of the wire do no more than charge and discharge a circuit or circuits comprising capacity and self-induction of variable magnitude. The frequency of the oscillatory charging or discharging of such a circuit is quite distinct from the wave frequency. The simplest form of the apparatus consists of a steel wire 1·06 mm. in diameter, loaded with a soft iron armature at its centre. The iron is kept in vibration by an electromagnet with a core of laminated stalloy, and it carries two platinum wire contacts dipping into two mercury cups. The wire is provided with a tension adjuster, and runs well at frequencies between 100 and 250. The one mercury cup serves to interrupt the current through the electromagnet; the other mercury cup serves to make and break a circuit containing a battery of cells and a condenser of self-inductance in parallel. The result is to set up damped trains of electrical vibrations in the condenser and self-inductance circuit. Part of the self-inductance constitutes the primary of a small transformer, and the alternating current to be used for experimental purposes is taken off the secondary of this transformer. The apparatus shown by the author was such that frequencies of 490, 959, and 2,880 were produced by using capacities of 2·88 mfd., 0·8 mfd., and 0·1 mfd. The oscillographs exhibited showed that the electrical oscillations were produced by this apparatus only at the break of the mercury contact. Adding resistance to the circuit that is interrupted causes the appearance of oscillations at the make of the contact; and the result is better if, instead of adding a resistance, a condenser shunted by a self-inductance be placed in the circuit. If, further, the added oscillation circuit contain a winding which can be used as primary of a transformer, waves can be taken from this transformer as well as from the transformer associated with the first oscillation circuit. By joining up the two secondaries so that these two waves either assist or oppose each other, some interesting results have been obtained. For instance, the secondaries can be so joined that the result is seen in the oscillograph as a continuous curve, or complex curves of definite formation can be built up, and are often useful, for telephonic tests. In concluding, the author mentioned a curious phenomenon which he has noticed in connection with the sparks at the platinum-mercury contacts used by him. The contact point has an amplitude of motion of about 4 mm., and the mercury cup possesses an adjustment for raising or lowering it while the wire is vibrating. It is found that if the cup be slowly raised, a series of sparkless points are passed through. These points are very sharply defined; a movement either way of about 0·07 mm. restores the usual sparking condition.

Heat Developed in Thoria by its Radioactivity.—In the May *Physical Review*, the experiments of G. B. Pegram and H. W. Webb on the elevation of temperature of thorium oxide due to its own radioactivity are described. About four kilograms of the material were placed in a spherical Dewar bulb, and this, with a metal cylinder for protection, was put in an ice bath. One junction of a thermo-couple was put in the mass of oxide and the other junction was kept in the ice. The measurements of the E.M.F. between the junctions showed that the mass of thorium oxide maintained a higher temperature than the ice bath. By sending a small current through wires previously laid in the oxide, heat was introduced at a known rate and the small elevation of temperature measured by the thermo-junctions. A comparison of the elevation of temperature produced naturally in the oxide with that produced artificially as indicated, led to the conclusion that the thorium oxide was developing heat at the rate of $0{\cdot}96\times10^{-5}$ calories per hour per gram, or about one-tenth of an erg per second per gram. From this value the heat developed by pure thorium oxide in its equilibrium state was calculated to be 2×10^{-5} calories per hour per gram. As measured by the total energy liberated per second, thorium oxide is about a three-millionth part as radioactive as radium bromide.

Continental

Electric Pendulum.—A pendulum is essentially a regulator, and should be employed as little as possible for driving, or for transmitting a driving force. Mechanical escapements have reached a great perfection, but wherever solids are in sliding contact there is friction and wear, and even when the friction is minimised by means of oil, the oil becomes varied after a time and loses its lubricating power. On Cornu's principle, now extensively applied, a bar magnet is attached to the bob, and moves in and out of a fixed coil. The driving impulse may thus be transmitted magnetically without any solid contact. An extension of this is proposed by C. Féry, in Bulletin No. 278 of the French Physical Society. He substitutes a horseshoe magnet for a bar-magnet. The second pole moves through a ring of copper attached to the bob of an auxiliary pendulum synchronous with the first pendulum, but which automatically sets itself to swing a quarter-period behind the first pendulum in phase. It is this auxiliary pendulum which releases the current impulse used for driving the chief pendulum, and works any relays used for recording apparatus. The minimum interference with the swing of the chief pendulum is thus secured.

Atmospheric Electricity.—The study of atmospheric ionisation has lately been assiduously cultivated on account of its influence on the range of wireless transmission. D. Smirnow contributes some general results of his observations to the *Physikalische*

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Zeitschrift for May 15th. In the winter, when the sun's effect is feeble, positive ions accumulate in the upper air, and the field intensity between them and the negatively charged earth increases. The author distinguishes three main controlling factors. The cooling of the earth's surface at night produces a diminution of the conductivity of the air nearest to it, and a consequent diminution of the field above. This process is reversed in the morning. Ascending currents, especially in summer, carry up positive ions mainly, and leave behind the negatively charged dust. This produces a decrease of the field in the lowest layers. As regards the direct effect of the sun's rays, they produce negative charges in the highest atmosphere, a diminution of the positive ions in the middle strata, and a diminution of the potential gradient near the ground. This is especially marked in winter in the northern hemisphere, when the earth is nearest the sun.

ELECTROCHEMISTRY AND ELECTROMETALLURGY

At the thirteenth meeting of the American Electro-Chemical Society, held at Albany, April 30th, Mr. F. T. Snyder contributed a Paper upon the "Distillation of Turpentine by Electricity." Pine woods contain volatile hydro-carbons with boiling points varying from 130° C. to 250° C., and the fraction boiling between 155° to 170° constitutes what is commercially known as turpentine. The process of obtaining turpentine from wood is an extractive one, as the turpentine is actually contained in the raw wood. One of the chief difficulties in connection with turpentine distillation is the fact that at 175° C. the turpentine commences to decompose, and the higher the temperature the greater the decomposition. Consequently, it is necessary to distil it within relatively narrow temperature limits. If the heating is insufficient, part of the turpentine is left in the wood; if the temperature is too high, a portion of the turpentine is decomposed; and if decomposition does take place, small quantities of objectionably smelling products are produced and become incorporated with the turpentine, and this very materially affects its selling price. There are two processes for obtaining turpentine: one by tapping the tree and subsequent distillation of the resinous products obtained, and the other, which is of more recent date, at any rate in America, the distillation of wood refuse. The difficulty of distillation in ordinary iron retorts is the tendency for the wood against the sides of the retort to become overheated and spoil the quality of the turpentine. It was considered that perhaps the temperature might be more easily regulated electrically than by ordinary fire heating. An experimental plant, electrically heated, was recently fitted up at Vancouver, B.C. As the results obtained were considered satisfactory, a commercial plant capable of dealing with three cords per day was erected, and has been in operation satisfactorily at Vancouver since July, 1907. Oblong "cans" are placed in the brick retort, consisting of a number of brick chambers, and the retorts are flanged so that they dip into grooves round the top of the retort, which are filled with tar, thus forming a gas seal when the can is in the retort. An electrical current at 110 volts pressure is carried through the retort by means of wrought-iron strips, which are threaded through the brickwork. The current supply for each retort is independently controlled by the switchboard, which also holds the direct-reading pyrometers, one of which registers the temperature at the outside of the can, and the other which registers the temperature at the centre. The leads of the pyrometers end in flexible extensions on the top of the retorts, so that they can be removed from the one can to the other. The turpentine vapour passes from the retort through a removable copper pipe, and thence through a condenser. The brickwork of the retort when a newly-filled can is placed into it has a temperature of 250°. The can rapidly absorbs heat from the brickwork, the temperature of which is maintained by a current of 400 amps., which is passed through the resistance strips for about two hours. During this time the temperature inside the can rises from 75° to 130°. The turpentine then commences to distil, but the temperature at the centre of the can is only about 45°. The current is then shut off, and the temperature of the can slowly rises by absorption of heat from the brickwork for two hours longer, when the temperature has reached 150° C. on the outside of the can and 205° C. in the centre of the can, and the turpentine has been substantially all removed. The temperature, being higher in the centre, is caused by a slow decomposition of the wood. In practice, it is found that from 90 to 95 per cent. of the turpentine in the wood, as determined by analysis, is removed during this interval. While the turpentine is coming off, the pitch in the wood melts and runs down to the bottom of the can and out through perforations, and is collected in the bottom of the retort, from which it is drawn off at the end of the run into the barrels in which it is shipped. It may be noted that this charcoal, being retort charcoal and cooled out of contact with the air, is tough and suitable for special purposes. The amount of wood held by a can varies with the quality of wood, but averages at Vancouver about 1,000 lb. The electricity used per can is about 90 kilowatt hours, and costs, at Vancouver, 18 cents per can of wood. The plant is operated by one man in each shift, there being two twelve-hour shifts per day. When the wood is large an extra man is employed on the day-shift to split it.

At the same meeting of the American Electro-Chemical Society E. W. Smith and R. S. Hutton presented a Paper on "The Direct Synthesis of Hydrocyanic Acid." The Paper is of interest because if it were possible to obtain a cheap method of direct synthesis, it would be very useful, from a commercial point of view, for the preparation of cyanides. The authors have carried out a series of experiments to ascertain whether the direct synthesis of hydrocyanic acid can be carried out at lower temperatures and under conditions which preclude the intervention of any of the complicated electrical conditions which prevail in the arc. The apparatus consisted of a rod of carbon heated by the resistance which it offers to the passage of an electric current, precautions being taken to prevent arcing. Water-cooled brass tubes served to conduct the electric current to the carbon rods (of 3 to 6 mm. diameter), the ends being electro-coppered and soldered to the tubes. The temperature was carefully regulated, and was estimated optically with a Wanner pyrometer. The brass tubes were fixed air-tight into a tubulated glass flask of about 1·5 litres capacity, in such a manner that the heated rod was at a considerable distance from the glass walls. A slow current of gas was passed through the apparatus, the exit gases being allowed to bubble through water containing caustic soda solution. In all cases, the indication of hydrocyanic acid by the Prussian blue test was confirmed by an estimation of the quantity produced by titration with N/10 silver nitrate solution. In general, the experiments clearly prove that when carbon is maintained in contact with hydrogen and nitrogen below a temperature of some 1,800° C., cyanide is not produced in noticeable quantity. This conclusion was borne out not only by the analysis and the presence of cyanides in the caustic potash used as absorbent, but also by the unaltered appearance of the carbon rod. On the other hand, at all temperatures above about 1,800° C., the reaction proceeds, hydrocyanic acid is produced, and the carbon rod shows evident signs of attack, disintegrating to quite a marked extent; moreover, the relative quantity of hydrocyanic acid formed rapidly increases with the temperature, experiments having been performed at different temperatures ranging up to 2,500° C. In the case of ammonia, the production of cyanide is, as may be expected, increased, but it is of some interest to note that the temperature at which the reaction occurs is not to any marked extent lower than with nitrogen and hydrogen. Finally, the production of cyanides from mixtures of gases containing carbon monoxide, such as correspond to producer gas, has been shown to proceed satisfactorily, and particularly in this latter case the process is of practical value, on account of the difficulty and expense of preparing pure nitrogen. In another form of furnace an attempt was made to obviate the somewhat wasteful expenditure of energy which is necessarily incurred when the highly heated zone is surrounded on all sides with a free gas space. The form of apparatus used had two carbon electrodes, with a surrounding charge of ground carbon; the portion of the charge between the two electrodes being heated to a high temperature by the resistance which it offered to the passage of the current. One of the electrodes was provided with a central channel through its axis for the removal of the gas. A fireclay cylinder served to retain the charge of carbon in place, and a large water-cooled iron bell, with water seal, renders the whole chamber gas-tight.

According to the *Journal du Four Electrique et de l'electrolyse* for May the production of aluminium during the last ten years has shown a steady advance, as instanced by the subjoined table.

	Tons.			
	1898.	1901.	1904.	1907.
United States and Canada ...	2400	3200	3900	**8000**
France	600	1700	1700	**6000**
Germany, Austria, and Switzerland	1600	2500	3000	**4000**
United Kingdom	300	600	700	**1800**
Italy	—	—	—	**300**
	4100	7500	9300	**20,100**

Twenty-five years ago the total daily production of aluminium at Salindres was but 10 kilograms per day, and this was the world's production. Although last year 20,000 tons were manufactured, there was a shortage, and the price was high. More works have been, and are being, equipped for the manufacture of this metal, and with the very much lower prices now prevailing, and the active sales, there is no doubt but that this year will see a still larger production It now remains for further outlets and uses for this metal to be discovered; it is no longer out of the question to solder the metal, but there are not many, if any, really satisfactory methods known for plating upon the metal, and here is a fruitful field of research for electrochemists.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published May 21st, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

1906 Patent

21,347. Felten & Guilleaume-Lahmeyerwerke Akt.-Ges. An improvement in the method of signalling, or selectively setting in operation apparatus from a group of several, by means of a set of vibratory bodies, for example, springs, at the receiving station. Any one spring can be set in motion by transmitting an intermittent or varying current of a frequency corresponding to the vibration frequency of the spring. Instead of the rotary generator as hitherto proposed for generating the current, a vibrating contact and electromagnet in series with a battery can be used. One contact, in which the natural period of vibration of the vibrating body can be varied, may be used in place of several contacts having different periods. Four claims, two figures.

1907 Patents

9,390. J. F. Simpson. An improved track brake for tramcars, &c. (See also Electrical Engineering, Vol. I., p. 912.) The brake shoes are drawn magnetically into contact with the rails, the electric current operating the magnets being taken either from the motors (acting as generators) or from the line wire. In order to bring the whole weight of the car on to the shoes directly they grip the rails, relative longitudinal movement between the car body and the brake mechanism is allowed for. A roller attached to the brake mechanism is so arranged under an arched surface fixed to the body that relative movement between body and brake causes the body to be lifted up off the wheels, all the weight being taken by the brake shoes. Four claims, two figures.

10,367. S. O. Cowper-Coles. A perfectly smooth electrolytic deposit of iron which is close in texture, will readily anneal, is difficult to rust, and which does not flake off during the process of deposition, may be obtained by using an electrolyte of ferrous chloride, suplho-cresylic acid, and iron oxide kept in suspension. A current density of 75 amps. per square foot may be employed, and the electrolyte is preferably maintained at a temperature of about 65° C. Th electrolyte is kept as neutral as possible by the use of a large anode surface, and by keeping the iron oxide in suspension. Three claims.

10,636. P. B. Black and T. H. Black. In a surface-contact system of electric traction, in which contact boxes are used, an armature is pivoted between the poles of a magnet so that when the magnet is energised the armature swings round and closes a switch. The present specification describes an improved form of armature which is so pivoted that it returns to its original position on cessation of the magnetic flux by its own unaided weight. The contact arm of the switch is fixed to the spindle of the armature. Four claims, three figures.

13,882. T. W. Lowden and the Westinghouse Metal Filament Lamp Co. Elastic supports for filaments subject to expansion and contraction. Instead of using a loop, two straight parallel filaments are connected together at one end by a cross-piece of conducting material to the extremities of which the ends of the filaments are welded. A spring is attached to the centre of the cross-piece, and is fixed at its other end to the glass pedestal or to the side of the bulb. This arrangement permits of unequal contraction of the two parallel filaments. When several pairs of filaments are in one bulb, the cross-pieces may be connected together mechanically (but insulated from each other), and supported from the pedestal or bulb by means of one spring. Two claims, five figures.

16,051. Siemens Bros.' Dynamo Works and W. Parker. When continuous-current turbo-generators fitted with commutating poles are run in parallel, there is often a tendency for certain machines to take an excessive share of the load. This may be due to the fact that one machine has a larger amount of kinetic energy than another, and therefore takes a sudden load easier, or it may be due to a difference in the characteristics of the machines. The difficulty is overcome by the following arrangement, by which the commutation flux is increased, but the main flux reduced when the load increases. Each commutating pole is wound with one or more incomplete turns, the extra half-turns being arranged on that side of the commutating pole which any rotating armature conductor leaves last. These extra half-turns will produce an increase of the commutation flux, but a decrease of the main flux in the case of a generator, whilst in the case of a motor an increase of flux in both main and commutating poles will be produced. Thus the arrangement can be advantageously applied to motors. The commutating poles may be wound in the ordinary way, and the half-turns added afterwards, or the part turns may be arranged in the gap between the main and commutating pole windings. Four claims, six figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Names in brackets indicate communicators of inventions from abroad.

Summaries of the more important of these patents will appear in our next issue.

1907 Patents

2,986, Dawson & Buckham. Electrical apparatus for transmitting and receiving signals.
4,988, Heyland & Korda. Rotary transformers.
5,301, Igevsky. Electric furnace.
10,065, Coward. Manufacture of insulators.
10,119, Newbery & British Prometheus Co. Electric cooking and heating apparatus.
10,169, McNeil. Electric fire alarms.
10,171, Allgemeine Elektricitäts Ges. Control of electrically-operated winding engines.
10,513, Beck. Arc lamps and electrodes.
10,515, Condict. Braking electrically-propelled vehicles.
10,641, Mitchell. Leakage detectors for surface contact electric traction systems.
10,662, Winther-Hansen & Bouchsein. Arc lamp.
10,665, British Thomson-Houston Co. (*Allgemeine Elektricitäts Ges.*). Switches and fuses.
10,666, British Thomson-Houston Co. (*Allgemeine Elektricitäts Ges.*). Electric switches.
10,687, Brown. Electrical block signalling system.
10,943, Brown. Connecting up electric cables.
10,969, Felten & Guilleaume-Lahmeyerwerke Akt.-Ges. Repulsion motors.
11,066, Leitner. Dynamos for train lighting.
11,086, Sullivan. Telephone receivers.
12,462, Lawley-Pinching & Walton. Sockets.
13,279, Simpson. Brakes for tramway vehicles.
13,543, Highfield. Control of the supply of electrical energy to consumers.
15,451, British Thomson-Houston Co. (*General Electric Co.*). Manufacture of refractory electrical conductors.
18,261, British Thomson-Houston Co. (*General Electric Co.*). Laminated core structures.
21,299, Bellini & Tosi. System of directed wireless telegraphy.
23,586, Weman. Galvanic element.
25,343, Allgemeine Elektricitäts-Ges. Alternating current commutating machines.
27,177, Barclay. Electric insulators.
28,427, Raymond & Ramp. Oil tight casings for transformers.
28,634, Lamme & Storer. Electric locomotives or motor vehicles.

1908 Patents

35, Weissenborn. Electrical pattern for the manufacture of Jacquard cards.
889, Amalgamated Radio Telegraph Co. Radio-telegraphy.
3,700, Schmidt. Arc illuminating apparatus.
3,770, Bluemel, Bluemel, Bluemel, & Shill. Electrically-controlled pneumatic dispatch tubes.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patent

16,503, Deutsche Gasglühlicht Akt.-Ges. (Auer ges.). Method of attaching tungsten filaments in electric lamps.

1908 Patents

8,206, Elektricitäts Ges. Alioth. Electrical devices for the measurement of speeds.
8,288, Felten & Guilleaume-Lahmeyerwerke Akt.-Ges. Differential relays.
9,479, Schäffer. Supporting-hooks for lamp filaments.
9,502, Allgemeine Elektricitäts-Ges. Arc lamps.
9,577, Allgemeine Elektricitäts-Ges. Dynamo-electric machines.
9,676, Fromaget. System of electro-magnetic transmission.
9,844, Felten & Guilleaume-Lahmeyerwerke Akt.-Ges. Automatic cut out.

Expiring Patents

No patents of electrical interest expire during the current week.

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STOCK AND SHARE LIST

NAME.	Amount of Share.	Dividend Paid. 1906	Dividend Paid. 1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ltd.	10	7	7%	10½—11	
Do. 4½% Cum. Pref.	10	4½	4½%	9⅞—10⅜	
Do. 6% Cum. Second Pref.	10	6	6%	10½—11	
Do. 4½% Debenture, Red.	Stock	4½	4½%	102—105	
Bromley (Kent) E.L.& Power Co.,Ltd.	5	5⅛	5⅛%	4⅛—5	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	94—97	
Brompton & Kensington E. S. Co.,Ld.	5	10	10%	6¾—7¾	
Do. 7% Cum. Pref.	5	7	7%	6¾—7¾	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%*	99—102	
Ch. Cross, W. E. & City E. S. Co.	5	5	5%	3¼—3⅜	
Do. 4½% Cum. Pref.	5	4½	2¼%	4⅛—4⅜	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	3¼—4⅛	
Chelsea Electric Supply Co., Ltd.	5	4½	4½%	3¼—3⅜	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9¼—10¼	
Do. 6% Cum. Pref.	10	6	6%	12—13	
Do. 5% Deb. Red	Stock	5	5%	124—127	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	102—105	
City of Durham E. P. Dis. Co.	5	4	2%	2¾—3	
Do. 5% Pref.	5	5	5%	3⅜—4⅛	
County of London Elect. Sup. Co. Ltd.	10	5	5%	7⅜—8¼	
Do. 6% Cum. Pref.	10	6	6%	10¼—11	−¼
Do. 4½% Deb. Red	Stock	4½	4½%	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	96—99	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	⅛—1	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	65—75	+2
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4⅜—5¼	
Do. 5% Cum. Pref.	5	5	5%	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½%	6¼—6⅝	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	90—93	
Kensington & Knightsbridge E.L.Co.	5	10	10%	7—8	−½
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N'tng Hill E.L. Cos. Db. Rd.	Stock	4	4%	97—101	
London Electric Supply Corporation	3	4	2½%	1—1⅛	
Do. 6% Pref.	5	6	6%	4⅜—4⅝	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6½%	4⅜—4⅝	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅜—4⅝	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D	100 & 500	4½	4½%	96—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	7¼ 8¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	8%	5½—6	
Do. £2 Pm.	5	8	8%	5½—6	
Do. 5% Pref. (fully paid)	5	5	5%	5¼—5½	+⅛
Do. 10/- Pm.	5	5	5%	5¼—5½	+⅛
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7%	5⅞—6¼	−⅛
Do. 4% Deb. Red.	Stock	4	4%	94—98	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7¼—8¼	
Do. 7% Non-Cum. Pref.	5	7	7%	6¾—7¼	+¼
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—⅜	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4%	2⅜—2⅞	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅝—⅞	
Do. 7% Cum. Pref.	1	7	7%	1⅛—1⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5%	1—2	
Do. 5% Cum. Pref.	5	5	5%	1⅝—2⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¾—8	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5¼	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	88—91	
Central London	Stock	4	3%	80—83	+3
Do. 4% Preferred	Stock	4	4%	90—92	+3
Do. Deferred	Stock	4	2%	62—65	+7
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	81—84	
City and South London Cons.	Stock	2⅝	4¼%	39—41	−1
Do. 4% Perp. Deb.	Stock	4	4%	100—103	+1
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1893	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11½d.	¾—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4%	6—7	
Do. 4% Perp. Deb.	Stock	4	4%	87—90	
Mersey Cons.	Stock	nil	—	1—3	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1%	43½—44½	−1
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	75—78	
Do. 3½% Convertible Pref.	Stock	3½	3½%	73—76	
Metropolitan District	Stock	nil	—	12½—13½	−½
Do. 6% Perp. Deb.	Stock	6	6%	110—115	+5
Do. 4% Deb.	Stock	4	4%	69—74	+7
Do. Perp. Extension Pref. (5%)	Stock	nil	—	20—25	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3⅛%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	39—43	+1
Whitechapel and Bow 4% Deb.	Stock	4	4%	103—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅝—⅞	
Do. 5% Cum. Pref.	1	5	5%	⅝—⅞	
Do. 4½% Deb. Red.	Stock	4½	4½%	85—90	−1⅛
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93 - 96	−1
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6%*	3¾—4¼	
Do. 5% Perp. Deb.	Stock	5	5%	88—92	
Do. 4½% 2nd Deb.	Stock	4½	4½%	64—72	+1
City of Birmingham Trs. Co., Cm. Pf.	5	5	5%	4¼—4¾	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	97—100	

NAME.	Amount of Share.	Dividend Paid. 1906	Dividend Paid. 1907	Stock Exchange Quotation.	Rise or Fall since Last Week.
	£	%			
Dublin United Trams Co.	10	6	6%*	12½—13½	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	94—97	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	⅜—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	⅛—⅜	
London United Trs., Ld., Cm. Pf.	10	5	5%	6¾—7¼	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	80—85	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	¼—½	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	94—97	
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—⅝	−⅛
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅛—1	
North Metropolitan Trams Co.	£4 10s.	1/-	⅛-*	⅜—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	4%	½—⅝ xd	
Do. 5% Cum. Pref.	1	5	5%	½—⅝	
Do. 4½% Deb. Red	Stock	4½	4½%*	91—94 xd	
Provincial Tramways Co. Ltd.	10	3½	4%	4½—5½	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6%	¾—1	
Do. 4% Deb. Red.	Stock	—	4%	76—80	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1⅛	
Do. 6% Cum. Pref.	5	nil	—	3½—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	58—61	+2
Do. 6% Pref. Ord.	Stock	6	30/-*	101½—103½	+2
Do. Def. Ord.	Stock	1¾	1%	16¼—16¾	+¼
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3¼—3½	
Do. 10% Cum. Pref.	5	10	10%	8—9	
Do. 4½% Debs.	50	4½	4½%	99½—102½	
Direct United States Cable Co. Ltd.	20	4½	4/-	13½—14	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	100—102	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	99½—101½	
Do. do. (Mauritius Sub.)	25	4	4%	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12⅝—13¼	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	100—102	
Eastern Telegraph Co.	Stock	5⅝	7%	129—134	
Do. 3½% Pref.	Stock	3½	3½%	83—86 xd	
Do. 4% Mort. Deb.	Stock	4	4%	100—102	
G. N. Tel. Co. (Copenhagen)	10	20	20%	28—30	−1
Indo-European Telegraph Co. Ltd.	25	13	65/-	53—56	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅜—½	
National Telephone Co., Ltd., Pref.	Stock	6	6%	108—110	
Do. Deferred	Stock	5½	6%	109½—111½	
Do. 6% Cum. 1st Pref.	10	6	6%	10½—12½	
Do. 6% Cum. 2nd Pref.	10	6	6%	10½—12½	
Do. 5% 3rd Pref.	5	5	5%	5⅜—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	98¼—100½	
Do. 4% Deb. Red.	Stock	4	4%	101½—103½	
Western Telegraph Co., Ltd.	10	7	7%	13½—13⅞	
Do. 4% Deb.	Stock	4	4%	100—102	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	6%	1⅛—1⅜	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅜—3⅝	
Do. 6% Pref.	1	6	7½d	1⅞—1⅛	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	6¼—6⅝	
Do. 6% Cum. Pref.	5	6	6%	5⅝—6⅛	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	93—98	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅞—1⅛	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅜	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	70—75	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	55—60	
Callender's Cable and Const. Co., Ld.	5	15	15/-	10—11	
Do. 5% Cum. Pref.	5	5	5%	5⅛—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	106½—108½	
Consolidated Electrical Co., Ltd.	1	3	3½%	⅜—⅝	
Crompton & Co., Ltd.	3	5	5%	1⅜—1⅝	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1⅛—1⅜	
Do. 6% Cum. Pref.	1	6	6%	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	100—103	
Edison & Swan United "A." £3 paid	5	4½	2/6	⅜—⅝	−⅛
Do. do. (fully paid)	5	4½	4/2	1½—2⅛	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	½—⅝	
Do. 7% Cum. Pref.	2	7	—	1½—1⅝	
Do. 4% 1st Mort. Deb.	Stock	4	4%	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7¾—8½	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10½—11½	
Do. 4½% Cum. Pref.	5	4½	4½%	4¾—5⅜	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	106—108	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	29—31	
Do. 4% Deb. Bds. Red.	100	4	4%	100—103	
Willans & Robinson, Ord. Shres	1	nil	5%	⅜—1¼	
Do. 6% Cum. Pref.	5	nil	6%	3⅜—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	72—76	

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LONDON ELECTRIC POWER BILLS

OUR report last week concluded the engineering evidence, and on Wednesday the financial portion of the Bill was gone into.

WEDNESDAY, MAY 20TH. (NINTH DAY.)

Sir THOMAS HUGH BELL, Bart., one of the promoters of the Bill, and managing director of Bell Bros., Ltd., said he was also a director of Messrs. Dorman, Long & Co., and that he had been one of the promoters of the Cleveland and Durham Electric Power Act of 1901. Before the promotion of the Cleveland and Durham Electric Power Company, he had laid down separate generating plants at several of his works, but, since the power company had come into existence, all power required beyond that supplied by the separate generating plants was to be taken from the power company, as it was better and cheaper. He was putting down the largest electrically driven rolling mills in this country, and all the power required could be taken from the power company to the extent of probably 1,000 h.p. He had applied his experience of the Tyneside district to London, and desired very much to see London put in the same position as other places in the north, of having a bulk supply. Dealing with the provisions of the Bill, he said he had left the question of prices and engineering matters to the engineers, but amongst the matters considered by the promoters was Clause 52, the modified Kitson clause, which had been drafted with a desire to act in concert as far as possible with existing authorised distributors. With regard to purchase, when an undertaking of a necessarily speculative character was embarked upon, such as that involved in electricity supply in London, it was essential that the undertakers should have somewhat extensive powers of recovering the capital which it was necessary to invest, for, of course, anything which had the effect of making the return of the capital less certain, meant an increase in the quantity of capital required for the purpose. It was for these reasons that the purchase clause, which provided for the return of the capital expenditure, had been drafted. They could raise their capital much more easily, if they had the power of recovering the money expended. It might be many years before they were in a position to pay dividends, and they must therefore have the power to get back the deficiency of income. As a justification of the clause, he mentioned that in no power company's act previously had a purchase clause been necessary; in fact, the joint committee of the two Houses of Parliament, presided over by Lord Cross in 1898, had reported that the power of purchase under the Electric Lighting Acts should not be made applicable to power companies. The terms of purchase proposed were something less favourable than those given to gas and water companies. The object of the clause was to be fair to the investors, and at the same time not to impose too heavy a burden upon the authority deputed by Parliament to purchase. He had gone carefully into the figures connected with the scheme, and was quite satisfied that it was a workable one, and, if it were passed substantially in the form presented to the committee, the necessary capital would be raised. He was prepared to take a substantial interest in the concern, and to be responsible for finding the sum of £250,000; in addition to this he was authorised to speak for Lord Fitzwilliam to the effect that he was prepared to take a substantial interest and be responsible for raising a very considerable sum. Mr. Owen Smith, who would follow him, would speak for the rest of the promoters. Subject to reasonable conditions obtaining in the market, there would be no difficulty in resigning the capital for this undertaking, on equitable and reasonable terms, although any obligations that were imposed upon the undertaking to raise money within a short limit of time would very largely increase the difficulty of raising it, for moneylenders had not altered in their habits, and if it were known that the money was urgently needed, the cost of obtaining it would very rapidly go up.

Lord CROMER asked if the obligation to raise money in a certain time was not closely allied to another aspect of the question. Both Mr. Parshall and Mr. Hammond had stated that contracts would have to be made with large power users before they could go to the public for capital. These contracts would be based upon the assumption that there would be a supply in a certain time, and therefore, apart from any obligation in the Bill, it appeared to him that the money would necessarily have to be found in a certain time in order to give the effect to any such contracts.

Sir HUGH BELL replied that the existence of a number of contracts of this character would very largely influence the raising of the capital, but he wished to emphasise the point that the larger the powers given under the Bill, the better not only for the promoters, but for the people they were going to supply. He also pointed to the clause in the Bill under which, before any compulsory powers for the purchase of land could be put into effect, the sum of £500,000 must be subscribed. Under Clause 75 of the Bill it was laid down that unless the company made a substantial commencement with its works within five years from the date of the passing of the Act, the powers under the Act should cease. The promoters were quite willing to reduce this period to two years, leaving it to the Board of Trade to determine whether a substantial commencement had been made.

Lord CROMER raised a doubt as to the interpretation of the word "substantial," but Mr. Fitzgerald pointed out that this would be interpreted by the Board of Trade, and that unless the word was in the clause, a mere nominal commencement of the works would be sufficient to safeguard the company.

Sir HUGH BELL'S cross-examination was commenced by Sir Ralph Littler, K.C. for the City of London, in reply to whom he stated that no contracts had yet been entered into for supply.

Mr. LEWIS COWARD, K.C., for the London County Council, asked if Sir Hugh Bell had anything in writing from Lord Fitzwilliam as to providing capital for the undertaking.

Lord CROMER said that he had received that morning a letter from Lord Fitzwilliam to the effect that he was prepared to take an interest in the scheme and to assist in its finance.

Mr. COWARD then referred to the Administrative Bill of 1905, in which it was provided that a substantial commencement should be made with the works in three years, and that supply must be given within five years. The witness thought sufficient concession had been made in reducing the period for the commencement of works to two years. With regard to the expense of raising the capital, it was quite impossible to fix a sum for this: obviously the promoters would not pay more than was required.

Lord CROMER asked if after the preliminary sums had been provided the remainder would be underwritten.

Sir HUGH BELL thought this would be the method adopted.

Mr. COWARD was pressing the witness to give a figure for the cost of raising capital in this way, when Lord Cromer suggested it would be unfair to expect a reply, for if Sir Hugh Bell gave a price then, he would probably not be able to get it any cheaper when the time came.

In answer to further questions by Mr. Coward, Sir Hugh Bell would not agree to accept the purchase clause in the Administrative Bill of 1905, as this was upon the terms of the Electric Lighting Acts. He agreed that no provision had been made for repairs, renewals, or depreciation, and that there was a danger of the plant being allowed to deteriorate towards the end of the concession, but he was willing to come under obligations to keep the plant in proper condition.

In reply to Lord Welby, who inquired what the London County Council wanted, Mr. Coward stated they asked for the insertion of the purchase clause which was agreed to by the Administrative Co. in 1905, for they held the view that under the purchase clause now proposed, the more the power company wasted the more the purchasing authority would have to pay.

Mr. BALFOUR BROWNE pointed out to the committee that, under the Electric Lighting Acts, the purchasing authority got the plant which was suitable and only paid for that plant, but under the proposed clause the purchasing authority would have to refund all the capital expenditure, whether the plant existed or not.

In the course of his cross-examination for the Electric Lighting companies, Mr. Balfour Browne asked if the interest paid out of capital during construction would be regarded by the power company as capital properly expended, and would have to be refunded by the end of forty-two years, together with 6 per cent. interest upon it. Witness replied that he thought it was, as it was capital; upon which Mr. Balfour Browne commented that although it was capital, there were no works to represent it.

In answer to further questions by Mr. Balfour Browne as to the raising of the capital, Sir Hugh Bell stated that he would not give a definite answer as to whether he would or would not find the £250,000 personally, nor would he mention the names of people from whom he was likely to get support; but he said he could give a guarantee that within six months of the passing of the Act, he would succeed in raising £250,000.

Mr. BALFOUR BROWNE: If you do not get your purchase clause, you will not raise the money?—If I have not an assurance of getting my money back, I shall not raise the money; no promoter would, and London will not get advantages which we think it ought to have.

Further cross-examination on the part of Mr. Balfour Browne elicited the admission that the money market was at present in a difficult condition, and there might be difficulties in the way of raising the capital.

On the point of whether any of the schemes before the committee would be mutually destructive, Sir Hugh Bell, replying to the chairman, stated that if there were two people in the market at the same time for money for the same purpose, there would be a difficulty for both of them, but from the point of view of supplying London with cheap electric power, he did not thing any of the schemes were mutually destructive. In answer to a question by the Chairman as to more specific information as to the reasons for his confidence of raising the capital, Sir

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Hugh Bell said he had approached certain very important financial houses in the City, and had received assurances which entitled him to conclude that the capital could be raised, always assuming that the Bill passed substantially in the form in which it now was. The most important clause in the Bill, from the financier's point of view, was the purchase clause. If this was cut down so as to take away from investors a fair security for their money, then the scheme would fall flat in the City. At the same time, he did not suggest that the purchase clause, as it at present existed, was incapable of modification. Any clause which gave the security he had already indicated would be acceptable to the financiers.

Lord CROMER next pointed out that in the case of the Administrative Bill a very long list of promoters was handed in. Up to now only three names of promoters had been given. Was it intended to give further names?

Sir HUGH BELL said he thought not, unless the committee insisted.

The CHAIRMAN said the committee had no right to insist. It was a question for the promoters whether they thought it advisable.

Mr. BALFOUR BROWNE pointed out that, so strong was the financial case for the Administrative Bill, that there was no cross-examination upon it.

Continuing under cross-examination by Mr. Balfour Browne, witness stated that he was not unwilling to come under an obligation to set aside a sum for renewal of plant. He disagreed with a suggestion that the Bill put "a screw" on the existing companies and local authorities in order to make them take a supply from the power company. They wished to supply the authorised undertakers, but if they did not, then the power consumer must be looked after. Asked to cite a single case of a pure power company which had been a success, Sir Hugh Bell said he was not prepared to do so, nor did he think it affected the question. Mr. Balfour Browne said that all the power companies on the north-east coast were grafted on to the Newcastle Supply Co., which had a distribution order, and the only other successful power company, and this also had distribution orders, was the North Metropolitan Power Co., with which this Bill proposed to compete.

In answer to further questions on the purchase clause, Sir Hugh Bell agreed that a sinking fund should be set aside to provide for obsolescence of plant, and that it should be handed over to the purchasing authority. At present there was nothing to this effect in the Bill.

In re-examination, Mr. Clode directed the attention of Sir Hugh Bell to the desire of the opposition to have the terms of purchase inserted in the Bill as they were in the Electric Lighting Acts, and pointed out that under these terms the dividends of the companies were unlimited. Consequently the two sets of circumstances were not similar. On the point as to the possibility of the purchasing authority having to pay twice over for plant replaced, Sir Hugh Bell said Mr. Balfour Browne had taken absurd assumptions and drawn ridiculous conclusions. He had seemed to imagine that plant renewed would be charged to capital twice over, whereas the replacement must be charged to revenue, as the plant would be renewed for a revenue reason. If, however, the cost was charged to capital, then it would be the duty of the auditor to call attention to the fact.

Mr. FREEMAN, for the London County Council, pointed out that Mr. Fitzgerald had already admitted that the auditor would not have the power to do this.

Sir HUGH BELL said he was willing to come under the necessary obligations to make this clear. On the point that the interest on capital during construction was to be treated as capital, this was nothing unusual. It was always done in the same way as preliminary expenses were treated as part of the capital.

Mr. OWEN HUGH SMITH, the next witness, said he was one of the proprietors of Hay's Wharf, chairman of the Farringdon Works and of Messrs. Pontifex & Sons. He was also a director of the Provident Clerks' Assurance Co., and a son of Mr. H. Collins Smith, a director of the Bank of England. In regard to some of the other promoters, he said that Mr. John Young was on the board of the Underground Electric Railways Company of London, Mr. Vincent Yorke was a director of the London and Westminster Bank, Mr. R. Miller was a director of the National Bank of India, and Mr. G. Rowe was a partner in a firm of stockbrokers. He had authority from some of his co-promoters to state that they would be responsible for the finding of substantial portions of the capital requisite for this scheme, and all of them would be prepared to take holdings. None of the promoters, however, had named any figures as to the extent to which they would go. The undertaking was at present in a very early stage, and it was not easy to get financial houses to name sums, but he thoroughly believed that they would be able to raise the capital.

In cross-examination by Mr. C. A. Cripps, K.C., for the London companies, witness stated that he was aware that Hay's Wharf took electrical energy from the County of London Electric Supply Co., but he was not familiar with the price which was put to him as £4 per kw. and 0·33d. per unit for direct current, compared with £4 10s. per kw. and 0·33d. per unit, which was the maximum price in the Bill for this class of supply.

With regard to the purchase and the payment of the full capital expenditure, Mr. Cripps put the case of an expenditure of £100,000 upon plant, which, when written down to £75,000, had to be replaced by new plant costing another £100,000, would promoters expect to be repaid £175,000 or only £100,000?—The witness hesitated to give an answer offhand, but Lord Saunderson pointed out that even if the company expected to be repaid the £175,000, the purchasing authority would be buying the increased revenue-earning power of the new machinery.

Mr. FREEMAN, for the London County Council, asked the witness to agree to the Administrative Bill purchase clause, but the answer was that this introduced so much uncertainty as to the amount the company would be repaid at the end of its period, that money would be very difficult to raise.

Lord LYTTON pointed out that the clause in question was put upon the promoters by Parliament as the result of the second reading debate, and was not their own clause.

Mr. FREEMAN replied that they had accepted it.

Lord LYTTON: They were obliged to.

The CHAIRMAN pointed out that during the examination of the witnesses it had been agreed that the purchase clause should be amended in so far as the provision to maintain the plant in proper order was concerned, and suggested modifications had also been acquiesced in.

Mr. TALBOT said that the only alteration to which they had consented, so far as he knew, was that power should be given to the auditor in respect of provision for renewals.

Lord WELBY said he would like a definition of the word "properly" in relation to the capital expenditure, in the clause saying the promoters should be refunded the amount properly expended. He doubted very much whether the auditor had power to deal with this.

Mr. TALBOT said the promoters would consider this point.

Lord CROMER stated that he wanted the auditor to be able to say not only that a certain sum had been expended, but that if necessary a certain sum had not been expended upon renewals, for instance, when it should have been expended. He suggested that the promoters should go into the question of the modifications agreed to by the witness, and bring up amended clauses giving effect to them.

In re-examination, Mr. Smith stated, with regard to the suggestion that the purchasing authority would have to pay much more than the undertaking was worth, that if the undertaking was not a success, obviously nobody would buy it, whereas if it was a success it would be a very advantageous bargain for the purchasing authority. The promoters fully anticipated getting £500,000 for the initial stages of the undertaking without going to the public.

Mr. OLIVER BURY, General Manager of the Great Northern Railway Co., was called to give evidence as to their desire for obtaining a cheap supply of electrical energy in connection with the conversion of their suburban lines to electric traction. For this purpose about 20,000 kw. would be required, and the main obstacle for carrying out the scheme had been the large capital expenditure required in generating plant, the cost of which it was estimated by their electrical engineers would be 35 per cent. of the whole cost of electrification. The company therefore welcomed such a Bill as this, because it would hasten the day when they could electrify. At present the working expenses upon their suburban traffic were such that the company kept the figures to themselves, and their feeling was that if a supply of electricity could be obtained at a sufficiently cheap rate, the cost of working these lines would be materially reduced.

THURSDAY, MAY 21ST. (TENTH DAY.)

Mr. J. F. S. GOODAY, General Manager of the Great Eastern Railway Co., was called in support of the Bill, and spoke as to the need of a bulk supply in London for the purposes of railway electrification. He instanced the bad results upon the East London Railway Co. since the through trains from the Metropolitan and District companies had been discontinued. If a cheap supply of electric power could be obtained, the question of electrifying the East London line would be seriously taken in hand.

In answer to Sir Ralph Littler, witness admitted that both the Metropolitan and Metropolitan District companies were partners in the East London Co., and therefore both could give a supply from their own existing generating stations. He said he was not pledging the Great Eastern Railway Co. to take electricity from the power company, for any purpose, but the Board had passed a resolution authorising him to give evidence in favour of the Bill. With regard to the possibility of a supply from the North Metropolitan Electric Power Co., he was not aware that the company could give a supply for railway purposes outside their area. Mr. Balfour Browne put it to the witness that the proposed power company could not supply the whole of the Great Eastern suburban lines.

In re-examination, Mr. Clode pointed out that there was a clause in the present Bill permitting supply for railway purposes outside the area.

Answering the chairman, Mr. Gooday said his company would not enter into contracts with any outside company for electric supply without considerable guarantees from the company that the supply would be afforded and be absolutely reliable. They

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were quite satisfied with the promoters of this scheme. None of the promoters were connected with the Great Eastern Railway Co., although Mr. Hugh Owen Smith had been a director some time ago for about a month.

Mr. V. L. RAVEN, Chief Assistant Mechanical Engineer to the North Eastern Railway Co., spoke as to the advantage of taking electric supply from the Newcastle Electric Supply Co. There had been no discontinuance of the supply, and he did not think the North Eastern Co. would have electrified their lines if they had had to go to the expense of a generating station of their own.

In cross-examination, Mr. Raven said there had been temporary breakdowns of supply, but none of them had necessitated falling back upon the steam engines for working the traffic. In case of breakdown they had no guarantee from the supply company, but their agreement provided that the railway company should receive the first supply after a breakdown.

Mr. E. M. DUNCAN, Consulting Electrical Engineer to Messrs. Maple & Co., said that firm had an electric lighting plant of their own, but the prices quoted by the power company were sufficiently low to justify Messrs. Maple taking a supply from them. The difference between the prices quoted by the power company and the St. Pancras Council would give a saving of £400 per annum to Messrs. Maple on the former terms. Another reason for preferring the power company was that St. Pancras, in supplying at 1d. per unit, retained the right of cutting off the current at any time on giving notice. In answer to Mr. Courthope Munroe, who appears for the St. Pancras Council, witness stated that he was not aware that special terms had been offered Messrs. Maple in respect of their Highgate Road factory, where the private generating plant was situated. Counsel thereupon refused to ask further questions, having hinted that negotiations had taken place with Messrs. Maple without the knowledge of the witness. In re-examination, however, witness raised the question as to whether any special offer could be made, if this would constitute preferential charging, which was prohibited by the Provisional Orders.

In answer to Lord Lytton, he said that Messrs. Maple would make a greater saving than the £400 per annum already mentioned as between the price offered by the St. Pancras Council and the power company, if the private plant was scrapped and the supply taken from the power company. The generating costs of the private plant were confidential figures.

Mr. COURTHOPE MUNROE, for the St. Pancras Council, said that the barring clause referred to by the witness was put into the application forms as a safeguard, as it was felt that they owed a duty to the lighting consumers, and that they should have the first supply in the event of a breakdown, but as a matter of fact during the past 15 years the clause had not been put into effect.

Mr. CLODE, for the promoters of the Bill, said this was the whole point of the Bill, viz., that the main supply of the authorised distributors was lighting, and that the power users were not sufficiently cared for.

Mr. J. S. CONRADI, Superintendent of the London factories of Messrs. Vickers, Sons, & Maxim, said that at their Erith works they had a private plant of 800 kw. capacity. Extensions were in contemplation at their Dartford and Crayford works to the extent of 1,160 kw. He was convinced that it would pay them to take this from the power company. He would be quite willing to scrap the existing generating plant at his Erith works in favour of taking a supply from the power company on the terms in the Bill. He said he had convened a meeting of manufacturers on April 10th of this year to discuss the question of electric power, when a resolution was passed protesting against the prices now being charged by authorised distributors as militating against the full advantages of electric power being obtained. The resolution called upon the Government to sanction such a scheme as that now proposed, and a further resolution stated that the manufacturers at the meeting would support the Bill, subject to certain modifications. These included an alteration in the maximum prices in the Bill, a lowering of the limit of 250 kw. under which the power company could compete, and a reduction of the period of seven years for the agreement under which supply would be given to power users. After the meeting, some 300 circulars were sent out to other firms asking for their assent to the resolutions, and as a result witness handed in a list of some 56 firms which had so assented, and from which a committee was formed, which had authorised him to attend and give evidence on behalf of the Bill.

Mr. TYLDESLEY JONES, in the course of a long cross-examination, directed his questions to showing that none of the concessions mentioned, and upon which the assent of many of the firms had been obtained, had been secured from the power company. This the witness agreed to, but stated that there had not been sufficient time to go into details with the promoters. Witness made the general statement that he was confident he could obtain energy from the promoters, but upon being questioned as to the cost of generation by his own private plant he refused to give the details. Similarly, Mr. Conradi said he had no knowledge of the manner in which the list of firms had been selected, nor in many cases of their business or possible demands.

Counsel for the opposition generally complained, but the chairman suggested that the witness could not be expected to say more than so far as his own works were concerned; he believed there would be an advantage in taking from the power company.

Several firms in the list were thereupon objected to, and the promoters promised to call representatives.

Mr. CYRIL HILL, Manager of Messrs. Locke, Lancaster & Co., lead merchants of Stepney and Poplar, said his firm took 500,000 units per annum from the Poplar Borough Council at 0·8d. to 0·9d. per unit, and 150,000 units per annum at 0·95d. per unit.

Mr. A. L. STRIDE, Chairman and Managing Director of the London, Tilbury & Southend Railway Co., referred to the powers which the company has for working by electric traction, and mentioned that a site for a generating station had been acquired, but no works commenced. Having gone into the question of electrification, the company had come to the conclusion, rightly or wrongly, that it would be cheaper to get a supply from an outside source. Negotiations had been carried on with Poplar, Stepney, East Ham, and West Ham, and with the Charing Cross Co., but all to no avail on account of the inability of any of these to supply outside their areas. They had almost arranged a contract with the Charing Cross Co., whose mains run over the Tilbury Company's tunnels, but the local authorities threatened a legal action to test whether the company were legally entitled to supply outside. He admitted that before the directors would embark upon any further extension of electrical working, they would require to see a reduction in the working expenses, but it was possible that the taking of a supply from a power company such as this would be a factor in such reduction.

A large number of other witnesses were called, who expressed their desire to have cheap electric power, and in cross-examination, the general answer was that they did not mind from whom such a supply was obtained; the main point was cheapness. Among the witnesses so called were Mr. James McGregor, managing director of Messrs. Johnson & Phillips, and Mr. Frank Grier, the chief goods manager of the London & North Western Railway, who referred to the tube railway which the company has powers to construct between Euston and Watford. The cost of a separate generating station was put at £250,000, and if this could be avoided, he thought it would hasten the construction of the line.

FRIDAY, MAY 22ND. (ELEVENTH DAY.)

Mr. A. G. LUPTON, Chairman of the Yorkshire Electric Power Co., was called on behalf of the promoters of the Bill, and said that a supply was commenced from the Thornhill generating station in December, 1903, and that up to date agreements had been made for the supply of between 7,000 and 8,000 h.p., of which 3,250 h.p. was within the last six months of 1907. Supply was being given to a number of urban district councils who did their own distribution, whilst the Brighouse Corporation had decided to close down their generating works and take the whole supply from the power company. Although local authorities generally in their area had opposed the company very strenuously at the commencement, their attitude had completely changed, for they had found that so far from doing them harm, the power company was able to supply them with power much cheaper than they could generate it themselves.

In answer to Lord LYTTON, witness stated that the general tendency of the establishment of large generating stations giving a supply of cheap power was to bring about the erection of new factories in the districts served.

Some other questions were put by the Committee to show that it had taken the company four and a half years to get clear, so to speak, and to yield a profit to the shareholders.

In cross-examination by Mr. FREEMAN, for the London County Council, Mr. Lupton stated that the clause in the Yorkshire Act stipulating a substantial commencement of the works in two years and the cession of their powers within four years if they were not in a position to give a supply, had not acted against the company, as they had been well within the margin of four years, and had made a substantial progress within the two years. As a matter of fact, they had never looked at the clause from the time the Act was passed

In answer to Mr. BLENNERHASSETT, for the Westminster City Council, he stated that the Yorkshire Company's powers were simply to supply authorised distributors by consent, and to railways, tramways, and canals without consent, of the Local Authority. They had no powers to acquire the undertakings of authorised distributors.

Questions were next put by Mr. SEYMOUR BUSHE, K.C., for the Westminster and Kensington companies, on the point that certain districts within their area of supply had been cut, there being electric supply authorities already existing in these areas. With regard to the supply to Brighouse, the price was £6 per kw. of maximum demand per annum, and 0·25d. per unit. The power company did all the conversion, and guaranteed that the maximum price did not exceed 1½d. per unit.

Mr. RIGG, K.C., for the City Corporation, directed his questions to showing that in the large towns comprised in the

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Yorkshire Company's area, the company was not entitled to lay mains through the centre of these towns without the consent of the Corporation, and witness admitted that no inconvenience had arisen from that clause.

In answer to Mr. TYLDESLEY JONES, on behalf of the London Electric Lighting Companies, Mr. Lupton stated that in spite of the hampering conditions placed upon the Yorkshire company, by cutting out certain areas from their power area, the company had made good progress.

In re-examination, the Hon. J. D. FITZGERALD, K.C., said he was glad of the admission on behalf of the London companies that the cutting out of specific areas in a power supply area must have had a hampering effect. The Yorkshire Power Co., said Mr. Lupton, was supplying in 26 districts, either through local authorities or through the medium of a distribution company, which had been formed by the Power Co.

At the conclusion of this evidence the Hon. J. D. Fitzgerald said he had drawn up alterations in the purchase clause, and desired to recall Sir Hugh Bell upon it. We gave the original drafting of the purchase clause on page 722 of our issue of May 14th. The first alteration, said Mr. Fitzgerald, affected the words "properly expended" in sub-section 1, as a criticism had been made that this meant properly expended upon the undertaking, but not necessarily properly chargeable to capital account, and accordingly the first amendment proposed was to strike out "properly" before "expended," and bring it in before the word "chargeable" later on, so as to make it perfectly clear that it was the amount expended and properly chargeable to capital account.

Continuing, Mr. Fitzgerald said that the following additional sub-sections were also proposed :—

"In the sixth and in every succeeding year after the company commence to supply electrical energy under the provisions of this Act they shall, before arriving at the profits of the undertaking available for dividend, set apart to form a fund (hereinafter in this Act called the 'maintenance and renewals fund') such sums as the said auditor may determine to be necessary to maintain the buildings, plant, mains, and apparatus of the company in an efficient and proper working condition, and to renew the same when necessary, and the company shall out of such fund maintain and renew the said buildings, plant, mains, and apparatus accordingly.

"If the company consider any determination of the said auditor to be incorrect or unreasonable, they may appeal thereon to the Board of Trade, whose decision shall be final.

"For the purposes of this section any sums so expended by the company in such maintenance and renewal shall not be deemed to be chargeable to capital account."

Sir HUGH BELL was recalled in connection with these alterations, and expressed his opinion that the effect would be to keep the plant in good and efficient order, as under these sub-sections the company would have to form a maintenance and renewals fund, and the auditor would determine whether a sufficient sum was being included for the purpose in question. If they were dissatisfied with the auditor's decision, they could appeal to the Board of Trade. There were also, he said, other small changes in sections 4 and 5 which were simply consequential. He also mentioned that sections 4 and 5 of the original purchase clause had been struck out by the desire of the Board of Trade, and consequently sections 6 and 7 now became 4 and 5.

Some discussion took place as to the inconvenience of this method of dealing with the matter, and it was agreed to have the new purchase clause printed complete by Monday morning. Discussion upon the alterations was thereupon not continued.

Sir HUGH BELL stated that he would like to add something to what he had already said on the question of finance. After the observations of the Committee he had made it his business to see if he could say more on this question, and was now authorised by Sir Edward Tennant to say that he would put himself in the same position as he (Sir Hugh Bell) would put himself. He had Sir Edward Tennant's authority to state that he would be responsible for capital to the extent of £100,000, or, if it was preferred, he could put it in this way, viz., that he, Sir Hugh Bell, was in a position to say that he was prepared to substitute the figure of £350,000 for the £250,000 which he had already mentioned.

In answer to Mr. FREEMAN, Sir Hugh Bell stated that it was the intention of the promoters that the requirements in the purchase clause that the dividend should be made up to 6 per cent., should remain if the purchase took place at the end of 42 years. He had not considered the question put to Mr. Hammond as to the attitude the promoters would take towards purchase in 1931, when the electric lighting companies in London would become purchaseable. Mr. Fitzgerald upon this point said he did not propose to bring up any suggestion, but if the London County Council had one, the promoters would consider it.

Mr. BALFOUR BROWNE, K.C., asked some questions as to the capability of the auditor to judge upon what he thought rather important points, namely, the sum necessary to maintain the buildings, plant, mains, and apparatus. An ordinary auditor, he presumed, would not be sufficiently expert to be a competent judge on that point, and he desired Sir Hugh Bell's opinion on the subject.

Sir HUGH BELL stated that auditors had now acquired such an enormous amount of information on subjects of this kind that it was becoming usual to refer to auditors even on expert points. Personally, he was quite accustomed to confer with his auditor on the very points as to whether the particular sum or rate on which he was depreciating certain of his plant was a right one or wrong one, and it was on this ground that they had to see the auditor was a proper person.

Mr. BALFOUR BROWNE said that an auditor had not necessarily any scientific knowledge of such questions as to what was necessary to keep the plant in order.

The CHAIRMAN asked if there would be any objection to the auditor taking expert independent advice to guide him on technical questions.

Sir HUGH BELL thought no one would object to the auditor being instructed if he were in doubt on any points; he did not see how he could put it any differently to that. Personally, he regarded it as purely an accountants' question, and not an engineers' question.

The CHAIRMAN stated that this was a point upon which he was not quite at one with witness, although from a financial point of view, he would be satisfied with the auditor because he thought he would be more drastic probably than the expert engineer.

Hon. J. D. FITZGERALD said he was informed that if a question of this kind did arise before an auditor, which he did not feel himself equal to deal with, it was the practice of the auditor to get advice. His next witness would be an accountant, and this matter would be dealt with.

At the suggestion of the CHAIRMAN, the promoters agreed to confer with the London County Council to see to what extent they could come to an agreement with regard to the purchase clause.

The accountant who will be called on Monday will be the last witness for the promoters of this Bill, and arrangements have been made for the various local authorities and others against the Bill to oppose first, leaving the promoters of the London Electric Supply Bill, who are represented by Mr. Balfour Browne, K.C., Mr. C. A. Cripps, K.C., and Mr. Tyldesley Jones, to wind up the opposition.

The CHAIRMAN inquired if, as the local authorities were opposing all three Bills, the Committee were to hear three speeches. He hoped they would not.

MONDAY, MAY 25TH. (TWELFTH DAY.)

At the commencement of the proceedings Mr. FITZGERALD stated that although the promoters had had a conference of three hours on Saturday with the London County Council in an endeavour to come to an agreement with that body on the question of the purchase clause, no definite arrangements had been arrived at, but it was proposed to carry on the conference for the next two days, when it was hoped that something definite could be announced.

Mr. W. B. WOODHOUSE, Engineer and Manager to the Yorkshire Electric Power Co., was called to amplify Mr. Lupton's evidence of Friday, which he corrected in one or two minor details. On the question of figures, he stated that the average price was below ¾d. per unit, and not 1d. as Mr. Lupton had said, and that transformed current was actually sold at £4 per kilowatt and 0·25d. per unit. At a load factor of 25 per cent. this came out at 0·69d. per unit. These charges were lower than those of any local authority in the Yorkshire area. The prices charged approximated fairly closely to those in the present Bill, and were considerably lower than the maximum prices he was entitled to charge under his own Act. As showing the progress of the power company, he stated that within a radius of four miles of the Thornhill generating station there were originally eight generating stations, but since the power company had commenced operations, five of these had been converted into sub-stations. The date of commencement of supply of the power company was December, 1904, and not December, 1903, as previously stated. The output last year from his station showed an increase of over 100 per cent., and for the present year there was every indication that the rate of increase would be exceeded. The lowest price in Leeds, he said, was 1¼d. per unit, and no mill in the Yorkshire area was taking the whole of its supply from municipal mains for electric driving, whereas the power company was already supplying no less than seven textile mills with power for driving all their machinery, and two others were being negotiated with. In the small area round the Thornhill Station there was an estimated horse-power of 36,000, of which the power company were supplying 8,000, and had contracts for 2,000 more. Offers of bulk supply had been made to several local authorities, under which a considerable saving over their present working costs had been guaranteed, but these offers had not been accepted. At the same time, the smaller local authorities had agreed to let the power company supply in their districts to large power users, and took a supply in bulk themselves for ordinary purposes.

In cross-examination Mr. Woodhouse stated that the estimated horse-power available for electric driving in the whole of the Yorkshire Power Co.'s area was 2,000,000. He explained that, so far as his company was concerned, they had no power to appeal against the decision of the local authority in large

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cities on the question of whether they should supply within the boundary or not.

At the close of this evidence Mr. Fitzgerald suggested that he should postpone his accountant's evidence on the ground that the purchase clause would not be in its final form until the conference with the London County Council had been concluded. Both Sir Ralph Littler and Mr. Balfour Browne for opponents opposed this course of action on the ground that it was the usual procedure, before the opponents to a scheme presented their case, that the promoters' case should be completed. All the opponents, it was argued, had been basing their calculations on the purchase clause as it stood, and they asked the Committee to say that the Bill as it stands must be adhered to and that the promoters should make application to introduce their purchase clause when it had been drafted.

After consultation, the Chairman suggested that the promoters should proceed with their further evidence, reserving the right to recall the accountant when the new clause was presented.

Mr. Lionel Maltby, F.I.C.A., and a member of the firm of Messrs. Deloitte, Pender, Griffiths & Co., auditors of a number of electric light, water and other undertakings, said he was familiar with the purchase terms of the Electric Lighting Act of 1888, but, as the period of purchase under this did not arrive until 1931 in London, there was no experience at present as to how these terms would work out in practice. The only purchases which had taken place had been by agreement. The general objection to the terms of the Electric Lighting Act in relation to the raising of capital was the uncertainty in the minds of investors as to whether they would get their money back, or how that section would be interpreted. Further, the company would find it difficult to raise fresh capital as their term drew to an end. Under the proposed clause as it at present stood, there would be no uncertainty, nor would there be any need for proceeding to arbitration for determining the purchase price. He did not think an auditor would allow the amount spent on renewals and repairs to be placed to capital; he certainly would not, and he would favour the introduction into the clause of a definite provision that the company should maintain the plant in a good and reasonable condition, because although the auditor would not permit renewals actually made to be charged to capital, he could not compel the company to make the necessary renewals. If such a clause were in the Bill as he had suggested, the auditor could do this in conjunction with an expert adviser, and the result would be that the purchasing authority would take over the undertaking in good working order. In his opinion the clause limited the amount of the purchase money. Hitherto no purchase clause had appeared in a Power Bill, and he regarded this as a departure in favour of the purchasing authority as compared with the purchase terms in the past of gas and water undertakings, especially in view of the fact that the sinking fund, insurance fund, and reserve fund would go towards diminishing the purchase price, whilst at the same time the purchasing authority was relieved altogether from any claim for goodwill or profits.

In cross-examination by Mr. Freeman, for the London County Council, Mr. Maltby agreed that he was most anxious to avoid any ambiguity. Questions were put to the effect as to what would happen, taking the life of plant at 25 years, as has been suggested by the engineers to the scheme, if, say, in ten years a new invention was to be made which rendered it absolutely necessary, from the revenue point of view, for the company to scrap some of its existing plant. Witness replied that he would propose to write off the sum still outstanding to capital account, either at once, or, in the event of it being too hard upon the undertaking to do this, the amount could be carried to a suspense account and spread over a short term of years. It would be the auditors' duty to see that the balance was written off when the plant was scrapped in this way. Mr. Freeman suggested that this might make the company unwilling to go in for new inventions, and so fail to keep the undertaking in a high state of efficiency when it was nearing the end of its term. Witness replied that he did not suppose the company would go in for new plant at any time unless they could see a profit coming from it.

Mr. Freeman then asked whether witness had calculated any sums as the amount which the purchasing authority would have to make up if the undertaking had not been paying 6 per cent. It was put to the witness that, assuming 4 per cent. only had been paid during the whole existence of the company, the sum which the purchasing authority would have to provide to make this equivalent to 6 per cent. would be £3,750,000, which would practically act as a prohibition on buying.

Mr. Maltby said he had not considered the matter in this aspect.

In answer to the Chairman, Mr. Fitzgerald stated that as the Bill stood, the 4 per cent. which was to be paid out of capital during construction would have to be made up to 6 per cent. at the end of the period, but Sir Hugh Bell had stated his willingness to modify this.

A further discussion took place as to the obligation of the purchasing authority, assuming the option to purchase is not taken advantage of in 42 years, but is postponed for a further ten years, as provided in the Bill. Mr. Fitzgerald stated that in his opinion the Bill made it quite clear that if the purchase were postponed for 52 years, or any other period of years, the obligation to make up the dividends did not apply. As the Chairman, however, had stated that in his opinion it was not quite clear, he was quite willing to make it so.

Some questions by Sir Ralph Littler seemed to indicate that he preferred the terms hitherto paid to gas and water companies, and Mr. Fitzgerald, for the promoters, suggested this in re-examination.

Sir Ralph Littler objected to this interpretation of his meaning, and stated that he desired the terms of the Electric Lighting Acts.

This closed the case for the promoters, Mr. Fitzgerald stating that a report by the Board of Trade with regard to certain alterations in the Bill had been complied with, and that a clause had been agreed upon with the Commissioner of Works. He also announced that clauses had been agreed with the Thames Conservancy, Duchy of Cornwall, the Metropolitan Water Board, the Camberwell Borough Council, Inns of Court, Duke of Bedford, London United Tramways, Commissioners of Sewers for Havering, the Commissioner of Sewers for Essex, West Kent Sewerage Board, and all the railway companies with the exception of one in the metropolis.

Case for the Opposition.

Croydon.

Mr. Wedderburn, K.C., for the Croydon Corporation, who led the opposition, drew attention to the fact that this area was distinct from any other area in that it was not industrial, and from the evidence of the promoters themselves was never likely to be. Croydon was also on the boundary of the area of the Bill, and he failed to see any reason why it could not be detached. In the Administrative Bill of 1905, the promoters had agreed a clause with Croydon to the effect that the powers of the Bill should not apply to Croydon except for wayleaves, supplying energy to railways, docks, &c., and by agreement only with the Corporation. This clause was agreed again in 1906. Mr. Hammond had stated that the clauses agreed with previous power bill promoters should be again accepted, and this was a clause which, if this Bill ever came to that stage, he thought the promoters were bound to accept if the Croydon Corporation desired it. There had been no evidence to the effect that the present supply at Croydon was in any way unsatisfactory. The capital expenditure upon the municipal undertaking was about £340,000, and he asked whether it was worth while to exchange this personal control for reliance upon one source of supply 20 miles away, unless there was a substantial financial advantage. The promoters' figures showed a saving of £5,908 to the Corporation if a bulk supply were taken, but the Corporation, taking the basis upon which the promoters had worked, estimated a loss of £329, whilst, if the proper figures had been taken, the loss would work out to £1,504. This was on the basis of scrapping the works. If the Corporation took a bulk supply for the purpose of the peak load, then they estimated a loss of £1,907.

The Chairman suggested that as the Corporation or any other distributor was not bound to take a supply, he did not think any argument as to whether they would gain or lose by taking a bulk supply would influence the decision of the Committee. Counsel would be more to the point if they confined themselves to showing how they would lose by the competition clause.

Mr. Wedderburn, in conclusion, although he had already stated that his area was a purely residential one, and that there were practically no power users, went on to argue that the Power Company could come in and compete for small power users on unequal terms. He therefore asked that, even if Croydon remained in the Bill, it should be left to the Corporation to decide whether they might give any supply in the district.

Mr. A. C. Cramb, Electrical Engineer to the Croydon Corporation, said there was nothing in the nature of a large factory in Croydon, and the introduction of factories would alter the whole residential aspect of the town at present. He characterised as absurd Mr. Hammond's suggestion that a man at 30s. per week would be sufficient to deal with the high-tension supply from the power company.

In cross-examination, Mr. Cramb said the income from power was £1,500 per annum, or 1½ per cent. of the total. Having ascertained that the cost of coal at Croydon varied from 15s. to 23s. per ton, that water had to be obtained partly from the town mains at 6d. per thousand gallons, and that cooling towers were used, Mr. Fitzgerald asked if it were possible under these conditions to generate at anything like the figures given in this Bill. Mr. Cramb answered that it was not proposed to do so, but that the present expenses were being reduced. Mr. Cramb also said that the present coal cost at Croydon was 0·5d. per unit. Asked as to whether it would not be an advantage to have the option of taking a bulk supply, instead of incurring further capital expenditure on new plant, witness replied that this would depend upon the circumstances.

In re-examination, Mr. Cramb stated that the Corporation would always be able to get a supply from the power company, even if the district were cut out of the area, as there was a clause in the Bill which enabled the company to supply in contiguous areas.

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MARYLEBONE.

The case for the Marylebone Borough Council was next taken.

Mr. E. W. DEBENHAM, Chairman of the Electricity Committee, said the Council were advised that the power company could not benefit them, because, on whatever price the power company might charge, there must be added something in respect of the purchase of the Metropolitan Electric Supply Co.'s business in the district. In spite of this, however, the price for lighting had been reduced from 5·15d. per unit to 4·42d. per unit. Apart from the purchase price for the company's undertaking, the Council claimed to be able to generate more cheaply than the promoters could supply. The Administrative Co. placed Marylebone in the "non-industrial area," and eventually the district of Marylebone was placed within the bulk area of the Metropolitan Electric Supply Co., who, however, had no powers of compulsory supply of any sort. The Council feared competition at cutting prices, in order that the company might secure their power business.

Mr. ARTHUR WRIGHT, Consulting Engineer to the Marylebone Borough Council, said he considered the load factor taken by the promoters as very low compared with most of the districts in London. He had made calculations which showed that to take a peak load from the power company would not be profitable, because it would cost them more than if they generated the whole of the energy themselves. The figures of his estimates showed an actual loss of £300 per annum at a 15 per cent. load factor. At any other load factor the disadvantage would be greater. In his tables, Mr. Hammond had assumed a higher load factor for Marylebone, viz., 54 per cent., than for Stepney, which was a purely manufacturing district, and for St. Pancras, where a much larger amount of power was used; and he could not understand why. The Marylebone costs, worked out from the accounts just published, were equal to £4·36 per kw. and 0·395d. per unit. When the existing works were selling 12,000 kw., the costs would be reduced to £3·1 per kw. and 0·35d. per unit. Of the 350 power consumers in the Marylebone power mains, 256 averaged 11·4 kw., and the average load factor was 12·8 per cent. The price charged on the present scale at this load factor was 1·445d. per unit, without discounts, whilst the power company's supply for such a consumer supplied with direct current was 1·473d. The Council's price, without any addition for the award in respect of purchase of the Metropolitan Co.'s business, would be 1·25d. per unit. The prices to the two largest consumers in Marylebone, of 57 kw. and 52 kw. respectively, were 1d. and 0·98d. respectively on the present scale. The power company's price would be 0·996d. and 0·946d. respectively; whilst without any allowance for the awards the Council's price would be 0·815d. His feeling was that the advent of the power company would give rise to a feeling that electricity could be supplied at much cheaper rates than was now the case in Marylebone, whereas the fact was that the Council was at present supplying more cheaply than the company could.

In cross-examination, Mr. Wright admitted that the power load in Marylebone was small, but it was a growing one, but said that if it were taken away by the power company, then the lighting would have to bear the whole of the standing charges, as the power load reduced the standing charges on lighting. He expressed the opinion that the diversity factor assumed by the promoters was too high. This was a figure which very few electrical engineers had information about. In the Victoria Falls Power Scheme, of which he was a joint engineer, they assumed a diversity factor of 1. In London it ought to be safe to assume 1·2, but, generally speaking, it was very dangerous to assume a higher figure than 1. The only terms upon which it would pay authorised distributors to take energy from the power company would be at about £3 per kw. and 0·22d. per unit; but judging from the power company's calculations, it looked as if at their proposed prices the cost of distribution would wipe out the advantage of generation on a large scale.

TUESDAY, MAY 26TH. (THIRTEENTH DAY.)

Mr. A. B. CANE, counsel representing the Marylebone Borough Council, first referred to the arbitration proceedings in connection with the purchase of the Metropolitan Electric Supply Co.'s business in Marylebone, and said that when it was considered that the Council was buying a 20 years' undisturbed monopoly, no one could say that the price of £1,250,000 was exorbitant, and he wished to repudiate any suggestion of having made a bad bargain. At the same time, the Council had been compelled by Parliament to make the purchase on the ground that competition should not be allowed with the company, which was already installed, and he asked that the Council, which was now working in place of the company, should be treated in the same manner that the company had been treated, viz., that they should be free from any sort of competition. It was admitted in the promoters' tables that 10 kw. would have to be generated at Barking for every 9 kw. delivered in London, and he contended that the cost of distribution would wipe out any benefit derived from the cheaper cost of generation. The Administrative Company excluded Marylebone from the industrial area, and did not propose to compete for the power business, but this company would undoubtedly come in and compete for the small power load that existed. In reply to a question by the Chairman, Mr. Cane said that undoubtedly the Kitson clause gave a measure of protection, but Marylebone preferred to be left alone altogether.

Mr. CLODE, for the promoters, said that, failing the clause in the Bill at present, the promoters were willing to accept the Kitson clause.

WEST HAM.

The opposition of the West Ham Corporation was then taken.

Mr. A. H. SEABROOK, Electrical Engineer to the West Ham Corporation, said the capital expenditure upon the electrical undertaking was £410,000. Three-quarters of the supply was for power purposes, and if the Newcastle Supply Co. was excepted, the business was larger than that of any of the power companies of the country. In fact, the consumption of one consumer, with whom they had a contract for five years, was larger than the whole of the bulk output of the Yorkshire Power Co. The total power supply in the borough would, in the next two weeks, amount to 8½ to 9 million units per annum, and including tramways, the total output for power purposes now amounted to 12½ million units per annum. He gave a list of power consumers whose maximum demand was over 250 kw., and also mentioned that there were a large number whose maximum demand was 200 kw. or thereabouts. Of the total power demand of 6,000 kw., about one-third was to consumers of over 250 kw. In making a number of corrections which he said were necessary to bring the tables up to date, he said that the works costs should be, at April, 1908, 0·572d. per unit instead of 0·585d.; the capital charges 0·330d. instead of 0·375d., and the total costs would be 0·842d. per unit instead of 0·958d. These corrections reduced the saving to the Corporation under the Bill to practically nothing, whilst, in any event, as the Corporation had a large number of contracts for day and night supply, with very heavy penalties attaching to failure, they would not be disposed to rely on an outside source of supply. He also doubted whether the profit shown in the clause in the Bill regulating supply to authorised distributors, in connection with consumers under 250 kw., would actually be made in consequence of the uncertainty of the diversity factor. Some of the power consumers in West Ham had a load factor of 80 per cent. to 100 per cent., and, of course, there was no diversity factor.

In cross-examination by Mr. Clode, Mr. Seabrook said that as the Corporation had already very large buildings, boiler plant, coaling plant, &c., the capital charges on additional generating plant would only amount to about 10s. per kilowatt, so that the question of extensions compared with taking a supply for the power company was not so serious as might be the case with other distributors. With regard to the usefulness of having a bulk supply to fall back on, he mentioned that the Corporation had authority to take such a supply from the power station of the Charing Cross, West End, and City Electricity Supply Co., which was in the borough.

Mr. H. E. BLAIN, Tramways Manager to the West Ham Corporation, gave evidence as to the possibility of interference with the tramway system by the laying of the power company's mains, owing to there only being two routes out of the borough into London.

Mr. CLODE said the promoters were perfectly willing to discuss a clause for the protection of the West Ham tramways.

Mr. MORTEN, in the course of his speech for the West Ham Corporation, referred to the railway works in the borough. In the London Electric Supply Bill, which is next on the list before this Committee, there was a proviso that the supply to railways should be restricted to haulage and traction, or for lighting carriages drawn by such haulage or traction, and he asked that, if the Bill went forward, this restriction should be put in. Speaking generally of the attitude of the West Ham Corporation, counsel said they were a self-governing county borough, and had gone to great expense in erecting a works with room for extensions up to 20,000 kw. Rather than give up the supply of electrical energy to a company, they would fight the company, and sell at a loss, if necessary, to do so. He regarded clause 52, which regulated the supply to authorised distributors, as infinitely worse than the Kitson clause.

HAMPSTEAD.

The case for the Hampstead Borough Council was then presented by the Hon. EVAN CHARTERIS. He stated that the capital expenditure upon the municipal electricity undertaking was £383,000, of which £80,000 had been repaid. The Hampstead Council, he said, in 1893, came to the conclusion that the period for repayment of loans allowed by the London County Council, viz., 42 years, was too long, and it initiated the lower period of 25 years. In spite of this handicap, a very successful undertaking had been built up. The supply of power was very small, practically a negligent quantity, but there was a fair amount of energy sold for heating purposes in Hampstead, which the Council naturally desired to keep.

Mr. C. FLEETWOOD PRITCHARD, the Chairman of the Electric Lighting Committee, gave evidence in which he, alike with other opponents, challenged the accuracy of the basis of the tables put in by the promoters.

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The Chairman said that this was the first time the question of heating had been put before the Committee, and he presumed that the promoters, at a later stage, would deal with this matter.

Mr. Clode said he was not disposed to deal with it at the moment, but it would be dealt with in the promoters reply.

Stepney.

Mr. Williams next addressed the Committee on behalf of the Stepney Borough Council, arguing that the trend of the action of Parliament hitherto had been that it would not inflict irreparable hardship upon the authorised distributors, whose money had been invested in electrical undertakings in the proposed area. In a general review of his case against the Bill, as revealed in his cross-examination of the promoters' witnesses, Mr. Williams referred to the question, already raised by the Committee, of what would happen to London in the event of damage to the Barking station from various causes, such as a foreign invasion, &c., and expressed the opinion that, great as were these dangers, there were equally great dangers from within. In the event of accident to the generating plant, which shut down the whole supply to London, the forces of disorder would have their opportunity; this, he said, was a risk too great for the Committee to sanction. He complained of the possibility of competition for lighting business under the clause which allows a power-user to use 20 per cent. of his total supply for lighting. As an instance, he argued that, if the power company supplied the Tilbury Railway Co. for power, this 20 per cent. would be sufficient to light all the stations in the borough, which at present brought in about £1,200 per annum to the Council's electricity undertaking.

Mr. W. C. P. Tapper, Borough Electrical Engineer and Manager of the Stepney Electricity Works, said the capital expenditure to date was £288,000, and further powers had been granted for an expenditure of £87,886 in connection with the Blyth's Wharf scheme. The average price for private lighting was 2·21d. per unit; for power, 0·95d.; and for public lighting, 1·27d., making an average over the whole of 1·62d. per unit. The power supply during the past year showed an increased consumption of 604,000 units compared with the previous year. When the Blyth's Wharf scheme is in operation, Mr. Tapper said that the charges would be £3·12 and 0·33d. per unit against £4 10s. and 0·33d. in the Bill. Compared with the Administrative Co.'s offer of 1905, the charge of the London & District Co. was 24·8 per cent. higher.

The Chairman again urged Council not to labour the point of whether the Council would be hurt or not by taking a bulk supply. They were not bound to do this, and the Committee would prefer that the question of possible competition should be dealt with. He also asked upon what experience the 20 per cent. for lighting clause had been based.

Mr. Clode said that he was informed that the 20 per cent. was put in by the Board of Trade when they first settled the clause.

LOCAL NOTES

AUCKLAND (NEW ZEALAND).—It is reported that the tramway strike is at an end.

BATH: *Electricity Accounts.*—The accounts for the past financial year show an increase in the revenue of £2.000, due mainly to growth of the power load from large consumers, including Messrs. Stothert & Pitt, and the Great Western Railway. The net loss on the undertaking has been reduced from £1,440 to £392. The gross profit was £9.671, but £10.C54 was absorbed by interest and sinking fund. The cost of coal has been very high during the year, but slight economies have been effected in other directions.

Sale of the Electricity Undertaking.—At Monday's meeting the Corporation decided by 28 votes to 9 upon the sale of the electricity undertaking, subject to the approval of the Board of Trade, to Mr. Schenk's syndicate, which already holds powers for supply in the surrounding districts. The terms of the sale were given on page 751 of our issue of May 14th. The Corporation are relieved of all financial responsibility, and the profit is calculated at £65.000.

BELFAST: *Tramways.*—At the weekly meeting of the Tramway and Electrical Committee on the 25th inst. Sir Robert Anderson, Lord Mayor, presiding, the general manager, Mr. Nance, submitted a report recommending the reduction of the car service at a saving of about between £6.000 and £7.000 per annum, and a scheme for the readjustment of the fares was also submitted and approved of by a majority.

BIRMINGHAM: *Electricity Accounts.*—The report for the year ended March 31st last records an increase in units sold from 10,887,684 to 20,793,670. of which 9.600,894 were for lighting and power, and 11.192,776 for tramways. The costs show a reduction of 0·294d. per unit, in spite of the high cost of fuel. The lamp connections have increased by 66.329 16-c.p. lamps, and the motors connected by 3,491 h.p. The accounts show a sum of £60.926 available for payment of interest and sinking fund.

Tramway Accounts.—The accounts for the year ended March 31st, to which we alluded briefly in our last issue, report a gross profit for the year of £121,112, and a net profit after meeting capital charges, &c., of £72.037. Of this, £37,037 is to be placed to reserve, and £35.000 carried to the borough fund. The traffic revenue over the 34 miles of route (equivalent to 56 miles of single track) has averaged 11·42d. per car-mile, and the average working expenses are given as 6·72d. The total revenue was £289,556, and the working expenses £168,444. 10,577,540 units of current were purchased from the Electricity Department at 1·283d. per unit.

BLACKBURN: *Proposed Tramways.*—Presenting a report of the Light Railway Commission at Blackburn to the Great Harwood Council on May 20th, Mr. T. Noble, chairman, said the impression was conveyed that the scheme would be proceeded with within the next two years, and the opinion was expressed that the suggested tramway would tend to link up the three townships of Great Harwood, Rishton, and Clayton. It was mentioned that an undertaking had been given that when the railway was being laid, the promoters would guarantee certain road repairs.

BOSTON: *Electric Lighting Order Revoked.*—The Board of Trade have revoked the electric lighting order granted to the Boston Urban District Council in 1906.

BRAY: *Electricity Supply.*—At the meeting of the Urban Council last week the electric lighting scheme came up for discussion on the recommendation of a committee that a sum of £5.000 be expended upon the existing works for the purpose of making the concern efficient and self-supporting. Mr. Bradshaw, chairman of the Electric Committee, set forth the details for the improvements, which he believed were the only way out of the fact that the works involved a loss of £1.000 per annum. After a lengthened discussion, the matter was postponed till a special meeting be held.

BRIGHTON: *Tramway Accounts.*—The Corporation Tramway undertaking shows a deficit of £969 as compared with a profit of £2,410 for the previous year. The revenue has declined from £16,153 to £12.641. It is stated that negotiations are in progress for the acquisition of the undertaking by a London syndicate who propose to use a different type of car.

BROCKLEY: *Proposed Tramways.*—A letter has been received by the Hon. Sec. of the Honor Oak Park and Brockley Tramways Committee from the Clerk to the London County Council stating that the Highways Committee do not see their way to recommend the Council to proceed with the construction of these tramways authorised from Lewisham High Road to Forest Hill during the present year, as they are of opinion that the tramways will not be remunerative, and they feel that the electrification of other and existing lines is more urgently required.

BURTON-ON-TRENT: *New Tramway Brake.*—A demonstration of Mr. P. J. Pringle's new grooved skid tramway brake has been made before the tramway committee. The matter is to be discussed formally at the next meeting, but we are informed that, in any case, it is proposed to fit up six of the cars which are used on the most hilly route.

Electricity Accounts.—The annual report and accounts show a surplus of £1,104, as against £793 for the previous year. Of this, £636 will be devoted to wiping off certain capital expenditure, and £468 carried to renewals fund. The price of fuel has increased by 33·7 per cent., and the revenue has been affected adversely by the introduction of metal filament lamps and trade depression. In spite of this, the gross profit has increased from £5,828 to £6,117. The motor load now exceeds the lighting load, and is nearly as great as the tramway load. The works costs are given as 0·812d. per unit, and the total working expenses as 1·055d. per unit. Capital charges bring this up to a total of 1·915d. per unit. Satisfactory results are reported owing to the extended use of the restricted hour principle, which is adopted in 481 out of the total 737 h.p. of motor load.

Tramway Accounts.—The annual report and accounts record a decrease of £686 in the receipts, notwithstanding an increase in the car mileage from 421,317 to 430,913. The surplus of income over expenditure was £4,745, but £4,866 were required for capital charges, and £1,000 was set aside for reserve and renewals, so that there was finally a loss of £1,121 on the year's working. The expenses are analysed as follows:—Traffic, 2·61d.; repairs and maintenance, 0·92d.; management, &c., 0·78d.; power, 1·89d.; capital charges, 3·29d. Total 9·49d. per car mile.

BURY: *Tramway Accounts.*—The annual report and accounts show a surplus of £4,606, of which £2,500 has been carried to reserve and depreciation fund, and the remainder to the rates. The working expense, exclusive of power, are given as 5·711d. per car mile, and the total revenue per car mile as 9·27d. The current consumption from the Bury station averaged 1·68 units per car mile at 1·06d. per unit; power was also taken at 1⅛d. per unit from the Radcliffe station. Extensive repairs have been carried out to the permanent-way during the year.

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CANADA: *Port Hope, Ontario.*—The Port Hope Electric Light and Power Co.'s generating station was destroyed by fire on May 9th. The loss is estimated at £10,000, and is said not to be covered by insurance.

CHANNEL ISLANDS: *Wireless Telegraphy.*—Notice has been given by the Post Office that telegrams for the Channel Islands are now received at inland rates at sender's risk for transmission, if possible, by wireless telegraphy.

CLACTON: *St. Osyth Light Railway.*—The Board of Trade have confirmed the Clacton-on-Sea and St. Osyth Light Railway (extension of time) Order, 1908, reviving the powers granted, and extending the time limited, by the order of 1904, for the compulsory purchase of lands and completion of the railway and works.

DUNDEE: *Tramway Profits.*—After a good deal of discussion it has been decided that a payment of £1,000 shall be made by the Tramways Department.

Tramway Extensions.—In connection with the proposed tramway extensions to connect the Maryfield and Fairmuir routes, the Council has decided to send a deputation to inspect Continental examples of the "trackless system," the adoption of which is proposed.

ERITH: *Tramways.*—A report just issued by the Tramways Manager shows that the financial result of the Urban District Council Tramways undertaking for the year ended March 31st last was as follows:—Total income, £8,539 (an average of 6·37d. per car mile); working expenses, £8,393 (6·26d. per car mile); gross profit, £145 (0·11d. per car mile); loan charges, £4,594 (3·43d. per car mile); net deficiency, £4.449 (3·32d. per car mile). In view of the approaching completion of the L.C.C. tramways to Abbey Wood, the District Council has suggested the desirability of an arrangement for through booking between Erith and Beresford Square, Woolwich, and *vice versa*.

HUMSBY: *Wireless Telegraph Station.*—At a meeting of the Electric Lighting Committee last week, Mr. W. H. Vignoles reported that he had been in communication with the Admiralty regarding the proposed wireless telegraph station at Humberstone, and expected soon to be able to put an agreement before the department for a supply of current.

HAMPTON WICK: *Electric Lighting Order Revoked.*—The Board of Trade have revoked the electric lighting order granted to the Hampton Wick Urban District Council in 1904.

HASLINGDEN: *Tramways.*—Great progress has been made by the Haslingden Corporation in the matter of converting the three miles of their tramway system from steam to electric traction. The new electricity generating station will not be ready for twelve months, however. In the circumstances, arrangements have been completed by which Accrington will for twelve months supply current and cars at a charge of 7d. per mile for a length of two miles, Haslingden finding its own inspectors and taking third party risks. The cars are to be running over the first mile about a month hence.

Workhouse Lighting.—A deputation for the Haslingden Board of Guardians met representatives from the Rawtenstall Corporation on May 21st, when Rawtenstall made the following amended offer:—To supply the workhouse building with electricity at 3d. per unit, the Guardians to guarantee that they would take at least 25,000 units. Rawtenstall agreed to maintain the necessary cable. It was decided that further information be obtained, and a committee was appointed to visit Bury, Burnley, and other workhouses that have electricity installations and make inquiries.

LONDON: *London County Council.*—In connection with the proposal to issue a guide to the tramways system, it was originally intended to charge 2d. per copy for this, but the Highways Committee now recommend that the first issue of 100,000 copies should be sold at 1d. per copy. It is not thought probable that the revenue derived from the issued of the guide will entirely cover the cost of printing and publication, but the general advantage to the tramway system is held to justify the charge of one penny.

Tenders for Centrifugal Pumps.—The Highways Committee recommend that they should be authorised to accept tenders for the centrifugal pumps (already advertised for) in connection with the second portion of the Greenwich generating station, during the Whitsun recess.

Battersea.—The Electrical Engineer has submitted to the Electricity Committee a scheme for wiring and fitting of premises of consumers or prospective consumers on (1) a cash purchase system (based on net cost with a percentage addition for administration, supervision, &c.); (2) a hire-purchase system (based on payment by instalments over a term to be agreed with the consumer, and not to exceed five years, with again a percentage addition); or (3) a perpetual rental hire system. The Engineer also suggested the establishment of a show-room, the provision and maintenance of outside arc lamps, and supply of energy for them at a fixed price per annum for a definite number of hours, the maintenance of installations, motors, lamps, &c., at fixed prices per annum, the distribution of electrical literature, and the supply of motors, lamps, fittings, &c. The committee are not in favour of adopting the scheme in its entirety, but think that a start should be made by the Council undertaking the provision and maintenance of outside arc lamps at fixed prices, applying the cash or hire purchase system of payment. The London County Council General Powers Act, 1906, requires that the charges shall be so adjusted as to meet the expenditure incurred, and the committee think the Council would undertake too great a risk in carrying out the whole of the work. They have accordingly decided that the wiring for the arc lamps shall be done through contractors, and that this course be continued until the scheme seems likely to be a success, or the applications for installations are sufficiently numerous to justify the Council in doing the whole of the work themselves.

Hampstead: Street Lighting.—The question of substituting flame arc lamps for 28 lamps at present in use for public lighting in Finchley Road was considered at a meeting of the Borough Council on May 21st. The Lighting Committee reported that they had had a trial of various kinds of lamps, and found that the Oliver magazine lamp was the most suitable: moreover, by using this particular lamp, another 10 lamps could be installed in Finchley Road without any increase of energy at the electricity station. The proposals involved capital outlay amounting to £890 10s., made up as follows:—Lamps, switches, posts, and lowering gear, £547 10s.; erection of posts, £20: excavating for mains, laying cable, and making good, £325. The total annual cost for the 38 lamps, including loan charges, would be £827, as compared with £742 for the present 28 arc lamps. There was, however, an outlay of £76 per annum for the maintenance of 22 gas lamps which would be displaced by the 10 additional flame arc lamps, so that the extra charge per annum to the general fund would be only £9. The inclusive annual cost per arc lamp would, therefore, be reduced from £26 10s. per annum to £21 15s. 3d. The above figures were calculated on the assumption that the £567 10s. capital outlay which would fall on the general fund would be paid from capital account, but the Finance Committee were of opinion that the sum should be borne out of revenue. The Lighting Committee's recommendation to substitute magazine flame arc lamps for the present lamps, and to erect an additional 10 flame arc lamps, was referred back.

Electricity Finances.—A comparative statement of income in connection with the electric lighting undertaking has been prepared, which shows a total for the year ended Lady Day, 1908, of £65,738, as compared with £64,587 for the previous year. In respect of current the income amounted to £60,582, as compared with £57,475 for 1906-7, other items being meter rent, £2,059 (as against £3,870); other charges, £126 (as against £91); public lighting, £2,970 (as against £3,150). The Finance Committee has appointed a sub-committee to consider the present system of accounts in connection with the works and electric lighting departments, including stores and wages, and to report as to any change that may be desirable.

Marylebone: The Electricity Undertaking.—The Borough Council, at its meeting on May 21st, had under consideration the question of revising the present rates of charges for the supply of electrical energy, and the practicability of framing a tariff that should be applied universally throughout the borough. The Consulting Engineer (Mr. Arthur Wright) reported that it would be commercially inexpedient to raise the average price received per unit, or to interfere during the present year with the option which the old "Metropolitan" consumers have of remaining on their original scale of charges. There will be, at any rate for the next year, not sufficient revenue to warrant the Council taking the risk of causing loss of business that might follow the compulsory change of tariff to the 4,000 odd consumers who are now charged upon the Metropolitan Co.'s scale. With reference to the standard demand indicator tariff, he thought that the change should at once be made of basing each summer quarter's account on its own maximum demand instead of upon the mean of the demands during the winter months. He also considered advisable revision of the meter rents, and further that in those cases where a consumer is prepared to guarantee his load factor, or the total annual consumption per kilowatt of demand, the manager should be authorised to quote such consumer a flat rate corresponding to his load factor or consumption per kilowatt, so as to enable a quarterly bill to be made out on a flat rate at the nearest farthing above the calculated figure. The Council decided that the existing scale of charges should be continued until June 30th, 1909, but that each quarter's account should be based on the actual demand for the quarter. The Council also adopted a recommendation that meter rentals based upon the declared maximum demand of the consumer be charged at the following rates until June 30th, 1909:—Up to 10 amp., 2s. 6d. per quarter; above 10 amp. to 25 amp., 5s.; above 25 amp. to 50 amp., 7s. 6d.; above 50 amp. to 100 amp., 10s.; all sizes above 100 amp., 15s. The rates apply alone to all sub-meters and meters for special classes of supply (*i.e.*, power, basements, signs, &c.). Small wall-plug meters for power purposes to be charged at 1s. per quarter.

The Electric Supply Committee, submitting estimates for the year ending March 31st, 1909, reported that for the year 1907-8 the total sales to private consumers reached the figure of 8,535,000 units. Making allowance for the effect of the high efficiency lamps now on the market, the estimated increase has been put at 250,000 units instead of 500,000. The total cost of production for the six months ended December last (for an annual output of 8·5 millions) were at the rate of 1·49d. per unit. The cost for a similar output this year would not exceed

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1·4d. The additional sales of 250,000 units were estimated to cost only 0·5d. per unit (*i.e.*, the cost of extra coal, oil, and station stores), and it was reported that the total cost should not, therefore, exceed :—8,530,000 units at 1·4d., and 250,000 at 0·5d., or a total of 8,780,000 units at an average of 1·374d. The committee reported satisfactory reductions in management expenses, which during the half year ended December were 0·248d. per unit sold, stating that the rate of costs for the ensuing year would be safely estimated at 0·230d. This compared with 0·270d. estimated last year. Distribution expenses were estimated at 0·220d., and miscellaneous expenses at 0·190d., there being left a margin of 0·734d. to cover generating expenses. The generating costs during the half year to December worked out at 0·8d. per unit sold. The consumption of coal per unit generated showed a very substantial improvement, and there was a saving in the quantity of current consumed at the station. The estimated deficiency shown by the estimate, £6,967, would, it was explained, be met out of the credit balance of £29,325 in hand at March 31st, 1907, which would not be depleted by more than £3,000 at March 31st, 1908. The Council was reminded that the advent of the metallic filament type of lamp, though for the moment causing a serious diminution in the gross revenue of every electric supply undertaking, was bound to prove ultimately a very great boon to the electrical industry. The loss of revenue sustained now was small compared with the increased extent to which energy would be made use of in the future, as the outcome of the economy brought about by the introduction of the new lamps. The estimate for capital expenditure, amounting to £10,600 (which, like the estimate of £166,652 on revenue account, was approved), was as follows :—Generating station—For coal and ash handling plant, £510; staying thermal storage drums, £750; spare armatures for coal crane and ash conveyor, £55; sundry expenditure, £285. Mains Department—For new services, £900; new meters and demand indicators, &c., £1,600; extension of distributing mains, new disconnection boxes, &c., £2,500; alterations to Aybrook Street sub-station buildings, £4,000.

Paddington.—The Borough Council has agreed to support the Bill of the Metropolitan Electric Tramways Co. for extension of their lines along Harrow Road as far as Edgware Road, subject to the promoters consenting to reconstruct Harrow Road Bridge, and bearing the cost of certain road widenings already partly carried out. It is stated that the company are willing to agree to these conditions.

St. Pancras.—A contribution not exceeding £25 towards the combined electrical exhibit at the Franco-British Exhibition has been recommended by the Electricity Committee.

LUTON: *The M.E.A. Meeting.*—The Chairman of the Electricity Committee and the Electrical Engineer have been appointed delegates to the Convention of the Incorporated Municipal Electrical Association, to be held next month at Nottingham.

ROME: *Municipal Generating Station.*—A scheme for the erection of a municipal generating station has been approved by the Municipal Council.

RIO DE JANEIRO: *Water-power Scheme.*—The large dam which the Rio de Janeiro Tramway, Light, & Power Co. have had under construction for the past two years was completed last week. It is stated storage is thus afforded for sufficient water to run the 50,000-h.p. plant for several months.

WARSAW.—*Telephones.*—A consular report states that the number of subscribers to the telephones in Warsaw is rapidly increasing. Within the course of six years the number has increased by 414 per cent., and amounts now to about 11,000. As the central telephone station is only constructed to provide for 13,000 members, it is proposed to erect another station in the near future. Manufacturers and merchants complain of the very high fee, which is £7 a year, and efforts are being made by them to have it reduced to £3. The Warsaw-Lodz line is little used, as it is often more convenient to use the telegraph; 75 c. is paid for three minutes' talk. Besides this it is difficult to talk, as the Lodz telephones are of an old type. The authorities have taken up the matter, and it is intended to supply the line with new telephones.

Electric trams.—It was expected that the electric trams would run at the end of the year, but there has been much delay and there is still plenty of work to be done, although the rails are already laid almost everywhere. In view of this, the tramway administration had again to buy horses from Hungary, where they are usually obtained, although during the last two years no horses were bought in the expectation that the trams would run. The total number of tramcars will be 200.

Electric Light.—In the second half of the year the larger streets were illuminated by electric light; but these works also were much delayed, and the electric company asked the authorities for a postponement up to July, 1908. The company themselves sustained losses by the delay amounting to £1,700.

WEST HAM.—*Tramways.*—The Borough Council has received a letter from the Chief Officer of the L.C.C. Tramways, inquiring what the Council is prepared to pay for the use of the tramways between the Iron Bridge and Abbott Road or Orchard Street, if this length were electrified by the L.C.C. The West Ham Tramways Manager is to negotiate for such use upon the basis of either an agreed percentage upon the capital expenditure, or a rate per mile run by the West Ham cars.

WESTCLIFF-ON-SEA: *Decorative Lighting.*—It is stated that an elaborate scheme for decorative lighting of the cliffs has been decided upon, including festoons of incandescent lamps hung from the trees.

TENDERS INVITED AND PROSPECTIVE BUSINESS

CLEETHORPES.—Tenders are invited for the erection of a wireless telegraph station. Particulars from District Surveyor of Coastguard Works, 28 Pavement, York, or Director of Works Department, Admiralty. Tenders by June 12th.

CLYDE NAVIGATION TRUST.—Tenders are invited for the supply of asbestos packing, coal, electrical stores, india-rubber, oil, &c. Particulars from Superintendent of Stores, 16 Robertson Street, Glasgow. Tenders by June 6th to T. R. Mackenzie, General Manager.

DARTFORD.—Tenders are invited for a surface condensing plant. Particulars from the Borough Electrical Engineer, fee £1 1s. returnable, and tenders to the Town Clerk by June 3rd.

GREENOCK.—Tenders are invited for the supply of steam coal (washed singles and pearls), oil, and engine-room stores for the year ending June 30th, 1909. Particulars from Burgh Electrical Engineer, fee 5s. returnable. Tenders to Town Clerk by Tuesday, June 2nd.

HANLEY.—The Local Government Board have sanctioned a loan for the Electricity Department of £20,643 out of the £21,969 applied for.

HASLINGDEN.—The Guardians desire tenders for carrying out the work of the proposed new infirmary to contain 158 beds, together with maternity ward and nurses' home and proposed new boiler house, with engine-room and chimney. Applications to be accompanied by a fee of two guineas. Tenders close on Tuesday, June 2nd, 1908.

HOLYWOOD (COUNTY DOWN).—At the monthly meeting of the District Council last week, Mr. George Murdoch presiding, letters were read regarding the proposed electric lighting of the town, and it was decided to have a consultation in committee with an electrical engineer regarding the approximate cost of the scheme.

ILFORD.—Tenders are invited for surface condensing plant and cooling tower, steam and feed pipes, boiler feed pump, &c., and extensions and alterations to main switchboard. Full particulars from Mr. A. Shaw, Electrical Engineer to the Council, Electricity Works, Lea Street, Ilford, and tenders to the Chairman of the Urban District Council by June 10th. (See an advertisement last week.)

LONDON: *London County Council.*—The Council has decided to proceed with the construction of the tramways from Crystal Palace Road to Forest Hill on the conduit system at a cost of £32,400 for trackwork, and £230 for cable ducts and sub-station equipment.

Woolwich.—The Borough Council is to invite tenders for the supply of about 6,000 tons of coal for the year commencing June 25th. Of this amount 3,000 tons of washed nuts are required for the Plumstead Electricity Works, and 1,500 tons of rough coal for the Electricity Works at Woolwich.

NEWCASTLE-ON-TYNE.—Tenders for various stores, including incandescent lamps and arc-lamp carbons, are required by the River Works Committee by June 1st. Particulars from Secretary, Berwick Street, Newcastle-on-Tyne.

SHEFFIELD.—A Local Government Board inquiry is to be held on June 2nd, into a proposed loan of £20,000 for the electricity department.

SWANSEA.—The erection of two power stations at a cost of £25,000 to £30,000 for the supply of electrical energy to the new King's Dock has been decided upon.

Annual Tramway Congress.—As we have already announced, the Tramways and Light Railways Association has decided to inaugurate an annual congress, and it has been definitely settled that the first shall be held this year at the Franco-British Exhibition on July 9th and 10th. Members will be received in the Congress Hall of the Exhibition by the Chairman of the Council, the Hon. Arthur Stanley, M.P., and by the members of the Reception Committee at 10.30 a.m. on Thursday, July 9th. At 11 a.m. Sir Clifton Robinson, Vice-President, will open the proceedings with a lecture on "The Tramways of the World," in which he will relate the experiences of his extended world's tour from which he has just returned. At 12 noon a Paper will be read on "Tramway Rail Joints," by Mr. A. H. Gibbings. On the following day Mr. A. L. C. Fell, Vice-President, will take the Chair at 11 a.m., and Prof. C. A. Carus-Wilson will deliver a lecture on "Rail Corrugation." This Paper will be discussed later at a meeting to be held at 35 Parliament Street, Westminster, on Friday, July 24th. In the evening of July 10th a dinner will be held at 7.30 p.m. in the Banqueting Hall of the Exhibition.

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TENDERS RECEIVED AND ACCEPTED

BIRMINGHAM.—The tender of Messrs. John Bowen & Sons for additional buildings at the Dale End Station for testing department and office accommodation has been accepted subject to the approval of the Council.

EAST HAM.—The Borough Council has received the following tenders for the reconstruction and electrification of the tramways in the Romford Road:—G. J. Anderson: (*a*) permanent way, £10,054; (*b*) overhead work, £750; (*c*) paving sides, £7,035. Acme Flooring & Paving (1904) Co., Ltd.: (*a*) £8,255; (*b*) £320; (*c*) £6,376. Fry Bros.: (*a*) £9,515; (*b*) £578; (*c*) £6,838. W. Manders: (*a*) £8,765; (*b*) £785; (*c*) £6,693. G. Law: (*a*) £10,148; (*b*) £755; (*c*) £7,890. D. T. Jackson: (*a*) £9,121; (*b*) £589; (*c*) £6,650. W. Griffiths & Co., Ltd. (accepted): (*a*) £8,074; (*b*) £608; (*c*) £6,425. Dick, Kerr & Co., Ltd.: (*a*) £8,634 (*b*) £503; (*c*) £6,752. R. W. Blackwell & Co., Ltd.: (*a*) £8,553; (*b*) £479; (*c*) £6,876. In the first instance, a resolution was passed accepting the tender of the Acme Flooring and Paving (1904) Co., Ltd., but eventually this was deleted. The tender of W. Griffiths & Co., Ltd., amounting in the gross to £15,108, or alternatively £15,761, with an allowance of 1s. 6d. per yard in case of old setts taken up and retained by them, and £2 per ton for old rails, has now been accepted, subject to their supplying English made rails, the firm originally tendering for Lorain American steel rails. Acceptance is also subject to the other following conditions:—(*a*) the track work to be commenced within three weeks from date of formal notification of acceptance of tender, and to be completed and ready for inspection by the Board of Trade within ten weeks from the aforesaid date, and (*b*) at least two-thirds of the unskilled labourers employed to be residents in the borough. The acceptance of the tender for the tram track and roadway work is, of course, also subject to the sanction of the Board of Trade and the Local Government Board respectively.

ERITH.—The Urban District Council has accepted a revised offer from Beadle Bros., Ltd., for the supply to the electricity department of Longhurst rough small coal at 12s. per ton. In February last the coal was quoted at 12s. 6d. per ton.

HANLEY.—The tender of the British Westinghouse Co. for the supply and erection of a new 500-kw. steam generating set has been accepted.

HASLINGDEN.—At the Town Council meeting on May 21st the Town Clerk submitted a tabulated list of the tenders received for the overhead tramway equipment, and that of Messrs. Dick, Kerr & Co.'s was accepted.

The Haslingden Town Council have accepted the following for the erection of the combined destructor and electricity generating station: Masonry, J. Tomlinson, Haslingden; joinery and plastering, T. Tattersall, Ltd., Haslingden; slating, H. H. Tomlinson, Haslingden; painting, R. Whittaker, Haslingden; steel work, T. Blackburn, Preston; chimney, J. Tomlinson, Haslingden; Weigh-bridge, Hodgson & Stead, Manchester. The contract for clinker crushing machine was deferred.

An estimate was submitted for the purchase of the site of the refuse destructor and electricity works at Prinny Hill, amounting to £1,400. The Town Clerk was authorised the seek the necessary borrowing powers.

LEEK.—The tender of Messrs. Crompton and Co. for switchboard extensions at a cost of £9 has been accepted.

LONDON: *London County Council.*—The following tenders have been received for the manufacture, supply, and delivery of 175 sets of maximum traction swing bolster trucks required for the Council's tramways:—The Brush Electrical Engineering Co., £26,670: alternative tender, £26,276 (not to specification); Mountain & Gibson, tender for foreign steel, £26,775; alternative, £26,250 (not to specification); Heenan & Froude, £27,037 10s.; Mountain & Gibson, tender for British steel, £27,650; alternative, £27,125 (not to specification); United Electric Car Company, £27,650; Magnolia Anti-Friction Metal Company of Great Britain, £28,043 15s.; Metropolitan Amalgamated Railway Carriage and Wagon Company, £29,050; Thornewill & Warham, £29,575; Hurst, Nelson & Co., £29,793 15s. The lowest tender in accordance with specification is that submitted by the Brush Electrical Engineering Co., Ltd. This firm takes exception to the terms of the arbitration clause in the form of contract, and states that it presumes that any question arising after the completion of the contract affecting financial matters would be referable to independent arbitration. Moreover, the firm has not completely filled in, as required, the schedule of rates of pay to be observed in the execution of the work. In these circumstances the Highways Committee do not see their way to recommend the Council to accept either of the tenders submitted by the company. The third and fourth tenders, submitted by Mountain & Gibson, Ltd., provide for the use of steel of foreign manufacture, and one of these is also not in accordance with the specification. The third lowest tender, according to specification, is that submitted by Heenan & Froude, Ltd., and this provides for steel of British manufacture. This is only £262 10s. higher than the tender submitted by Mountain & Gibson for steel of foreign manufacture. Having therefore very carefully considered the matter, the Committee recommend the tender of Heenan & Froude, Ltd., amounting to £27,037 10s., should be accepted for the work.

The following tenders have also been received for the supply and delivery of track rails and fastenings required for the construction and reconstruction of further lines included in the programme of tramway works for 1908-9. Alternative tenders were invited for about 2,000 or 5,000 tons, and the following are the particulars of the six tenders received after arithmetical errors have been corrected:—Société Anonyme des Aciéries d'Angleur, Belgium, for about 2,000 tons, £12,429 14s. 2d.; for 5,000 tons, £32,098 6s. 8d.; Edward Le Bas & Co., London (made by Société Anonyme d'Ongrée, Belgium), £12,623 3s. 9d. and £32,523 10s.; P. & W. MacLellan, Ltd., London (made by Angleur Co., Belgium), £13,115 11s. 3d. and £34,068; Messrs. Bolling & Lowe, London (made by the Phœnix Company, Ruhrort, Germany), £13,191 5s. and £33,805 10s.; Bolckow, Vaughan & Co., Ltd., London and Middlesbrough, £13,306 17s. 6d. and £34,640; Walter Scott, Ltd., Leeds, £13,761 5s. and £35,832 10s. The Chief Engineer's estimates comparable with the above tenders are £14,227 10s. and £36,567 10s. respectively. The first four tenders are for rails of foreign manufacture. The lowest tender for rails of British manufacture is that of Bolckow, Vaughan & Co., Ltd., amounting to £34,640 for 5,000 tons, and this is £2,541 13s. 4d. higher than the lowest tender actually submitted for the same quantity. The Highways Committee point out that, in the past, in cases in which materials required for tramway construction and reconstruction works have been obtained from abroad, considerable delay has arisen owing to difficulty in arranging for deliveries to be made in accordance with the requirements of the work for which the materials were to be used; further, in the event of it being necessary to reject any of the work, the delay caused thereby is a very serious consideration. Moreover, if one of the tenders for the supply of foreign rails be accepted, additional expenditure will have to be incurred for the inspection of the materials during manufacture. In these circumstances the Committee recommend the Council to accept the tender of Bolckow, Vaughan & Co., Ltd., for 5,000 tons.

Expenditure not exceeding £187 12s. is recommended for the provision of eight low-range meggers, 500 volts, 100 megohms, for testing the connections of magnetic brakes used on electric cars.

The tender of Messrs. Henry Bessemer & Co., Ltd., of Sheffield, for 3,500 driving-wheel tyres at 23s. per tyre, and 2,000 trailing-wheel tyres at 18s. per tyre, has been accepted. The total amount of the tender is £5,825.

The following tenders have been received for the manufacture, supply, delivery, and erection of rotary sand-drying apparatus for use in the tramway department:—Mountain & Gibson, Ltd., £650; Mountain & Gibson, Ltd. (alternative), (recommended), £620; the Albany Engineering Co., Ltd., £730; Ernest Newell & Co., Ltd., £1,192; Heenan & Froude, Ltd., £1,280; F. W. Rowlands & Co., £1,450.

Camberwell.—In March last the Borough Council accepted the tender of the Britannia Electric Lamp Works (1905), Ltd., for the supply of English-made plain and frosted electric lamps. The Public Health Committee, having learned that this company are now in liquidation, has decided to accept the tender of S. Burnby & Son at the following prices:—Plain lamps, 100 and 200 volts, 8 c.p., 7s. per doz.; 16 c.p., 7s.; 32 c.p. 8s.; frosted lamps, 100 and 200 volts, 8 c.p., 7s. 6d.; 16 c.p., 7s. 6d.; 32 c.p., 8s. 6d.

Marylebone.—The Borough Council has accepted the following tenders for the annual supply of stores, materials, and tools to the Electricity Department:—Pryke & Palmer, asbestos braiding tape, 2s. 11½d. per lb.; W. T. Henley's Telegraph Works Co., Ltd., vulcanised I.R. insulated wires and cables, 600 megs. grade S.W.G., 1/18s., £2 0s. 10d.; 3/22s., £2 11s. 2d.; 3/20s., £3 11s.; 7/22s., £3 17s. 8d.; 7/20s., £5 9s. 3d. per ¼ mile respectively; 7/18s., £4 2s. 1d.; 7/16s., £6 12s. 11d. per ⅛ mile respectively; 7/14s., £4 16s. 1d.; 19/20s., £2 19s. 3d.; 19/18s., £4 16s. 1d.; 19/16s., £7 6s. 1d.; 19/14s., £10 16s. 6d. per 1/16 mile respectively; fittings, wire, 3/25s., 9s. 6d. per 110 yards; fire resisting tape, 3s. 6d. per lb.; flexible twin glacé cotton wire, S.W.G., 35/40, £1 12s. 6d. per gross yards; 70/40, £2 2s. 6d. per gross yards; flexible twin silk-covered wire, S.W.G., 35/40, £1 17s. 6d. per gross yards; 70/40, £2 10s. per gross yards. St. Helen's Cable Co: rubber tubing, ⅛ in. thick, 3s. 2d. per lb. General Electric Co., Ltd.: para rubber strip, 7s. 6d. per lb.; tubular lamps, 12s. per doz. Pooley & Austin: white silesian tape, 2s. per lb.; incandescent lamps, 16 c.p. 72s. per gross, 8 c.p. 72s. per gross, 32 c.p. 8s. per doz., 6d extra for frosting; white selvedge tape, 2s. per lb. British Insulated and Helsby Co.: binding wire tin copper, 14, 16, 18, 20, 22, S.W.G., 1s. 1d., 1s. 1½d., 1s. 2d., 1s. 3d., 1s. 4d. respectively. Edison & Swan, Ltd.: batten holders, 4s. 10½d.;

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cord grip holders, 4s. 3d.; screw holders, 3s. 10d.; tumbler switches, 10 amp. 16s., 5 amp. 7s. 9d.; linked tumbler switches, 10 amp. 41s., 5 amp. 25s. per doz. respectively. Baxter & Caunter: wall sockets and plugs, 10 amp. 21s. per doz., 5 amp. 8s. per doz. Lundberg & Sons: switch plugs, 5 amp. 22s. per doz., 10 amp. 56s. per doz. W. McGeoch & Co., Ltd.: distribution boards, 1s. 6d. per double pole way; porcelain fuses, 3s. per doz. Union Electric Co., Ltd.: flame arc lamp carbons cored. 23 in. by 11 mm., 29s.; 23 in. by 10 mm., 25s.; 23 in. by 9 mm., 16s. 10d.; 12 in. by 9 mm., 14s.; 12 in. by 8 mm., 12s. 6d. per 250 feet respectively. Sloan Electrical Co.: Excello arc lamp globes, 2s. 10d. each; arc lamp carbons cored: 12 in. by 18 mm., 12s. 4d. per 250 feet; solid: 12 in. by 12 mm., 5s. 10½d.; 12 in. by 11 mm., 10s. 10½d.; 12 in. by 9 mm., 8s. 7d. per 250 feet respectively. Le Carbone: carbon brushes with flexibles at per doz. respectively: diagram No. 1, 5s. 0¾d.; No. 2, 7s. 6d.; No. 3, 5s. 10½d.; No. 4, 6s.; No. 5, 13s.; No. 6, 13s. 1½d.; No. 7, 5s.; No. 8, 4s. 1½d.; No. 9, 6s. 10½d.; No. 10, 3s. 9d.; No. 11, 6s. 7½d.; No. 12, 6s. 6d.; No. 13, 8s. 10½d.; No. 14, 9s. 3d.; No. 15, 11s. 7½d.; No. 16, 7s. 9d.; No. 17, 7s.; No. 18. 13s. 1½d. (without laminations); No. 19, 5s. 10½d.; No. 20, 17s. 6d.; No. 21, 2s. 7½d.; Nos. 22 and 23, 5s. 3d.; No. 24, 3s. 4½d.; Nos. 25 and 26, 3s. 9d.; No. 27, 6s.; No. 28, 6s. 7½d.; No. 29, 7s. 9d.; No. 30, 5s. 7½d.

PLYMOUTH.—The tender of Messrs. Cory Brothers, Cardiff, for the supply of a cargo of coal not exceeding 1,000 tons at 14s. 1½d. per ton has been accepted. The price of the last cargo was 15s. 4½d. per ton.

SOUTHEND.—The Corporation have accepted the tender at £370 of E. and B. H. Davey for the construction of a condenser water-tank at the electricity works. There were 11 tenders, varying from that accepted to £797.

SOUTHSEA.—The tender of Messrs. W. T. Glover & Co. for an additional high-tension cable at £1,030 has been accepted.

UXBRIDGE.—The Joint Hospital Board has received the following tenders for the installation of electric lighting at the new hospital buildings:—Taylor & Co., £109 10s.; Tilley Bros., £145; Eric Rivers Smith, £103; Wells, Rayner & Co. (accepted), £89 15s.; P. W. Baker, £110 4s. (10 years' guarantee); Windsor Electrical Co., £106; Park Bros., £96 10s.; Charles Pulan, £93 10s.; Cannon & Sons, £193 5s.

WEYMOUTH.—The tender of the Brush Electrical Engineering Co. for a turbo-generator, with condenser, &c., has been recommended for acceptance.

COMPANIES' MEETINGS AND REPORTS

AUCKLAND ELECTRIC TRAMWAYS.—The general meeting was held on Wednesday of last week. Auckland is the only important city in New Zealand where the tramways are not worked by a Municipal Tramway Board. The Chairman of the Auckland Electric Tramways Co., Ltd. (Mr. C. G. Tegetmeier) informed the shareholders that overtures had been made by the Auckland Council with a view to purchase. As the period of tenure does not expire until 1932 (when the undertaking will be purchaseable on the basis of a going concern), the directors would prefer to continue working the undertaking, all the more as the traffic is developing steadily. However, the Board has expressed its willingness to enter into negotiations for the sale of the tramways on an equitable basis, having regard to the terms and tenure of the concessions and to the present and prospective profit-earning capacity of the system. Last year nearly 22½ millions of passengers were carried—an increase of about 1,500,000 over the previous year. On special days the number of passengers has risen to about 110,000, which is a record figure for a population of 75,000. The balance available for distribution was £32,623, and the dividend paid on the ordinary shares 6 per cent., after placing £10,000 to reserve. The contribution to depreciation was also £10,000, and Mr. Tegetmeier considered that the average of £10,000 per annum set aside for that item during the last four years was adequate. For the period up to April 24th of this year about a million more passengers have been carried than for the corresponding period of last year, and the receipts have increased by £5,749. Thirty-two new cars have been added to cope with the developing traffic. The company has now about four hundred shareholders in New Zealand, and the issue of £50,000 in preference shares was nearly all taken up in Auckland.

CAPE TOWN TRAMWAYS.—The report and accounts referred to on page 757 of our issue of May 14th, were adopted at the meeting last week. Mr. R. Littlejohn, who presided, said the company had suffered in common with many undertakings from the reaction which followed the abnormal inflation of business immediately after the war.

CALCUTTA ELECTRIC SUPPLY.—At the annual general meeting held last Friday, the report given on page 796 of our last issue was adopted. Colonel A. J. Tilgate, who presided, said that the dividend recommended fell short of that of the previous year by ½ per cent., owing to the fact that the directors had special circumstances before them which might affect the company in the early future. Since the closing of the accounts it became necessary to issue more capital, and the directors had offered to the shareholders 20,000 five per cent. preference shares, which were all taken up.

CALLENDER'S CABLE & CONSTRUCTION.—The annual meeting of this company was held last Thursday at Hamilton House, Mr. Henry Drake presiding. In moving the adoption of the report, the chairman observed that the prohibitive price of metals and the stringency of the money market had rendered the company's operations difficult and less remunerative than in previous years. The most pronounced factor in restricting business in heavy mains had been the abnormal price of copper which prevailed in the first eight months of last year, leading to the temporary abandonment of nearly all new enterprise in electrical supply, and to the curtailment of extensions of existing networks in every direction. This was not confined to the home trade, as diminished orders were observed in almost every area throughout the world, in which the company carried on its business. The continuing downward trend of the market offered no inducement to consumers to undertake new work or to fill up their depleted cable stocks. The recent return of copper to its average price came after the season was at an end, and it might, therefore, be said that practically the whole of the company's business during the past year consisted of extensions which were absolutely necessary in connection with electrical supply stations already in existence. The subsequent stringency of the money market had delayed that improvement in business which might otherwise have been expected. Their business in Germany had been consolidated, and their own company had been registered under German laws, with its headquarters in Hamburg, excellent results having already attended this step. The available balance for distribution was £81,357, and the directors recommended the payment of a dividend at the rate of 10 per cent. per annum, with a bonus of 5s. a share, carrying forward, after placing £10,000 to Suspense Account, a balance of £45,107. Mr. John Varley seconded the motion. Mr T. O. Callender (managing director) observed that the past year had been a good deal less satisfactory than the two previous years. The most important reason for the falling off in the business was the uncertainty which prevailed in regard to the price of copper, which had fallen from £122 per ton to something below £60. However, the company was doing a fair business, and their works were occupied to a very considerable extent. No large contracts had been placed with them, and consequently they were not so busy as they should have liked to be, but he was sure that the company would get its fair share of all the business that was going. In his opinion an improvement in the business was sure to come, and the work waiting for execution, which at present was hung up, would, to a very large extent, be placed in the hands of this company. The report, which was referred to in our last issue, was unanimously adopted.

GENERAL ELECTRIC COMPANY (AMERICA).—The annual report for the year ended January 31st last states that the profits were $6,586,653, of which $5,183,614 were paid in dividends, leaving $1,403,039 to be carried forward. The effect of the drop in price of materials has been to reduce the book value of stocks, &c., by about $2,000,000. During the year the business of the Stanley G.I. Manufacturing Co. has been absorbed. A site has been secured near the city of Erie for the erection of new works, but building operations have been deferred for the present. The orders received for apparatus actually manufactured by the company represented $59,301,040, and the total sales reached a value of $70,977,168, an increase of 18·2 per cent. over the previous year. The orders received during the six months from February 1st to July 31st, 1907, increased 22 per cent. over the corresponding period of the year 1906. Owing, however, to the disturbed financial conditions prevailing during the latter part of the year, orders received for the second six months of the year decreased 25 per cent. as compared with the previous year. Attention is called in the report to a number of important traction contracts, including several for 1,200 volts continuous current. The sales of Curtis turbine sets are increasing, and several sets of 14,000 kw. capacity are in process of manufacture. The area of floor space of the various works now reaches a total of 6,400,000 sq. ft., and 20,000 men are employed as against 28,000 last year, the decrease being due to the shrinkage of orders during the last quarter already referred to.

MANX ELECTRIC RAILWAY.—The ordinary general meeting was held at Douglas last week. The meeting was only formal, and no business was transacted, as the report and accounts for the previous year had been dealt with at the meeting in London last December.

PERTH ELECTRIC TRAMS.—At the meeting last Friday the report referred to on page 796 of our last issue was adopted. The chairman, Mr. A. P. Stoneham, said that although the results were not quite as good as during the previous year, when the exhibition was held, there was every indication of a steady increase in the traffic receipts.

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UNDERGROUND ELECTRIC RAILWAYS OF LONDON.—At an extraordinary meeting held on Tuesday, resolutions passed at a meeting on the 11th inst., approving the Great Northern, Piccadilly, and Brompton Railway Bill, now before Parliament, agreeing to a scheme "for the conversion or exchange of the profit-sharing secured notes of the company, and for other purposes," and winding up the company voluntarily for the purpose of carrying the scheme into effect, were confirmed.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted Tuesday night, was £59 to £60 per ton (last week £60 to £60 10s. per ton).

LIQUIDATIONS, BANKRUPTCIES, &c.—The first meeting of creditors in the bankruptcy of E. A. Gresham, electrical engineer, Westborough, Scarborough, will be held to-day at the Official Receiver's Office, 24 Bond Street, Leeds, and the public examination will take place at the County Court House, Albion Place, Leeds, on June 30th, at 11 a.m.

The liabilities of Alfred William Bennett (lately trading as Bennett & Co.), electrical engineer, 45 Elford Grove, late 32 Park Cross Street, Leeds, are stated at £1,124 13s. 4d., and there are said to be no assets.

The first meeting of the creditors in this case was held on Monday last at 24 Bond Street, Leeds, when, no resolutions being passed, the estate remains with the Official Receiver, who, therefore, acts as trustee. The failure was ascribed to competition and bad trade.

A petition for the winding up of the Kevan Electric Co., Ltd., will be heard before Mr. Justice Swinfen Eady on June 2nd.

The Electric Traction Construction and Equipment Co. is to be wound up voluntarily. Mr. C. R. Jeeves, assistant secretary to the company, is liquidator.

ARC LAMPS, LTD.—This firm has now made definite arrangements for shifting their works from St. Paul's Crescent, Camden Town, to St. Albans. The new works will be called the Sphere Engineering Works, and Messrs. Arc Lamps, Ltd., will manufacture their lamps and also turn out other engineering details there. The works will be quite up to date in respect to the building, and quite on modern engineering lines. The firm expects to be installed there by the middle of next month. The whole building, however, will not be completed for three months from now, but it will be sufficiently advanced by June 20th for the firm's removal.

In connection with the Royal Naval and Military Tournament now being held at Olympia, the whole of the electric light fittings, which were used in the Royal box, have been supplied for the occasion by the Edison and Swan United Electric Light Co., Ltd., of 36-37 Queen Street, London, E.C.

ST. PETERSBURG RAILWAYS.—The Siemens & Halske Akt.-Ges. and the Allgemeine Elektrizitäts-Gesellschaft have made an offer to the St. Petersburg Municipality, to take over the construction and management of the City Railways for a period of sixty years.

NEW PUBLICATIONS

"Die Revision elektrischer Starkstromanlagen." By P. Stern. (Hannover: M. Jänecke.) M.3.60.

Lead Refining by Electrolysis. By A. G. Betts. (London: Chapman & Hall.) 17s.

"Transactions of the North-East Coast Institution of Engineers and Shipbuilders." Parts V. and VI., Vol. XXIV., Session 1907-1908. (London: Andrew Reid & Co.)

Metallic Filament Lamps for Street Lighting.—In connection with the results obtained at Exeter with Osram lamps for street lighting, it may have been noticed that the figures do not appear quite so favourable as others we have collected. It should be explained, however, that the conditions at Exeter are slightly different. The gas company, under the severe competition to which it is subjected by the electricity works, maintain their mantles and lamps exceptionally well, and, in consequence, Mr. H. D. Munro, the City Electrical Engineer, has used a 55-watt Osram lamp in place of the old gas lamp, whereas for instance Mr. Wilkinson at Harrogate takes only a 35-watt lamp to compare with an ordinary incandescent gas-burner. Moreover, we understand that a number of the Osram lamps at Exeter have been renewed before they have actually burnt out, to prevent their being reported "out" by the police. Thus the figure of average life given is somewhat lower than what it should actually be. The proportion of lamps with long lives has been increasing lately, and it must not be forgotten that Exeter was practically the first place to adopt Osram lamps to any extent for street lighting, so that the lamps used in the earlier stages of the experiment did not possess all the improvements of the more recent lamps sold.

MISCELLANEOUS CITY NOTES

BRITISH COLUMBIA ELECTRIC RAILWAY.—An interim dividend at the rate of 5 per cent. has been announced on the preferred ordinary stock, together with an additional dividend at the rate of 1 per cent. for the nine months ended March 31st, 1908.

COMPANIES STRUCK OFF REGISTER.—The following companies have been struck off the Register of Joint Stock Companies:—Ariel Arc Lamp Syndicate, Electrical Inkless Printing Syndicate, Medical Electrical Institute.

GLOBE TELEGRAPH AND TRUST CO.—A dividend of 5s. 9d. per share has been announced.

WEST INDIA AND PANAMA TELEGRAPH.—A dividend of 6s. per share has been recommended on the first preference shares, and 26s. per share on the second preference shares.

APPOINTMENTS AND PERSONAL NOTES

Mr. H. A. Howie, Deputy Electrical Engineer, Wolverhampton; Mr. F. W. Purse, Deputy Electrical Engineer, Warrington; and Mr. B. H. Hornby, Deputy Electrical Engineer, Bolton, were the three candidates for the position of Electrical Engineer to be interviewed by the Watford Urban District Council. It was stated that the undertakings with which these candidates were connected were all profitable. By 11 votes to 9, Mr. Purse, who is 30 years of age, was appointed.

NEW COMPANIES

BRADNINCH AND DISTRICT ELECTRIC SUPPLY CO.—This company was registered on May 20th, with a capital of £2,000 in £1 shares, to carry on at Bradninch, and elsewhere in Devonshire, the business of an electric light company in all its branches. The subscribers are:—D. K. Muir, J. P. Hepburn, J. Horsburgh, W. A. Nicks, H. C. Nicks, W. Baker, F. W. Cuming. No initial public issue. Registered without articles of association. Registered office:—Kensham, Bradninch, Devon.

CAMPBELL & ISHERWOOD.—This company was registered on May 15th, with a capital of £10,000 in £1 shares, to take over the business of electrical and mechanical engineers, carried on by G. F. D. Campbell and J. A. G. Williams, at Raleigh Street, Bootle, Lancashire, and elsewhere, as "Campbell and Isherwood." The subscribers are:—G. F. D. Campbell, J. A. G. Williams, C. E. Campbell, E. J. Faraday, T. F. Meade, G. F. Thomas, A. J. McQueen. No initial public issue. The number of directors is not to be less than two nor more than five: the first are G. F. D. Campbell, J. A. G. Williams, and L. Murphy. Qualification, £200. Remuneration (except managing director) as fixed by the company. Registered office: Raleigh Street, Bootle.

E. A. PREVETTE.—This company was registered on May 14th, with a capital of £3,000 in £1 shares, to acquire patents and rights for inventions relating to an electrical burglar-alarm and an electrical clock, to acquire the business of E. A. Prevette, at 35 Grove Road, Eastbourne, and to carry on the business of electricians, electrical, telegraph, mechanical, sanitary, gas, and water engineers, clock and watch makers, railway contractors, ironmongers, builders of electric tramcars, motorcars, cycles, and other vehicles, manufacturers of, and dealers in, dynamos, motors, telephones, bells, electroliers and arc and other lamps, &c. The subscribers are:—Miss A. F. White, E. A. Prevette, R. G. Hudson, R. H. Bradford, E. Prevette, A. J. R. Morris, D. W. A. Roberts. No initial public issue. Registered without articles of association. Registered office: 35 Grove Road, Eastbourne.

GRASSE AND CANNES ELECTRIC TRAMWAYS SYNDICATE.—This company was registered on May 22nd, with a capital of £2,100 in 2,000 ordinary "A" shares of £1 each, and 2,000 deferred "B" shares of 1s. each, to construct, lease, or acquire tramways and light railways in France or elsewhere, to equip, maintain, and work the same by electricity, or other power, &c. The subscribers are:—H. R. Green, A. H. Chifferell, A. B. Bose, C. Orchard, E. E. Johnson, G. Jackson, H. W. Newman. No initial public issue. Registered without articles of association by Lumley and Lumley, 37 Conduit Street, W.

TEWKESBURY ELECTRIC LIGHT.—This company was registered on May 4th, with a capital of £5,000 in £1 shares (2,000 pref.), to acquire the interest of J. Parker under the Tewkesbury Electric Lighting Order, 1905, to adopt an agreement between the Town Council of Tewkesbury and J. Parker, and a provisional contract between the same parties whereby the company will acquire a lease of a site for the generating station, and to carry on the business of an electric light and power company in all its branches. The subscribers are:—J. Mitchell, A. Johnson, J. Parker, T. W. Meats, C. W. Jones, J. H. Edwards, A. L. Stephens. Minimum cash subscription, £1,000. The number of directors is not to be less than three nor more than five; the first are:—J. Mitchell, A. Johnson, J. Parker, and J. H. Edwards. Qualification, £100. Remuneration as fixed by the company. Registered by Clarkson, Greenwell and Co., 10-11 Lime Street, E.C.

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ELECTRIC DRILLS AND GRINDERS

THE use of individually operated tools considerably increases the efficiency of the average workshop, as it is generally cheaper to take the tool to the machine than to take the work to the tool when dealing with heavy work. For this reason electrically operated tools, particularly drills and grinders, have become very popular, and are in extensive use in workshops of all kinds. In a catalogue recently issued by the Armorduct Manufacturing Co., Ltd., of Farringdon Avenue, E.C., some new types of the well-known "Little Hustler" drills and grinders are described. The motors in those machines intended for operation off direct-current circuits are shunt-wound, and speed variation is obtained by means of a mechanical gear. The general appearance of a breast drill of this type for use on direct-current circuits is seen from Fig. 1. The motors can

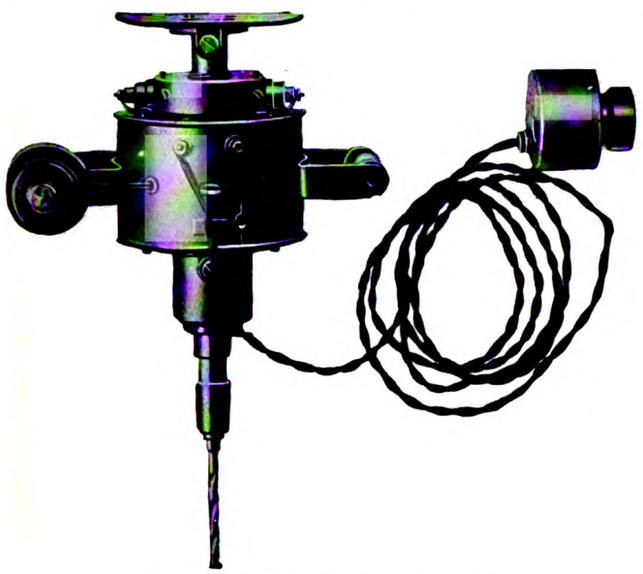


FIG. 1.—PORTABLE ELECTRIC DRILL.

be obtained for all voltages up to 500 volts, and drills and grinders for operating at this high pressure should be found particularly useful for tramway work. The difficulties in the way of bringing out a compact and reliable machine for 500 volts were very great, and this type of machine is quite a recent addition to the list. All machines have three running speeds, the fastest running at 1,730 to 830 r.p.m., and the slowest at 100 to 45 r.p.m. This last machine has a drilling capacity of 2 inches in cast iron, weighs about 130 lb., and takes 3·5 amps. at 250 volts. A feature of the design is the employment of an aluminium alloy for all non-magnetic parts, for the purpose of keeping the weight as low as possible. A ball-bearing thrust is provided for taking up the thrust of the drill. In Fig. 2 is illustrated the patent automatic overload cut-out with which all the direct-current machines are supplied. It is contained within the adapter plug shown on the right of Fig. 1, and is adjusted to a certain maximum current. The motor is automatically stopped

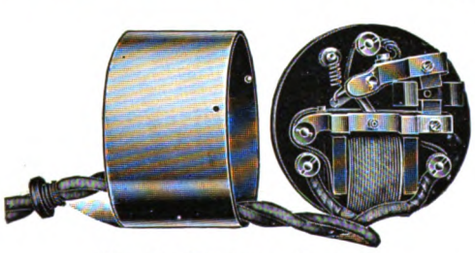


FIG. 2.—OVERLOAD CUT-OUT.

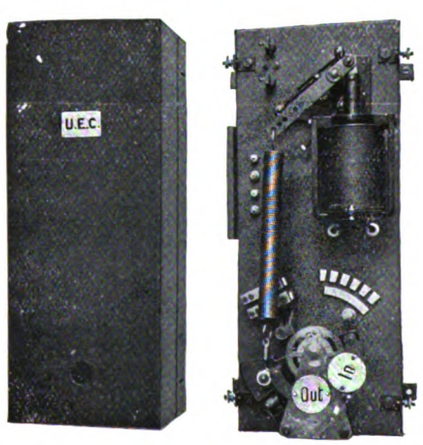
when an excessive overload is applied, and automatically re-started when the pressure is reduced to the normal value. The chief advantage of this method of protection over the ordinary form of fuse protection is that in the latter method a serious loss of time is incurred in the replacement of the fuses, whereas with the automatic cut-out the machine is ready for work again directly the overload is taken off.

Drills similar to the above, but for use on either two- or three-phase alternating-current circuits, can be obtained, but reliable drills for operating off single-phase circuits have not yet been constructed. These alternating current machines can also be obtained for operating pressures up to 500 volts. All machines are fitted with reversing switches for tapping purposes at a slight extra cost. The larger motors must be supported from some kind of pedestal or bracket. A recent development in this direction is a form of swinging bracket which is attached to the wall, and from which a drill is supported by means of a carriage frame. The wall-bracket is movable within a semi-circle, and the frame supporting the drill moves the length of the bracket arm. The feed is obtained by means of a lever working in a ratchet bar. Another novelty is a special drill for use in mining soft stones, slate, alkali, and similar semi-hard substances. This is a rotary drill, similar in construction to those already described, and would, of course, not be suitable for drilling hard stones—for the latter purpose drills of the percussion type are necessary. The machine is attached by means of two substantial collars direct to a two-legged frame, which is fitted with a ratchet drive, thus admitting of lowering and raising according to requirements. The motor, which is totally enclosed in a dust-proof outer case, is a 2 h.p. three-phase motor, but will give an output of 8 h.p. for short intervals. The drill weighs about 230 lb., and the two-legged support 66 lb.

For drilling iron or steel plates, a drill may be used in combination with an electro-magnetic hold-on frame. The magnet coils are contained within the base of the two supports, and take 0·4 amps. at 220 volts. These magnetic hold-on equipments can, of course, only be used where a direct-current supply is available. Another useful tool is a small hand grinder. The tool is held by means of a handle, and an extended neck between the motor and the wheel. These machines have, of course, only one speed.

AUTOMATIC MOTOR STARTING SWITCHES

AUTOMATIC starting devices for use with electrically-driven pumps are employed in cases where a continuous water supply is dependent upon storage tanks which are filled from time to time by the pump. At certain pre-determined minimum or maximum levels of the water in these tanks the motor is started or stopped by means of a float gear. In some cases the motor starter can be arranged quite close to the tank, and in these cases the switching on or off can be effected mechanically direct by the float, and its counter-balance weight. Starting switches of this class may be termed "Float Starters." In other cases the tanks may be situated some distance from the pump, rendering it difficult, or inadvisable, to arrange the starter in such a position as to allow of the float operating direct mechanically, and in these cases a small contact arrangement is operated by a simple float mechanism fixed on the tank. This contact is connected electrically to the automatic starter, which may or may not be arranged near the pump. A contact pressure gauge may also be used in place of the float contact arrangement. Starting switches of this class may be termed "Contact Starters." The Union Electric Co., Ltd., of Park



ELECTRICALLY OPERATED STARTER FOR 10-H.P. C.C. MOTOR.

Street, Southwark, S.E., supply automatic switches of both the above types, and a description of these will be of interest.

A starting switch of the first-class, which is operated mechanically direct from the float mechanism, is constructed as follows:—On a fixed centre spindle three levers are arranged, each capable of movement in either direction. One lever is attached to the float mechanism, another is provided with a tilting weight, and the third carries the brush for the starter contacts. When the water level in the tank falls, the float sinks, and carries with it the float lever, which can turn

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through an arc of 100°. This lever engages the tilting-weight lever by means of a pin, and as soon as the weight passes the centre line the tilting-weight lever falls. The latter lever during this movement draws with it the starting lever and causes the same to move across the resistance contacts, the speed at which the resistance is cut out being controlled by a fan mechanism. As the water level in the tank rises, the float rises, and the float mechanism moves the float lever back, this carries back with it the tilting-weight lever, the starter lever remaining for the time being in its position, but as soon as the tilting-weight lever is carried over the vertical position, the weight falls and carries with it the starter lever. This return movement is not retarded by the air fan, as the mechanism is fitted with a ratchet arrangement. From the above description it will be seen that the operation of switching "on" is effected by means of the weight of the float, and switching "off" by the counter-balance weight.

The second class of apparatus consists of a small switch operated by means of a float, which is electrically connected to an automatic starting switch. A suitable form of starter for this purpose is illustrated on the previous page. This is an automatic starting switch for direct-current motors from 1 to 10 h.p. output. A strong solenoid is excited by closing the circuit by means of the contact arrangement. The core of this solenoid is free to move, and is connected through a lever to a tension spring. When the core is sucked into the solenoid, this spring is extended, and owing to the pull exerted by the spring the starter lever is drawn over the contacts of the starter, the rate of movement being retarded by the mechanical time element. The current through the solenoid windings is only momentary, as the windings are short-circuited as soon as the starter arm reaches the first contact stop. The lever which holds the spring in tension is held in position by a pawl, controlled by an electro magnet in the releasing circuit, which is closed by either the float contact apparatus or a contact pressure gauge. This switch is claimed to have all the advantages of the slow-starting automatic switch, and to be free from the disadvantage found with dash-pot types, namely, that the speed of operation varies in accordance with the air temperature. This apparatus is supplied for both direct-current and alternating-current motors.

NEW "EDISWAN" ARTISTIC FITTINGS

THE latest edition of the electric light fittings catalogue of the Edison and Swan United Electric Light Co. contains a number of new designs of fittings which distinguish themselves by their utility as well as artistic excellence of design. A feature of the catalogue is its large number of illustrations, most of which are photographic reproductions one-sixth full size. The accompanying figures are chosen from among them, and represent a handsome electrolier, and an example of the special ornamental pendant for the company's large bulb "radiolite" lamps.



FIG. 1.—SPECIAL PENDANT FOR LARGE BULB LAMPS.

The large collection of fittings comprise examples of various styles, from those which, owing to their simplicity and suitability for everyday use, have become more or less independent of fashion, to others which represent the most novel artistic designs. The collection of pendants and electroliers is particularly complete, and a number of handsome bronze statuettes are included.

One of the most useful features is the comprehensive general and numerical indexing, by means of which any fitting can be found, either under its catalogue number, or under its description. The arrangement is also to be commended, every class of fitting being brought together under its respective class heading, as plain pendants, hall pendants, ceiling fittings, bronzes, &c. This saves time in referring to any particular type, eliminating the necessity, which is often found, of turning over pages of fittings of another class in order to find one sandwiched in, as it were, amongst others of a different type.

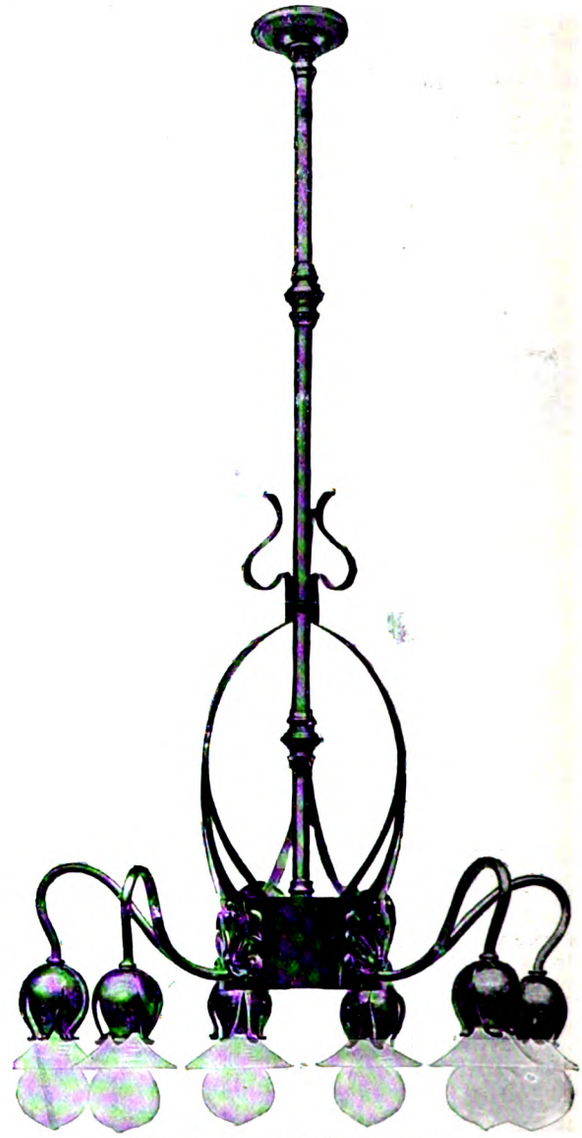


FIG. 2.—SIX-LIGHT ELECTROLIER.

The Westinghouse Metal Filament Lamp.—In case the origin of the 220-volt 32 c.p. metal filament lamp mentioned by Mr. T. H. Lowden in the discussion on Mr. Hirst's Paper last Thursday may not be quite clear, we have obtained some information as to the arrangements for the manufacture of these lamps. The 200-volt 32 c.p. lamp which was spoken of as being already on the market in this country is made at present at the Vienna works of the Westinghouse Metal Filament Lamp Co., and sold in this country by the British Westinghouse Co. The Lowden Electric Lamp Co., Ltd., have only so far manufactured experimental lamps for the Westinghouse companies, and have been carrying on a large amount of experimental work relating to details of manufacture. The building of a factory in England for the manufacture of the Westinghouse metal filament lamp on a large scale will however be commenced very shortly, and probably a new company will be formed for the purpose. There is, of course, a close connection between the different companies concerned. We understand from Mr. Lowden that great improvements are being made in the filaments and their supports which have considerably reduced the liability to breakage in transport, and that the production of lamps of lower candle-power for high voltage is now regarded only as a matter of time.

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SUMMARY

A slight fire occurred on Monday at one of the Paris telephone exchanges. (Page 842.)

In connection with the alleged damage to cables by trawlers off the Irish coast, two questions have been asked in the House of Commons, and the President of the Board of Trade has stated that he has the matter under consideration. The subject was brought up at the International Telegraph Conference at Lisbon, to which a letter, signed by the cable companies, has been submitted. There is now no doubt that the damage has been done by trawlers, as pieces of net have been found on one of the damaged cables of the Commercial Cable Co. It is thought that the question will be settled between the cable companies and the fishing industries without the intervention of the Government. (Page 842.)

Letters have been received from Hooper's Telegraph & Indiarubber Works and the Union Cable Co. *apropos* of the letter we published last week on the price of cable. Both firms characterise the prices of the Cable-Makers' Association as too high. Mr. W. C. P. Tapper writes to correct an inaccuracy in the fuel costs at Stepney, published in our last issue. The fuel costs per unit generated were 0·49d. (Page 843.)

At the last meeting of the Newcastle Local Section of the Institution of Electrical Engineers, an informal discussion was opened by Mr. C. Turnbull upon the subject of the overload capacity of generating sets. Mr. Turnbull said that the maximum overload of the plant should be the maximum overload of the engine, the dynamo being made to suit. The dynamo should also be capable of running continuously at any load which the engine would deal with economically. Mr. G. G. Stoney dealt with the question more particularly as regards turbo-generators, and Mr. Brooking mentioned a way of avoiding damage through overloads to cables. (Page 843.)

Under Electrochemistry and Electrometallurgy a gas battery in which the calorific energy produced by the oxidation of sulphur dioxide to sulphuric acid is described. The E.M.F., however, is only from 0·5 to 0·3 volt. The depolarising of batteries of the Bunsen type is brought about by the addition of oxidising agents; when, however, the concentration of the oxidising substance falls below a certain strength it becomes inefficient as a depolariser. Dr. Heintz states that if the concentration of the sulphuric acid is kept high the depolarisation is efficient, even with dilute solutions of the oxidising agents. (Page 844.)

Under "Electrical Science" a report is given of Sir Oliver Lodge's presidential address to the Faraday Society on the work of Lord Kelvin. (Page 844.)

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MR. A. A. VOYSEY, Electrical Engineer to the City of London, has made a full investigation of the subject of the street lighting in the City. He reports that light for light, high-pressure incandescent gas-lighting costs four times as much as flame arc-lighting, and that about £6,000 a year may be saved and a doubling of the average illumination throughout the City streets effected by flame arc-lighting assisted by a few metal filament lamps. (Page 845.)

THE Institution of Electrical Engineers has awarded premiums to Messrs. STONEY and LAW, PECK, SNELL, BARLOW, and Drs. RUSSELL and GEE for Papers read during the past session. Students' premiums have been awarded to Messrs. SPEYER, CARR, and HAMILTON. The Wiring Rules Committee will commence the preparation of a revised edition in the autumn. A Government grant of £100 a year has been given to the British Committee of the International Commission for standardisation. These and others matters are dealt with in the annual report of the Institution of Electrical Engineers. (Page 847.)

A TREATISE on "The Steam Turbine," by R. N. NEILSON, is reviewed in this issue. (Page 849.)

THE Patent Specification for the IGEWSKY electric furnace, a description of which appeared in our issue of May 14th, was published on Thursday last. Among the other specifications published is one by E. A. MITCHELL, describing a device for indicating when a road-stud on a surface-contact traction system is left alive by a passing car. Another by J. S. HIGHFIELD relates to coin-operated switches for small consumers on electric lighting systems. The process for manufacturing tungsten filaments, in which the powdered tungsten is mixed with a cadmium-mercury-bismuth alloy, is described in detail in a specification by the BRITISH THOMSON-HOUSTON Co. The specification for the BELLINI and TOSI system of directing wireless telegraphy, and one by C. B. RAYMOND and H. M. RAMP relating to oil-tight casings for transformers, are also published. An application by F. HARRISON for amendment to a patent for a process of producing tungsten alloys has been made. A patent by ALEXANDER MUIRHEAD for some improvements in transmitting apparatus for use in submarine telegraphy expires during the current week. (Page 850.)

A 600-KW. rotary converter which has recently been installed in a sub-station in Glasgow is provided with special arrangements for starting up from the alternating side. (Page 851.)

A SHORT illustrated article describes an application of chain driving to large powers. (Page 852.)

A PAPER read at a recent meeting of the Société Belge d'Electriciens by Prof. E. PIÉRARD gave full details of the temporary re-establishment of the Antwerp Telephone Exchange system after the fire which completely destroyed the exchange last October. A new C.B. exchange was in course of construction at the time, and its switchboard has been adapted for use with the old single-wire circuits, which are still in the majority in Antwerp. (Page 853.)

THE most interesting feature during the past week in connection with the London Electric Power Bills, which are still under consideration by Lord Cromer's Committee, was the evidence on Tuesday of Mr. James Falconar, chairman of the company which promoted the Administrative County of London and District Electric Power Bill. Mr. Falconar was called by the London electricity supply companies against the London and District Electric Power Bill, and he explained that the promoters of the Administrative Bill had now abandoned the project on the ground that, after having most carefully considered the matter, they had come to the conclusion that the conditions had so materially altered since 1905 that there was now no scope for a power company on the lines now proposed. The two main reasons for this conclusion were that the existing authorities had so reduced their cost of generation that it was doubtful whether the power company's agreement with them to supply at lower rates than those at which they themselves could generate would be profitable; and, further, in many areas agreements had been made with the largest consumers for several years ahead. The cross-examination of Mr. Falconar, on behalf of the promoters of the London and District Bill, brought out the fact that the decision to abandon the Administrative Bill was not absolutely unanimous, and, in fact, Mr. Samuel Insull, of the Chicago Edison Co., had sent over two of his assistants to London to give evidence in favour of the scheme now before the committee. The last opposition, namely, that of the group of eight of the largest London supply companies, is now being placed before the Committee, and since our last issue all the Borough Councils have stated their cases, and also the Middlesex County Council, and the London County Council. The opposition of the latter was set out at some length by Mr. Freeman, K.C., and was confined to suggested modifications in the Purchase Clause, and restrictions with regard to the raising of capital and the commencement of work. In this connection we give this week the modified Purchase Clause of the promoters, which, however, by no means satisfies the requirements of the London County Council, and, as a matter of fact, negotiations between the two parties have fallen through. The chief alteration in the new Purchase Clause is that definite provision is made for the institution of a maintenance and renewals fund, the object being to prevent the promoters from allowing their plant to fall into a bad state of repair near the end of their concession, and at the same time forcing the purchasing authority to pay the full capital expenditure. The London County Council and several other opposing authorities desire to impose the purchase terms of the Electric Lighting Acts. (Page 857.)

THE Belfast Corporation have finally agreed to a through service over their lines of the Cavehill and Whitewell Tramways, and reserve the right of purchasing the undertaking at any time within five years, at a sum not exceeding £600,000.—The statement which has been made in some quarters that the Bray electricity undertaking is working at a loss of £1,000 per annum, is incorrect. The deficit on the last year's working was £390.—The liquidation of the deficit on the Glasgow telephone undertaking, which amounts to £16,000, is to be spread over a period of five years.—A new electric ambulance station has been opened in the City of London.—The first of the overhead trolley lines of the London County Council tramways, from Hammersmith to Harlesden, was opened last Saturday.—Notwithstanding an increase in the price of coal of 25 per cent., the total costs, including capital charges, at Nottingham, have decreased from 1·70d. to 1·63d. per unit sold. (Pages 863-865.)

AN application is to be made to the Local Government Board for £36,345, for the purpose of remodelling the Wigan electricity station.—The tender of Messrs. Siemens Bros.' Dynamo Works for generating plant driven by a Howden engine, and the tender of Messrs. Babcock & Wilcox for boilers, have been provisionally accepted by the Bermondsey Borough Council.—The tender of Messrs. Siemens Bros.' Dynamo Works for two engines and dynamos has been accepted by the Walthamstow Urban District Council. (Pages 865-866.)

A FURTHER issue of capital is to be made by the Durham Collieries Electric Power Co., in order to cover the great expense which has been entailed by the conversion of the plant to the same frequency as that of the Newcastle-on-Tyne Electric Supply Co., in conjunction with whom the supply is now given.—A scheme

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for the reconstruction of Bruce Peebles & Co., Ltd., has been submitted for the sanction of the Court.—The Felten & Guilleaume-Lahmeyerwerke, in their annual report, state that, although business has been generally very good, it has been thought advisable to reduce the dividend from 11 to 10 per cent. Their dynamo works turned out 9,330 machines last year, aggregating 385,000 h.p.—A prospectus has been issued offering for subscription 250,000 7 per cent. cumulative participating preference shares of £1 each by Marconi's Wireless Telegraph Co. The money is to be devoted principally to the completion of the company's transatlantic wireless telegraph stations. (Pages 867-868.)

THE appeal by the National Telephone Co. against the decision that the company are liable to pay royalty to the Post Office for private lines used between two firms for business purposes has been allowed. The three appeal judges were unanimous that the lines in question were exempt from the Postmaster-General's monopoly, and by a majority of two to one decided that the company was not liable to pay royalty on them by the terms of its licence. The dissenting judge was the Master of the Rolls. Lord Justice Fletcher Moulton, however, expressed the opinion that if two business firms shared the cost of connecting their premises by a private line used for both their businesses the line would be within the Postmaster-General's monopoly and would be liable to royalty. (Page 871.)

SOME particulars are given of a 200,000-volt insulator for the suspension type. (Page 874.)

THE Hull municipal telephone accounts show a net profit of £1,055 after deducting sinking fund and interest charges. We publish some particulars this week, and reserve our more detailed analysis until our next issue. (Page 872.)

WE are able to publish this week the text of a report submitted by Mr. A. A. VOYSEY, Electrical Engineer to the Corporation of the City of London, to the Streets Committee on the experimental lighting by means of arc lamps, which has been carried out during the past winter by the two City electric light companies in certain streets. The report deals with the matter in some detail, and, with its numerous photometer curves, is not only of importance on account of its proof that better illumination can be obtained at a less cost with flame arcs than with high pressure gas, but also as giving interesting comparisons of the distribution of light obtainable with various arrangements of lamps. The relative merits of central suspension and posts at the side are discussed from several points of view, especially as regards distribution of illumination; the general results are favourable to the use of the former arrangement when other circumstances permit. The experiments have so far been directed mainly to the lighting of main streets, but the improvement of the illumination of the side streets of the City is quite as important a problem. This part of the subject is dealt with in a general way in the report, and further experiments in this direction are recommended. In the more confined spaces a considerable field should be afforded for the metal filament lamp, the application of which to street lighting in provincial towns has met with so much success. As was recently pointed out by Mr. HAYDN HARRISON at the Institution of Electrical Engineers, street illumination by metal filament lamps is not only cheaper than by ordinary incandescent gas-burners, but is even cheaper than with enclosed arcs, and can compare with ordinary open arcs. We heartily endorse Mr. Voysey's plea for more artistic design of lamp standards, and we hope that his unhesitating conclusion that about £6,000 a year may be saved, and a doubling of the average illumination throughout the City streets may be effected, by flame arc lighting, assisted by metal filament lamps at certain points, will receive the due consideration of the City Fathers. The illumination of the streets in the famous "square mile" should not be inferior to that of any municipality in the world.

LAST year when judgment was delivered in the case of the Postmaster-General *v.* the National Telephone Co., to the effect that the private telephone lines between premises of different ownerships were covered by the Post Office telegraph monopoly, we warned contractors that the decision was of general application and would affect others as well as the National Telephone Co. Although this decision has now been reversed in the Appeal Court, care should still be exercised in carrying out work of this nature, as there will still be an appeal to the House of Lords, and the final decision, if in favour of the Post Office, will apply to work already done, as well as to prospective contracts. Firms who erect private telephone lines, therefore, whether on a rental or "sale outright" basis, should insert a clause in their agreements with the purchaser or lessee, that in the event of a royalty becoming payable, or of the Postmaster-General objecting to the connection altogether, the burden is to rest on the purchaser or lessee and not on the contractor. It should be noted, also, that although the appeal has been allowed in the present case, Lord Justice FLETCHER MOULTON expressed the opinion that the Post Office monopoly extends to cases where two business houses are connected by a telephone line, the cost of which they share; therefore, before such contracts are accepted the contractor would be well-advised to obtain a licence from the Postmaster-General as a preliminary step.

THE annual report of the Council of the Institution of Electrical Engineers, which we publish this week in an abbreviated form, signalises no new change of policy, and the financial position disclosed in the accounts (which we do not publish, as every member has received a copy) is eminently satisfactory. There was thus no necessity for a large attendance of members at the annual general meeting last Thursday, at which the report and accounts were adopted, and, as is now well known, these meetings are sometimes so poorly attended that the number of members present has been less than the number of speeches required for proposing and seconding the various formal resolutions that are put. But the question arises: is it not bad policy to let the annual general meetings drift into mere matters of form? The meeting has to adopt the Council's report for the year, and this is only presented at the meeting itself. It might well happen on some occasion that the report contained matters upon which it was desirable to hear expressions of opinion from the members generally, but so long as the meeting is regarded as one of mere formality, it would be difficult to awaken any sudden general interest in it after a long period of indifference. The occasion should also be one upon which the general

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policy and work of the Institution should be open to discussion. The remedy for the present condition of affairs is difficult, and probably the only one would be to add something to the proceedings of the annual general meeting which would attract more men to it. To revert to the practice of holding the meeting before or after an ordinary meeting, at which a Paper is discussed, would not meet the difficulty satisfactorily. If the annual meeting were taken before the Paper members would be shy about protracting the discussion, as it would take away valuable time from the technical debate to come. On the other hand, if it were taken after the ordinary meeting, the proceedings would be hurried, as members would want to get away home. A proposal was made some time ago that the various sectional committees of the Institution, which now do very little to justify their existence, should each present a report on the position and progress during the year of its particular branch of the industry that it represents. There are four of these Sectional Committees:—(1) Traction, Light and Power Distribution, (2) Telegraphs and Telephones, (3) Manufacturing, and (4) Electrochemistry and Electrometallurgy. If reports by these were prepared by the beginning or middle of May each year, and circulated to the members with an intimation that there would be an open discussion at the annual general meeting, it would do much to arouse interest in the meeting and to secure an attendance capable of intelligent appreciation or purposeful criticism of the Council's report also.

American Municipal Electrical Convention.—The annual convention of the International Association of Municipal Electricians will be held at Detroit, Mich., August 19th, 20th, and 21st.

Proposed Electrification of Dock Plant at Alexandria.—In November last the Egyptian Government announced its preparedness to proceed to the execution of the important scheme it was known to have been contemplating for some time for the electrification of the discharging apparatus and quay plant of the port of Alexandria. Specifications were issued in due course, and tenders invited; the contract was expected to amount to a considerable sum, not less than £E200,000. In a period of declining enterprise generally it is not surprising that some twenty-five firms, of various nationalities, responded with tenders. From that moment to the middle of April nothing more was heard of the matter, and extreme surprise was occasioned among those firms by whom considerable trouble, expense, and ability were expended in the task of framing designs and estimates for a contract of the particularly complicated character of the electrical engineering in this instance. Towards the close of April the Government published a note in the Press, stating that it had been decided to abandon the scheme for the installation of the electrical plant, owing to the lack of available funds and the decline in exports and imports. Further down, however, the note, as published in the *Egyptian Gazette*, proceeds to say that "for these reasons the Government considers it opportune to postpone the work." It would therefore appear that the scheme will be carried out sooner or later, and this, or something like it, appeared to be indicated by implication by Admiral Sir Massie Blomfield, who, on retiring from the post of Director-General of the Port of Alexandria and Lighthouses Administration, referred, in his farewell address last month, to the projects for the completion of the Government's intentions to render Alexandria a port, in its equipment, design, and spaciousness second to none in the Mediterranean. It is being said in Egypt that the French tendering firms were likely to feel the disappointment most keenly. There are no clear grounds for ascertaining why it is generally assumed in Egypt that this important contract would have fallen to the French, unless it be on account of the particular care and elaborate minuteness with which the French tendering firms did their work of *reconnaissance* and design; but that is the impression generally held. In any case the scheme would have been an interesting demonstration of electrical engineering applied to a great port. Whether it will be adhered to in full on its realisation is not yet certain, nor yet whether the tendering firms will stand in the same order of success. Doubtless modifications will occur in the one and the other.

ARRANGEMENTS FOR THE WEEK

(TO-DAY) THURSDAY, JUNE 4TH.

Royal Society.

4.30 p.m. Among the Papers down for reading is the following:—"The Electrical Properties of Porcelain, with Special Reference to Dielectric Losses," by H. F. Haworth, communicated by Prof. W. E. Ayrton, F.R.S.

TUESDAY, JUNE 9TH.

Faraday Society.

8 p.m. Meeting at the Institution of Electrical Engineers, 92 Victoria Street, Westminster. Paper to be read:—"The Utilisation of Atmospheric Nitrogen in the Production of Calcium Cyanamide, and its Use in Agriculture and Chemistry," by Dr. Albert R. Frank.

FRIDAY, JUNE 12TH.

Physical Society.

8 p.m. Meeting in the Physics Laboratory of the Royal College of Science, South Kensington. Included in the agenda are the following Papers:—(1) "Experiments on a Directive System of Wireless Telegraphy," by Messrs. Bellini and Tosi; (2) "On the Resistance of a Conductor of uniform thickness whose breadth suddenly changes, and on the Shapes of the Stream Lines," by Prof. Lees; (3) "On the Self-Inductance of two Parallel Wires," by Dr. Nicholson.

Fire at a Paris Telephone Exchange.—The *Morning Post* reports that a small fire broke out on Monday on the second floor of the central telephone exchange in Rue Gutenberg. Although there was considerable panic amongst the operators, no one was injured. The fire was got under control in about forty minutes, but a good deal of damage was done, and the service to about 1,200 subscribers will be interfered with for some days.

Damage to Cables by Trawlers.—In connection with the note on page 818 of our last issue, relating to damage to cables by fishing trawlers off the Irish coast, reference may be made to a question by Mr. Boland, in the House of Commons on Thursday, who asked the Vice-President of the Department of Agriculture (Ireland), whether his attention had been called to the published statement of the diplomatic representations made by the United States Government on the subject of the breaking of the submarine cables off the coast of Kerry by trawlers; whether he was aware that these trawlers carry on operations within the prohibited limits, and, in addition to the damage done to the cables, had inflicted serious loss on the local fishermen; and whether, in view to safeguarding the interests of the fishermen and of the cable companies, nine of whose cables are laid in a space of one and a half miles in Ballingskelligs Bay, he would endeavour to secure protection from the operations of these trawlers in this district. Mr. T. W. Russell replied that the alleged damage to submarine cables by steam trawlers had been brought under the notice of the department. The protection of cables was not the direct work of the department, who had, however, taken all steps that were reasonably possible to secure the due observance of their fishery bye-laws. In reply to a similar question in the House, addressed to the President of the Board of Trade by Mr. Joynson-Hicks, on Tuesday last, Mr. Churchill replied that he had received numerous representations from bankers, brokers, merchants, and shipowners, and that he was considering, in consultation with the Postmaster-General, whether any steps might be taken under the International Telegraph Convention and the Submarine Telegraph Act, or otherwise, for the protection of the cables. He understood that one of the companies concerned had recently substituted a stronger cable in the area afflicted, with good results. With regard to issuing warnings, there were very obvious objections to showing the routes of these cables on the Admiralty charts. A letter signed by representatives of all the cable and telegraph companies has been submitted to the International Telegraph Conference now sitting in Lisbon. In this letter it is stated that the Anglo-American Company alone within the last two years has been obliged to repair the shore ends of three out of four of its cables which land at Valentia, at a cost of over fifty thousand pounds. It has been proposed that, as in the case of the seal fishing industry of Newfoundland, a guard-boat should be kept near the fishing grounds where the cables lie, to warn off the trawlers. Although it has been stated that the damage was done by coral, pieces of fishing net have been found on the cables, which have also been found flattened for a considerable stretch, and it is evident that trawlers have done the damage. At the Lisbon Conference a German delegate announced that a trawl had been invented which would not cause any damage to cables. The chief difficulty of the situation is that the Government has no power to interfere outside the three-mile limit, but it is thought that the question may be settled between the cable companies and the fishing industries without Government intervention.

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CORRESPONDENCE

THE PRICE OF CABLE.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—The letter of Mr. H. Ellis Thompson in your issue of May 28th may be dealt with in various ways according to the interests affected. In your editorial note you mention "The designation vulcanised rubber cable of the '600 megohm' class is perhaps a loose one," and we quite agree, as no one appears to know what the insulating material on "class wires" may be guaranteed to consist of. In one catalogue of "association grade wires" the specification of the insulating material for 300-megohm grade, 600-megohm grade, and 2,500-megohm grade appears to be the same for each, consisting of a thick lap of pure para rubber and two coats of best vulcanising rubber, with the same diameter for each grade, which raises the question as to what "best vulcanising rubber" can be expected to represent.

When manufacturing firms compete for a contract to a strict and definite specification, their prices begin to approach the comparative level of the "foreign wire." We would suggest for contracts of the description mentioned in Mr. Thompson's letter, consulting engineers might issue specifications, giving the true description of the component parts of the wires and cables they wish to have, and specifying the mechanical and electrical tests which have proved reliable in obtaining the best results, such as the rules issued by the Institution of Electrical Engineers.

The experience gained by the behaviour and durability of wires and cables supplied to the Government Departments and other public authorities should be of value to the consulting engineers, and we believe they would then find they could ensure for their clients vulcanised india-rubber wires satisfactory to them for insulation, durability, and price.

Yours faithfully,
JNO. P. HOOPER, Managing Director.
(Hooper's Telegraph and India Rubber Works.)
31 Lombard Street, London, E.C.
June 1st, 1908.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—It is the "C.M.A." which, like the blessed word "Mesopotamia," does the trick. Some engineers prefer to pay 100 per cent. more for their cables in order to have the magical letters "C.M.A." attached, and "C.M.A." manufacturers are to be congratulated. We know other engineers who have been buying cable not made by the C.M.A. manufacturers for the last eight years, and who are quite content to go on in the same jog-trot way, getting a fair share of work at remunerative prices and pocketing the money which the letters "C.M.A." did *not* cost them.

Yours faithfully,
J. A. BLACKWOOD, Secretary and Manager.
(The Union Cable Co., Ltd.)
27 Eagle Wharf Road, London, N.
June 1st, 1908.

STEPNEY ELECTRICITY SUPPLY ACCOUNTS.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—With reference to the notice of our accounts appearing on pp. 813-4 of your current issue, I beg to call your attention to two inaccuracies in the costs per unit sold. You have evidently divided the total number of units sold into the coal costs and dust destructor steam costs *separately*, and the results thus obtained make our coal costs appear much lower than is actually the case, while the cost of destructor steam becomes ridiculously low. On p. 814 the extract you have made from my report gives the accurate costs per unit for coal and destructor steam, and, of course, do not agree with the figures you show on the previous page.

Yours faithfully,
W. C. P. TAPPER, Engineer and Manager.
(Electricity Works.)
27 Osborn Street, Whitechapel, E.
May 30th, 1908.

[Mr. Tapper is right. The items for "coal" and "steam for dust destructor" under "generating costs" should be added to give the costs of fuel per unit sold. The fuel costs per unit sold were, therefore, 0·49d. for the year ended March, 1908, as compared with 0·48d. in the previous year. The fuel costs per unit *generated* from coal were 0·439d. in 1907-8, as against 0·405d. in the previous year, and from destructor steam 0·400d., as against 0·451d. in 1906-7.—ED. *E.E.*]

OVERLOAD CAPACITY OF GENERATING SETS

Newcastle Discussion

AN informal discussion on the above subject was opened at the last meeting of the Newcastle Local Section of the Institution of Electrical Engineers by Mr. C. Turnbull (Borough Electrical Engineer, North Shields).

Mr. Turnbull remarked that in the early days of electricity supply the steam engine was almost always more powerful than the dynamo which it drove. Engine building was an established industry when dynamos came into being, and engine builders were accustomed to build to liberal proportions, while electrical manufacturers were not then emancipated from the instrument makers, who suffered from the delusion that it was merely necessary to touch two wires together to enable them to carry any current. It was standard practice in those old stations to have an engine which could run its dynamo off its legs, and a switchboard which would not safely carry all the current which the dynamo could give it. Switchboards even yet have not entirely overcome this fault.

Engines are still frequently made more powerful than the dynamos attached to them. A case recently noticed was that of a 3,500-kw. set, which gave better economy to 6,900 kw. than at nominal full load. It would probably have given up to 8,000 kw. with the by-passes open. The most economical load was at 5,000 kw. In a case of this kind one must come to one of two conclusions: either the nominal rating is a misnomer, or else there is an astonishing waste of potential power. One can hardly believe that the dynamo would be capable of doing from 5,000 kw. to 7,000 kw. continuously at ordinary power factors, with good regulation, and if it were not able to do this it could not work on the best part of the curve. Probably some £700 more spent on the dynamo would have enabled it to stand up to the engine's full load, and this small sum would have given the owners of the plant some 2,000 kw. extra capacity. This would have also saved in running costs, as less plant would have been in operation if this set could have run at these heavy loads. For a maker to supply the engine so much more powerful than its dynamo shifts the economical part of the consumption curve beyond the user's reach, and in case of a short puts an unduly heavy strain on the dynamo. One sometimes hears that dynamos need not be made with great overload capacity. It is difficult to agree with such a contention. The stresses which a dynamo must endure when a partner breaks down are tremendously severe, and the breakdown of one machine may wreck the whole of the running plant if the dynamos be not liberally proportioned. Good overload capacity enables one to face such contingencies, if not with an easy mind, at any rate with hope. There is another thing which particularly applies to direct-current sets, that commutators run much better below full load.

Mr. Turnbull summarised his views as follows:—The consumption curve usually slopes down to a certain point and then up again. Full load might be defined as the point where the most economical load is exceeded by, say, 10 per cent. Overload is beyond this. Combined plant must give at least the specified power. It must also be capable of running continuously at full load as specified above, and at such overload as may be agreed. The maximum overload of the plant should be the maximum overload of the engine, the dynamo being made to suit. The dynamo should also be capable of running continuously at any load which the engine would do economically.

The discussion was continued by Mr. A. S. BLACKMAN, who thought that generating plant built a few years ago usually gave more overload capacity than modern machinery. He did not think that thermometers were used sufficiently in finding out the limit to which a machine can run on overload during working conditions, and he would like to know the limits to which it was safe to carry the temperature of armature windings. Mr. Turnbull had incidentally mentioned that switch-

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boards were frequently designed so as to render overload out of the question. This is probably due to the very careless way in which some specifications for switchboards are drawn up. For instance, he knew of one board in the Midlands designed to carry about 10,000 kilowatts capacity, in which the only stipulation was that it should carry the load with "reasonable temperature rise."

Mr. A. H. LAW said that overloads on engines could be frequently coped with by passing the high pressure steam directly to the low pressure cylinder. In colliery work, overload was nearly always accompanied by a poor power factor. Therefore the excitation of the dynamo must have a very large margin. In lighting work the overload often improved the power factor, either if it came directly or through synchronous motor generators. For alternators, the voltage drop was the limiting factor even more than the temperature rise. In direct current there was the commutation limit. As regards insulation, it should be remembered that overloading a machine is safe for a certain definite time only, the life becoming shorter as the overloads are increased.

Mr. G. G. STONEY (Messrs. C. A. Parsons & Co.) pointed out graphically the relation of overload to normal load, and exhibited a curve to show the varying behaviour of a reciprocating and a turbine set. According to Mr. Turnbull's definition, full load was located at point R 10 per cent. beyond point A, the most economical point on the curve XAR for the reciprocating engine. In the turbine set nominal full load was usually taken at point F on the curve XAR^1, the $1\frac{1}{4}$ load being located at the point A, and the $1\frac{1}{2}$ load at point R^1. The point to remember was that in a reciprocating engine, the consumption rapidly ascends again after it has reached its economical point, while

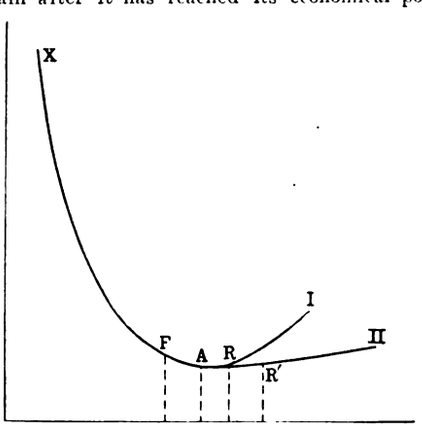


DIAGRAM ILLUSTRATING MR. STONEY'S REMARKS.
I. Curve for reciprocating engine.
II. Curve for turbine.
F. Turbine, full load.
A. Turbine, $1\frac{1}{4}$ load.
R. Reciprocating engine, full load.
R'. Turbine, $1\frac{1}{2}$ load.

in the turbine the curve continued practically horizontal. Moreover, the turbine, if it ran five minutes under overload, would run equally well for 500 hours. The point could be put this way: an alternator had a time limit but no load limit, while the turbine had a load limit but not a time limit, and the proper combination of a turbo-alternator depended on the balancing of these conditions. The best specification was generally one which required a 5 per cent. voltage regulation at full load, and an overload of 25 per cent. to the point where bye-passing became necessary, with a capacity of 50 per cent. overload when the bye-pass was opened.

Mr. BROOKING (Messrs. Glover & Co.) wished to know whether overload was confined to engines, dynamos, and switchboards in this Paper. If not, he would like to mention that cables, which form an important part of a supply system, are also subject to overload evils, such as decentralisation, expansion, and contraction. The trouble of decentralisation has been now overcome by the use of paper insulated cables and solid bitumen cable. The trouble of expansion and contraction has not, however, been thoroughly dealt with up to the present. A patent has recently been taken for the control of expansion and contraction locally along the conductor, and this is being taken up by his firm. The method consists of spacing each wire of the strands some little distance from one another, and doing away to a certain extent with the inner core. Expansion and contraction, therefore, takes place between the spaced wires at every inch of the length.

Mr. TURNBULL, in reply, referred to Mr. Ram's story of the station where everybody got behind pillars when a generator was being paralleled. He thought this illustrated the question of overload on some switchboards. The main point of his contention was, that it was better to run one machine at the point on Mr. Stoney's curve marked R^1 than two machines at the point marked F^1. Mr. Brooking's communication with regard to loose wire cable was interesting, but he would be inclined to say that the cable might easily absorb water.

ELECTROCHEMISTRY AND ELECTRO-METALLURGY

J. W. JUNGER, in an American Patent (No. 885,054), describes a gas battery in which the calorific energy of the reaction $SO_2+O+H_2O=H_2SO_4$ is converted into electrical energy. The sulphuric acid formed in the process is reconverted into sulphur dioxide by heating it with carbon. The apparatus consists of a stoneware vessel, which is divided into two parts by means of a porous non-conducting plate. In both compartments there are plates of conducting carbon, for example, graphite, the one being arranged as an oxidising electrode and the other to act as a reducing electrode. The one acting as oxidising electrode is surrounded with porous carbon, the best form of which is porous graphite, and is moistened with a solution of nitroso-sulphuric acid in highly concentrated sulphuric acid. The other plate is surrounded with finely powdered porous coke or retort carbon, and is moistened only with strong sulphuric acid. The porous partition is also saturated with sulphuric acid. Air and moist sulphur dioxide are passed through the battery, which, when it is connected with a suitable resistance, gives a constant electrical current. Sulphur dioxide, in presence of the oxygen of the air and water, is converted into sulphuric acid, which flows out from the battery. This, as already stated, may be reconverted into sulphur dioxide. The E.M.F. of the battery depends upon the concentration of the sulphuric acid, and varies between 0·5 and 0·3 of a volt.

In the *Centralblatt für Accumulatoren und Galvanotechnik* of May 20th, Dr. K. Heintz describes a method for obtaining the best effect from primary batteries of the Bunsen type. The E.M.F. of the cell depends upon the employment of a successful oxidising agent in order to prevent polarisation. Generally speaking, owing to dilution, the oxidising agent after a short time loses its power, and it is necessary to empty out the battery and to add a fresh quantity of this oxidising substance. The depolarising action is thus dependent upon the concentration of the oxidising agent. It is now stated that it is not necessary to use strong solutions of chromic acid or permanganic acid, provided that strong sulphuric acid is employed, and the acid when mixed with the electrolyte should not have a sp. gr. less than 1·25. By acting in this way, comparatively weak solutions of oxidising agents will work satisfactorily until they have been practically completely reduced. When they are no longer active a portion of the solution is withdrawn, some more oxidising agent added, and then strong sulphuric acid. It is thus not necessary to disconnect the battery and take it to pieces, but simply to withdraw a small portion, as already stated, of the electrolyte. After a time, however, the concentration of the produced salts becomes too great, and then the whole of the electrolyte must be replaced. The chief point, of course, is in it not being necessary to use concentrated solutions of the rather expensive depolarising agents, and in the fact that in the presence of strong sulphuric acid they can be completely used up.

ELECTRICAL SCIENCE

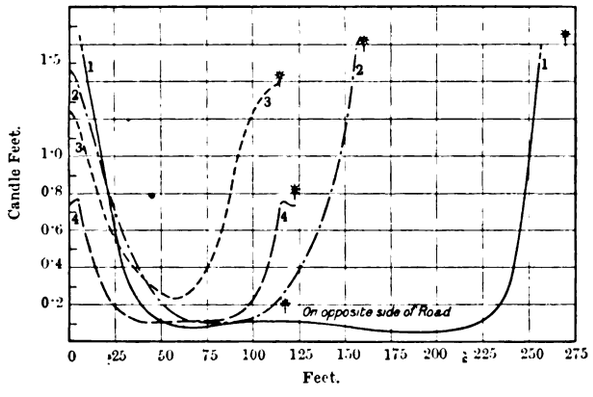
Presidential Address of Sir Oliver Lodge to the Faraday Society.—Sir Oliver Lodge commenced his presidential address before the Faraday Society on the work of Lord Kelvin last week by pointing out the difficulty of doing justice in the course of a short address to a man who from an early to an old age had turned out work embracing practically all branches of physical science. He had calculated the age of the earth, worked in the domain of electro-statics, optics, elasticity, telegraphy, besides many other practical subjects. Sir Oliver himself dealt with the more recondite and abstruse branches of his activity. He was not entirely able to agree with some of Lord Kelvin's assumptions, neither did he always consider that his practical work entirely bore out his conclusions. For instance, in the case of the kinetic theory of solidity, Kelvin seemed to consider that solids could be made from fluids and fluids from solids, and that matter might be ether in motion. But more recently he seemed to have rather modified his views, and appeared satisfied with the postulate of action at a distance through space without the intervention of connecting medium. Sir Oliver Lodge himself was unable to accept the explanation of action at a distance without the intermediary of some form of matter. Nothing in Lord Kelvin's work was finer than his publications in 1851, or showed the extraordinary keenness of mind aided by the tremendous natural powers which he possessed. His prescience was at that date even greater than that of Helmholtz. Posterity would probably consider that the greatest of all his work was that upon the conservation of energy and his enunciations upon the laws of thermodynamics. Reference was also made to the importance of his work upon absolute measurements, and Sir Oliver pointed out that some persons appeared to think that absolute measurements meant the metric system, but it did not matter in the least what units were employed so long as they were understandable.

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STREET LIGHTING IN THE CITY OF LONDON

ON page 803 of our last issue reference was made to a report by the Engineer to the City of London as to the cost of street lighting in the City, especially in reference to the experimental electric lighting carried out during the past winter by the City of London Electric Lighting Co. and the Charing Cross, West-End, and City Electric Supply Co. We are now able to publish the report of Mr. A. A. Voysey, Electrical Engineer to the City, embodying some interesting photometric measurements, which has been presented to the Streets Committee. The report reads as follows: —

It is now my duty to report on the subject of the public lighting of the City, having regard to recent experiments which have been made with a view to improve and cheapen it. In the first place, I propose briefly to refer to what is called the science of photometry, of which I have made some use for the purpose of this investigation. Many people even to-day, in dealing with questions of artificial light, are content with a statement of the candle-power of the source of light—a statement frequently as false as it is vague—taking no account of the directions in which light is given, of the globe, lantern, reflector, position and surroundings of the lamp, all factors of the utmost importance in determining the useful lighting effect. However important the study of the source of light may be, the study of the actual illumination in the street under working conditions is far more essential. In 1892 the work of Mr. A. P. Trotter, now the Electrical Advisor to the Board

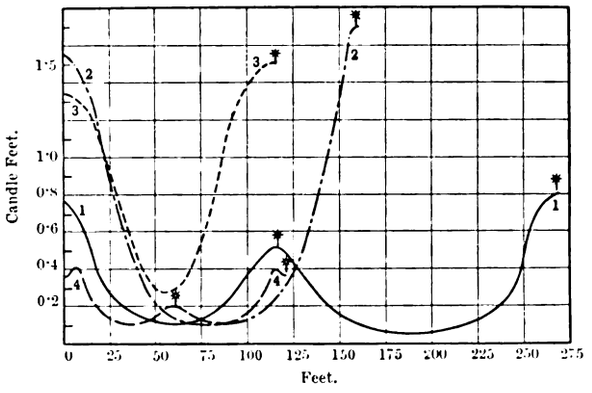


Curve No.	Street.	Lamps.	Current amps.	Height and support.	Illumination. Max.	Av.	Min.	Width of street.	Relative cost.
1	Holborn Viadt.	Flame arc	10·6	20·5′ post	2·0	0·41	0·05	77·5′	118
2	Cannon Street	,,	11·0	28·0′ central	1·6	0·56	0·1	50·0′	100
3	,,	,,	11·0	28·0′ ,,	1·4	0·12	0·23	50·0′	139
4	Queen Street	High-pressure gas 2 mantle	—	13·0′ post	0·76	0·29	0·1	50·0′	196

CURVE A, CURB LIGHTING.

of Trade, showed the lines on which such an examination might proceed, and at the same time provided an excellent illumination photometer for the purpose. I worked a great deal with this instrument in the City in 1896, taking measurements of the illumination on a horizontal surface six inches from the ground, and formed the opinion that the illumination measured on a horizontal surface may be taken as a sufficient indication of the effective lighting of a street. I am now again led to the same conclusion. But as the tendency is to measure illumination at a height of four feet from the ground, my recent tests have been made at this level. The photometer used is an improvement on the one used in 1896 and was sent to the National Physical Laboratory for verification. The unit of illumination is that produced by one candle-power at a distance of one foot and is called one candle foot.

Attached hereto will be found some curves showing the illumination given in Holborn, Cannon Street, and Queen Street by the experimental lamps. The length of the street in feet is plotted along a horizontal scale and the vertical scale is marked in candle feet and fractions thereof, so that the curves show the variation in illumination along the street. Curves "A" show the illumination along the curb line given by flame arc lamps in Holborn Viaduct and Cannon Street and by gas in Queen Street. Curves "B" are similar, but are taken along the centre of the road. Curves "C" show the difference in illumination along the curb in Cannon Street, between the central suspension of lamps at a height of 28 ft. and lamps on posts at a height of 20½ ft. Curves "D" are similar, but along the centre of the road. There is also shown the effect of turning out one of the centrally-hung arc lamps. Curves "E" show the effect of suspending the lamps in Cannon Street at 26 ft. instead of 28 ft. Curves "F" show the effect of lighting Tower Royal with the centrally-suspended flame arc lamp in Cannon Street, with a flame arc on a post and with two incandescent gas lamps. The arc-light curves marked "A" and "B" are each taken as the mean of several curves, and the atmo-

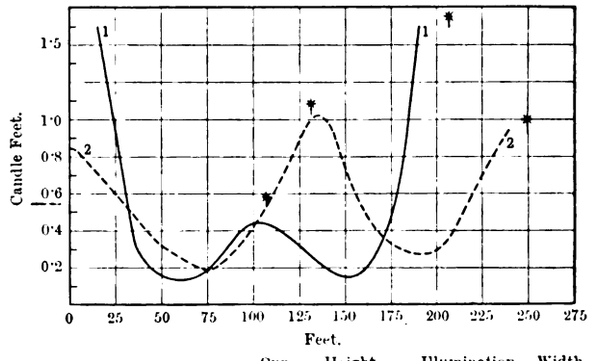


Curve No.	Street.	Lamps.	Current amps.	Height and support.	Illumination. Max.	Av.	Min.	Width of street.	Relative cost.
1	Holborn Viadt.	Flame arc	10·6	20·5′ post	0·8	0·28	0·6	77·5′	118
2	Cannon Street	,,	11·0	28·0′ central	1·7	0·66	0·10	50·0′	100
3	,,	,,	11·0	28·0 ,,	1·5	0·88	0·28	50·0′	139
4	Queen Street	High-pressure gas 2 mantle	—	15·0′ post	0·4	0·21	0·10	50·0′	196

CURVE B, CENTRE OF ROAD.

spheric conditions, when the tests were made, were clear and favourable. The Curves "C," "D," "E," and "F" were taken with a view to make specific comparisons, and they each represent a single set of observations. The atmospheric conditions prevailing when curves "E" were taken were distinctly inclined to be foggy.

It is now necessary to consider what conclusions can be drawn from the curves. I have already stated that I think the illumination given on a horizontal surface can be taken as a sufficient indication of the value of the lighting in a street. Next, I have formed the opinion from observation and testing that the minimum illumination is the most important factor in good lighting, and I have come to the conclusion that about one-tenth of one candle foot is the minimum below which it is not desirable to go in the main streets of the City. If that figure is adopted and maintained, then I think that the main streets of the City will be very well lighted. If the curves



Curve No.	Street.	Lamps.	Current amps.	Height and support.	Illumination. Max.	Av.	Min.	Width of street.	Relative cost.
1	Cannon Street	Flame arc	11·0	20·5′ post	2·0	0·68	0·14	50′	155
2	,,	,,	11·0	28·0′ central	1·02	0·56	0·19	50′	127

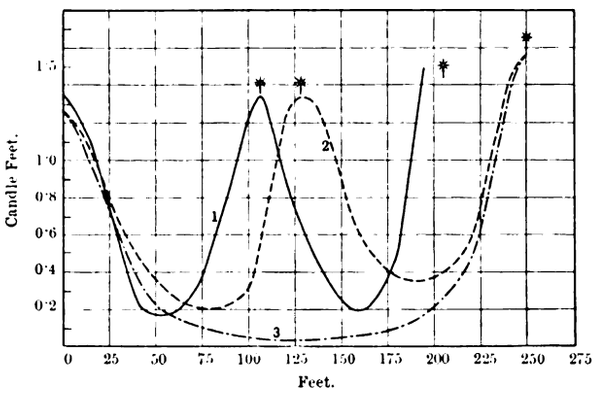
CURVE C, CURB LIGHTING.

for Holborn Viaduct are studied, it will be seen that, although Holborn Viaduct is a very wide thoroughfare, the lighting is not very far from complying with the minimum value which I think necessary.

In order to meet any possible objection to unpleasant colour, the Holborn Viaduct lamps are trimmed with carbons giving a pleasantly-toned light, but the illumination is thereby reduced. If 7 m/m and 6·35 m/m (cores 3/32 in. and 1/16 in. respectively) carbons are used in Holborn Viaduct, giving a

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yellower light, the minimum illumination would be increased so as not to fall far short of the necessary value, and it could be regarded as approximately fulfilling what I think are the reasonable requirements for the sufficient lighting of a City main street. I do not think that Holborn Viaduct can pro-



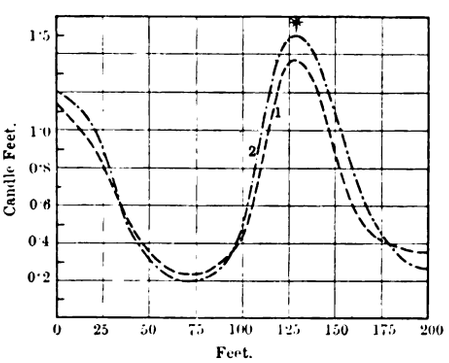
Curve No.	Street.	Lamps.	Current amps.	Height and support.	Illumination. Max.	Av.	Min.	Width of street.	Relative cost.
1	Cannon Street	Flame arc	11·0	20·5 post	2·0	0·7	0·17	50′	155
2	,, ,,	,,	11·0	28·0′ central	1·56	0·72	0·2	50′	127
4	,, ,,	,,	11·0	28·0′ ,,	1·56	0·4	0·04	50′	64

CURVE D, CENTRE OF ROAD.

perly be compared with Cannon Street, because, in addition to other reasons, the width of the Viaduct is about 50 per cent. greater than the width of Cannon Street. Therefore, I determined to make another test in Cannon Street, first with the centrally-hung lamps as used at present and then with identical lamps on posts on the footway, keeping the conditions of current and carbons the same for both. The arrangements for this test were kindly made for me by the City of London Electric Lighting Company, and the results shown in curves "C" and "D" indicate the advantage obtained by central hanging in a street such as Cannon Street, which is fairly typical.

The illumination curves of the centrally-hung lamps in Cannon Street show that the lighting also fulfils the suggested condition that the minimum should not be less than one-tenth of one candle foot, and I think the curves are very good ones and indicate what is obvious from an examination of the street, namely, that the lighting is very good, and, if we study the curves, the advantages of the central suspension and the extra height of the lamps are evident. From the central suspension there is, however, an additional gain for side streets and at the junctions of streets owing to the fact that the light of one lamp can be used over a greater area. For instance, 45 per cent. of the cost of lighting in Cannon Street is saved on gas in the side streets. This economy could to some extent be obtained by placing posts at the corners of streets, but I do not think it could be obtained to the same extent as is possible with the higher centrally-hung lamp.

An experiment was made in Cannon Street at the suggestion



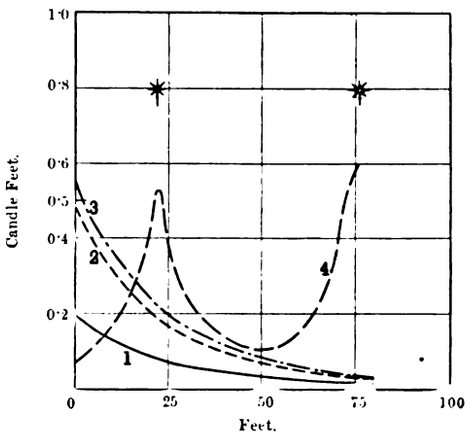
Curve No	Street.	Lamps.	Current amps.	Height and support.	Illumination. Max.	Av.	Min.	Width of street.	Relative cost.
1	Cannon Street	Flame arc	11·0	28′ central	1·37	0·66	0·23	50′	—
2	,, ,,	,,	11·0	26′ ,,	1·5	0·72	0·2	50′	—

CURVE E, CENTRE OF ROAD.

of the late Chairman, Mr. Stopher, some of the lamps being hung at 26 ft. instead of 28 ft. The result is given in curves "E," which, I think, show that the higher position is slightly better than the lower one. Curves "F" show the illumination in Tower Royal, a turning off Cannon Street, lighted by the centrally-hung arc lamp, and by the arc lamp on a standard in Cannon Street and by the two incandescent gas lamps on brackets in Tower Royal. The curves show the advantage of the central suspension.

Attention should be drawn to curve "D," No. 3, which shows the effect of extinguishing alternate lamps in Cannon Street. The curve does not fulfil the requirements of a well-lighted main street, but it shows a better result than Queen Victoria Street, and the lighting is very fair. If it were not for the fact that the cleansing of the streets is an operation which may be greatly assisted by good lighting, I should be inclined to recommend the turning out of half the lights in the main streets at midnight, and I think the matter is worth consideration. This is, perhaps, an opportune place to discuss the question of ligting hours. In my opinion the fixing of lighting hours between sunset and sunrise is a mistake, and I think the lighting might be curtailed on an average of about one hour per day, half in the morning and half in the evening, if a reasonable reduction were made in the annual charges. It is now desirable to consider the question of comparative cost, and this is bound up with the question of spacing.

The average distance between the centrally-hung lamps in Cannon Street is approximately the same as that of the standards in Holborn, though Holborn is 50 per cent. wider than Cannon Street. The average spacing of the centrally-hung lamps in Cannon Street is a little closer than the spacing of the old standards in that street, there being eleven of the



Curve No.	Street.	Lamps.	Current amps.	Height and support.	Illumination. Max.	Av.	Min.	Relative cost.
1	Tower Royal	Flame arc	11·0	20·5′ post	0·2	0·08	0·025	Nil.
2	,, ,,	,,	11·0	28·0′ central	0·48	0·16	0·04	Nil.
3	,, ,,	,,	11·0	26·0′ ,,	0·56	0·19	0·04	Nil.
4	,, ,,	Low pressure gas 1 mantle	—	11·6′ bracket	0·6	0·25	0·08	£6 14 4 per ann.

CURVE F.

suspended to ten of the lamps on standards. The extra lamp results really from the consideration of the side streets rather than from any need in Cannon Street itself. With regard to spacing, a regular distance should be followed as closely as possible, but due consideration must be paid to side streets and cross streets in order to obtain the most economical results. As will be seen from the curves, the distance between the lamps in Cannon Street varies from 112 to 165 feet. I think the latter distance may be regarded as the extreme, beyond which it is not desirable to go; whereas the former is closer than is necessary and can only be justified by a consideration of the side streets.

For the purpose of comparing the effect of gas with electric lighting I made a test in Queen Victoria Street, but I found a large portion of this street with a very low illumination, and neither from observation nor test did it appear to me at all comparable with Cannon Street. I therefore sought out a piece of good gas lighting, and I found this in a portion of Queen Street. It was interesting to find that the piece of street I picked fulfilled the condition which I had fixed as essential for a well-lighted street, namely, that the illumination on a horizontal surface four feet from the ground should in no place be less than one-tenth of one candle foot. The average illumination of the picked piece of gas lighting in Queen Street, which is, fortunately, just the same width as Cannon Street, is only about half that in Cannon Street, though it is about double the cost. This confirms what I reported three years ago as the result of some photometric tests, namely, that light for light, high-pressure incandescent gas light costs four times as much as the flame arc light. It may here be observed that departments of the Corporation, other than the Public Health Department, are now saving at the rate of about £3,000 a year, partly by changing from gas to electricity and partly by

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bringing electric lighting up to date, and I have good reason for saying that this sum could be considerably added to.

On the whole, I think it may be fairly assumed that about 500 eleven-ampere flame arc lamps will light the main streets well, whether centrally-hung or on standards. The cost of these at £17 10s. each would be £8,750. The present cost of lighting the whole City is about £22,000 a year, about half the cost being for electric light and the other half for gas. In addition to this a sum of about £17,000 appears to have been spent in the last nine years on providing and maintaining apparatus for gas lighting. The side streets can be very much better lighted by centrally-hung arc lamps than they are at present for a sum which I estimate approximately at £5,000 to £6,000 per annum. It is very important in my opinion that the main-street lighting should not be arranged independently of the side streets. Economical effective lighting of both is bound up one with the other. A few lamps arranged in the side streets off Cannon Street would quickly show what can be done. I have very little doubt that the average illumination throughout the whole of the City streets can be at least doubled, and a saving of about £6,000 a year effected.

On the subject of lamp supports, I think it may be remarked, with regard to the central suspension, that the plan followed in Cannon Street of making them as invisible as possible is a good one. Attachments would have to be securely made and the supporting wires carefully examined, and, no doubt, the existence of a large number of such supports in the City would necessitate some extra cost to the Corporation in the supervision of overhead wires. But if reasonable care is used in the matter, there should be no danger whatever attaching to the central suspension of lamps. In the main streets the plan of trimming the lamps in position during the early hours of the morning is a sound one. No doubt some small occupation of the roadway space during busy hours would take place when a lamp went wrong at such a time, but it must be remembered that a standard on the footway remains for several thousands of hours each year as an obstruction to traffic and must necessarily be a much greater cause of inconvenience than the very occasional visit for a few moments necessitated by a fault in a centrally-hung lamp.

In narrow streets it would be advisable to arrange for bringing the lamps down to the footways for trimming, because otherwise a serious obstruction to traffic would occur. In some very wide streets, like Holborn and Farringdon Street, it might be advisable to use standards placed in the centre of the road, and in any case a certain number of standards may be required.

While I recognise the importance of economy and the consequent need to use existing material as much as possible, I think I ought to point out the unsatisfactory condition of London in the matter of lamp standards and especially electric-lamp standards. The design is usually left to an iron-founder's draughtsman. Mr. Norman Shaw has very kindly given his gratuitous aid in matters affecting the appearance of London, and I think his help might very well be asked. If new posts are found to be necessary, I think some endeavour should be made to redeem the reputation of London in this matter.

I will re-state my main conclusions:—(1) That the illumination on a horizontal surface four feet from the ground is a sufficient indication of the useful light in a street; (2) that the minimum value of such illumination is the most important factor in good lighting; (3) that such minimum should not be less than one-tenth of one candle foot; (4) that this illumination can be approximately obtained by eleven-ampere flame arc lamps with yellow flame carbons, spaced approximately as at present, either on standards at 20½ feet, as in Holborn Viaduct, or centrally hung, as in Cannon Street, at 28 feet from the ground; (5) that a more even distribution of light, and a more economical result can be secured by the centrally-suspended lamp at 28 ft. than by the lamp at 20½ ft. on a standard; (6) that economy and efficiency require the treatment of main streets and side streets together; (7) that a demonstration should be made in the side streets of centrally-hung arc lamps as soon as possible; (8) that about £6,000 a year may be saved and a doubling of the average illumination throughout the City streets effected by flame arc lighting, assisted by a few metallic filament lamps where arc lamps have not a sufficient area for economical lighting; (9) that where central suspension is used, it should be without lowering gear in broad streets, and with lowering gear in narrow streets; (10) that any new standards which may be required should be designed according to the advice of some reliable guide, such as Mr. Norman Shaw; (11) that the lighting hours can be re-considered with a view to economy without prejudice to lighting efficiency; (12) that the question of reducing the lighting in the main streets at midnight should be considered.

In order to obtain as soon as possible the great advantages in economy and better lighting that I have shown to be possible, I think a small demonstration should be invited from both companies in the side streets, and some of the streets adjoining Cannon Street would be very suitable for the purpose. I also think it would be a great advantage if a provisional decision were come to as to whether the lighting is to be divided between the two companies, and, if so, in what proportions. If that is done, and the side-street demonstration of lighting found satisfactory, then the way will be clear for the preparation of complete plans and specifications for lighting the whole of the City, and instructions might be given accordingly.

INSTITUTION OF ELECTRICAL ENGINEERS

ANNUAL PREMIUMS.

THE following premiums for Papers and communications have been awarded by the Council this year. In accordance with precedent, in deciding upon these awards the Council have not taken into account Papers contributed by members at present holding office on the Council.

The Institution Premium, value £25, to Messrs. G. Stoney (member) and A. H. Law (associate), for their Paper on "High Speed Electrical Machinery."

The Paris Electrical Exhibition Premium, value £10, to Mr. J. S. Peck (member), for his Paper, "Protective Devices for High-Tension Transmission Circuits."

An Extra Premium, value £10, to Mr. J. F. C. Snell (member), for his Paper on "The Cost of Electrical Power for Industrial Purposes."

An Extra Premium, value £10, to Dr. A. Russell (member), for his Paper on "Dielectric Strength of Insulating Materials and Grading of Cables."

An Extra Premium, value £10, to Dr. W. W. Haldane Gee (associate member), for his Paper on "Electrolytic Corrosion."

An Extra Premium, value £10, to Mr. T. M. Barlow (student), for his Paper on "Heat Conductivity of Iron Stampings."

STUDENTS' PREMIUMS.

A First Students' Premium, value £10, to Mr. H. R. Speyer (Frankfort-on-Maine), for his Paper on "The Electrification of the Mansfield Copper Mines."

A Second Students' Premium, value £8, to Mr. L. H. A. Carr (Manchester), for his Paper on "Electricity and Matter."

Three Students' Premiums, each of the value of £5, to Mr. A. Hamilton (Glasgow), for his Paper on "The Brown-Mackenzie System of Electric Block Signalling"; to Mr. H. W. Gregory (London), for his Paper on "The Motor Converter"; and to Mr. P. C. Jones (Manchester), for his Paper on "Starters and Control Gear."

Students' Papers which have been awarded a premium are printed in the *Journal* in full or in long abstract. [An article by Mr. H. R. Speyer, on the Mansfield Copper Mines, also appeared in ELECTRICAL ENGINEERING, Vol. II., pp. 570, 609, and 650.]

At the thirty-seventh annual general meeting of the Institution of Electrical Engineers, held on Thursday, the Council presented its report for the past session. Since the date of the last annual general meeting, 202 proposals for election to corporate membership, and 314 proposals for election as Student have been considered, and 492 of these 516 have been elected, viz.: 7 Members, 165 Associate Members, 17 Associates, and 303 Students. Forty-five Associate Members and five Associates have been transferred to the class of Members; 43 Associates and 96 Students to the class of Associate Members; and one Student to the class of Associates. There have, however, been a number of losses through deaths, resignations, and erasures, and the total membership is 6,048 members of all classes, as compared with 5,945 last year.

SCHOLARSHIPS.

The Council have awarded two Salomons Scholarships, value £50 each, to Mr. Herbert Carnegie, of the Finsbury Technical College, London, and Mr. Alfred Hutt, of the Central Technical College, London. A David Hughes Scholarship, value £50, has also been awarded by the Council to Mr. Clifford Higgins, of the Central Technical College, London.

STUDENTS' SECTION.

The Students' Committee organised a visit to Switzerland in the summer of 1907, where they visited the following works, laboratories, and other places of interest:—Messrs. Brown-Boveri & Co., Ltd., Messrs. Escher Wyss & Co., Maschinenfabrik Oerlikon, Messrs. Sulzer Bros., Schweizerischer Lokomotiv

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und Maschinenfabrik, Winterthur, Zurich Polytechnic, and the Jungfrau Electric Railway Co. The arrangements of the visit were planned and carried out by the Chairman, Mr. E. W. Moss, and his committee, and the great success of the visit was largely owing to Mr. Moss's skilful organisation of the expedition. The party was everywhere most kindly and hospitably received. A series of visits to works and laboratories in and about London was made during the session.

The Manchester Branch of the Students' Section has also completed a successful session, having held seven meetings and read seven Papers. Visits to various works in the district were also organised by kind permission of the firms concerned. The Students' Committee at Manchester and Mr. J. Lawton Lovell, the Hon. Secretary, are to be congratulated on the success of the Section in that centre. Two meetings have also been held by the Glasgow Branch of the Students' Section, at which two Papers have been read under the chairmanship of Professor Magnus Maclean.

Imperial College of Science and Technology.

The Council have appointed Mr. Robert Kaye Gray, Past President, as the first representative of the Institution upon the governing body of the College, and he will hold office for a term of four years.

Home Office Regulations for the Use of Electricity in Factories.

The Institution was invited last year to consider and offer observations upon the new Draft Regulations prepared by the Secretary of State in pursuance of the Factory and Workship Act (1901). The question was referred to the Traction, Light, and Power and the Parliamentary and Industrial Committees in joint meeting, with Mr. Alexander Siemens, Past President, as chairman. Suggestions for the amendment of the rules were submitted to the Home Office, and Mr. Alexander Siemens attended on behalf of the Institution at the subsequent inquiry.

Wiring Rules.

Owing to the large demand for copies it was found necessary to reprint them in June, and in all about 3,600 copies of the last edition have been distributed. It is satisfactory to note that the rules have been adopted by 36 fire offices, and that 30 local authorities and supply companies have agreed to accept them as standard practice and to recommend their use. The committee hopes to resume its meetings in the autumn to consider such proposed amendments as have already been received, and also to revise the rules as far as may be rendered necessary by the putting into operation of the new Home Office Regulations.

International Commission for Standardisation.

The British Electrotechnical Committee was appointed by the Council on July 26th, 1906, to act under and in accordance with the proposed rules of the International Commission, which were provisionally agreed to at the preliminary meeting, held in June, 1906, in London. Sir John Gavey, C.B., was appointed President, and Sir William Preece, K.C.B., and Mr. Alexander Siemens, Vice-Presidents of the committee. The full list of the committee is as follows:—Sir John Gavey, C.B. (President); Sir Wm. H. Preece and Mr. Alexander Siemens (Vice-Presidents); Lord Rayleigh, Colonel Crompton, Colonel Holden, Mr. W. Duddell, Mr. K. Edgcumbe, Dr. Glazebrook, Mr. R. K. Gray, Mr. Robert Hammond, Dr. Gisbert Kapp, Mr. Mather, Mr. H. W. Miller, Mr. Mordey, Professor Perry, Mr. C. P. Sparks, Mr. Swinburne, Professor S. P. Thompson, Mr. Trotter, Mr. E. B. Vignoles, and Mr. Wordingham; Mr. G. C. Lloyd (honorary Secretary); Mr. C. le Maistre (Secretary).

In accordance with the rules of the Institution the committee is re-appointed annually. It has full direction of the work of the sub-committees, of which at present two have been appointed, the Sub-Committee on Nomenclature, with Mr. A. P. Trotter, the Electrical Adviser to the Board of Trade, as the chairman, and the Sub-Committee on Symbols, appointed January 16th, 1908, with the Right Hon. Lord Rayleigh as the chairman, and Professor Silvanus P. Thompson the vice-chairman.

At the second meeting of the committee, Colonel Crompton, the Honorary Secretary of the Commission, reported that committees had been formed in Austria, Belgium, Denmark, France, Germany, Hungary, Mexico, Spain, Sweden, and the United States, and that the matter was being considered in Australia, the Argentine Republic, Canada, Japan, South Africa, and Switzerland. With regard to Italy, he understood from Mr. G. Semenza, who had been a delegate at the preliminary conference, that there was every likelihood of a committee being formed there at no very distant date.

Owing to the death of Lord Kelvin, the office of President of the Commission became vacant, and steps to fill the vacancy will be taken at the next meeting of the Commission.

According to the rule which provides that each committee shall elect one delegate to the Council of the Commission, Dr. R. T. Glazebrook, F.R.S., has been appointed British delegate, and, together with the President of the British Electrotechnical Section, Sir John Gavey, C.B., will attend the meeting of that Council, which in all probability will be held in London next October.

A sub-committee will shortly be appointed to deal with the classification of electrical machinery and apparatus—that is to say, to undertake all practical questions. One of the first points to which they are likely to turn their attention is the question of "Standards of Light," and, with the co-operation of the other Electrotechnical Committees, it is hoped that a satisfactory decision may in due course be arrived at. Colonel Crompton announced that the British Government had officially recognised the Commission, and had allotted an annual grant of £100 to the British Committee.

Examinations in Wiremen's Work.

An Advisory Committee was appointed in 1906 by the City and Guilds of London Institute to revise their syllabus for examination in electrical wiremen's work, to which committee the Council of the Institution was invited to nominate representatives. Mr. James Swinburne, F.R.S., Past President, and Mr. W. H. Patchell, member of Council, were accordingly asked to act, and subsequently representations were made to the Council by that Institute that they were of opinion that considerable encouragement would be given to electric wiremen in raising their trade status if the Council could see its way to permit recognition by the Institution of Electrical Engineers of the City and Guilds certificates. It was agreed, subject to approval of the syllabus of instruction, to give assistance this year by appointing qualified persons to represent the Institution and attend the practical examinations. The following members very kindly agreed to give their services on behalf of the Institution and to furnish a short report on the manner in which the candidates performed the practical part of their work:—London Centre:—Woolwich, P. R. Friedlaender; Mile End Road, Dr. J. Henderson; East Ham, A. H. Seabrook; West Ham, W. T. Maccall; Poplar, J. H. Bowden; Clerkenwell, V. A. Mundella; Borough Road, J. T. Morris; Battersea, F. A. Bond; Chelsea, P. Still; Chiswick, A. W. Money; Paddington, W. R. Rawlings; South Tottenham, G. H. Baker; Wimbledon, H. Tomlinson-Lee; Kilburn, J. E. Pownall; Highgate, Dr. C. V. Drysdale; Barnsley, E. A. Barker; Bath, S. F. Walker; Belfast, R. Stanley; Birmingham, Dr. W. E. Sumpner; Blackburn, P. P. Wheelwright; Bolton, A. A. Day; Brighton, C. B. Smith; Bristol, Professor A. P. Chattock; Cork, H. G. Whiting; Croydon, A. C. Cramb; Darlington, E. Cox-Walker; Derby, W. C. Goodchild; Dublin, T. Tomlinson; Enfield, H. H. Perry; Huddersfield, A. B. Mountain; Kingston, J. E. Edgcome; Lancaster, W. A. Tester; Leeds, H. Dickinson; Manchester, E. S. Bradburne; Norwich, F. M. Long; Peterborough, G. H. Hardwick; Plymouth, E. G. Okell; Portsmouth, B. Handley; Redhill, A. W. Makovski; Rotherham, G. Young; Runcorn, A. Lester Taylor; Salford, A. Kelly; Sheffield, E. H. Crapper; Tunbridge Wells, Horace Boot; Wolverhampton, H. A. Howie.

The Territorial Army.

The Council was recently informed by the Army Council that the War Office proposed to establish Electrical Engineering Corps for attachment to the Territorial Army, at certain centres in the United Kingdom, and the Institution was invited to co-operate with the county associations in finding officers with electrical engineering qualifications to command these units. The Council is at present in communication with the county associations on the matter.

Museum.

Space has now been provided at the Institution for the temporary accommodation of the articles collected for the museum. Some valuable apparatus and objects of historical interest have been accumulated, due chiefly to the generosity of members and firms interested, and a committee is now in charge of the work of classifying and arranging the articles. It is hoped that members will assist in creating a museum worthy of the Institution by presenting apparatus of historical interest or by advising the Council of the existence of such.

Benevolent Fund.

The Committee of Management reports that the Benevolent Fund of the Institution shows a satisfactory increase for the past year. On December 31st, 1907, the capital account of the fund stood at £2.755 9s. 11d., as compared with £2,532 16s. 4d. at the end of 1906. The donations to the fund in 1907 include one of £52 10s. from the Western Electric Company, and another of £37 from the Committee of the Electrical Engineers' Ball. In January of the present year a special appeal was sent to all members of the Institution, with the gratifying result that the capital account of the fund has since the new year been increased to over £3,000. The special donations since the new year in answer to this appeal, which have not been taken account of in the balance-sheet for the year under consideration, include one of 100 guineas from Mr. W. B. Esson (Member). With their accustomed generosity, the Committee of the Electrical Engineers' Ball have given a further donation of £75 to the fund, this being their surplus from this year's ball.

Four grants in aid were made during the year under the rules of the committee.

The Wilde Benevolent Trust Fund stands at £1,744 16s., and one grant in aid has also been made from the income of this fund in 1907.

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REVIEWS OF BOOKS

The Steam Turbine. By R. M. Neilson. Fourth Edition. 604 pp. 5¾ in. by 9 in. 387 illustrations. (London: Longmans, Green & Co.) Price 15s.

THE preface to the first edition of this book, published only in 1902, commenced with the statement "that the steam turbine is likely to be extensively used in the future is admitted by most engineers"; but few indeed would have thought that within five years the turbine would already have superseded the reciprocating engine not only for driving the largest electric generators built, but also for propelling the nation's finest battleship and the fastest Atlantic liners afloat! Perhaps during recent years nothing in the engineering world has been more remarkable than the rapid development of the steam turbine and the confidence that has been shown in it. It is not surprising that a work which covers so admirably the whole field of turbine design construction and use should have reached the fourth edition so quickly. The present edition has been revised and enlarged; it contains eighteen chapters, covering some 600 pages, and is illustrated by 46 half-tone blocks and to-scale drawings, in addition to 387 figures consisting of curves, diagrams, and details of turbine parts.

The arrangement of the chapters, and the manner in which the theoretical and practical features are dealt with, is most convenient. After an elementary description of the construction and working of the turbine, particulars of all the most important early turbines are given in an interesting historical chapter. Obviously Hero's rotating steam globe is first referred to. This is said to have been used by a German mechanic in 1577 to rotate a broach in place of a turnspit, and a turbine, also of the Hero type, was used at a printing establishment in Edinburgh about the middle of last century. The earliest de Laval turbines were also improved Hero's engines. As a practical machine the turbine dates from about 1885, as in that year a double-flow Parsons' turbine was constructed which revolved at 18,000 r.p.m., and was used for several years generating current for incandescent electric lamp manufacture. The features which led to the success of the early turbines of both Parsons and de Laval are clearly indicated and described. After a chapter devoted to the conversion of the heat energy of steam into kinetic energy, the various types of steam turbines are divided, for purposes of description, investigation, and comparison, into six classes, according to the way in which the steam is expanded with relation to its action on the vanes or blades. This classification is adhered to in the subsequent theoretical investigation of the correct design of buckets and blades, and later in the description of the numerous actual machines which have been or are now made. The combined entropy, temperature, and velocity diagrams given for each class of turbine go far to assist the reader to obtain a good general idea of the nature and difference between the various classes.

The sources of loss, the determination of the efficiency of various parts of the machine, the relation of vane speeds and bucket efficiency thereto are investigated, and the influence of these considerations on the design of the actual turbines is examined.

Then follows a description not only of the general features, but of the special details of practically every British, American, and Continental steam turbine, arranged under the classification already referred to. In many cases successive types of the same machine are described and illustrated, so that the alterations which have resulted in improved running and greater efficiency are clearly demonstrated. The latest designs of several makers' machines, some of which are only now under construction, are exceedingly interesting. The author has obtained so much information of this character that it is perhaps invidious to call attention to omissions, but we note with some surprise that when reference is made to the stripping of blades in the Parsons' type, no mention should have been made of the tipped blade, which has proved such a perfect cure for trouble arising from the fouling of blades during the last two years. A chapter is devoted to low pressure or exhaust steam turbines, and full particulars and drawings of some important installations in which these are employed are given. After the effect of steam pressure, superheat, and vacuum on the efficiency of the various classes of turbines has been considered, particulars are given of numerous steam consumption tests.

Plans of several typical power stations in which turbo-generators are employed have been included, and these well indicate the diversity of design adopted by various engineers in their endeavours to arrange the boilers symmetrically and conveniently in relation to the turbines, which in the larger sizes occupy relatively so little space.

Not the least interesting chapter in this book is that devoted to ship propulsion by steam turbines, which only dates back to 1894, when the *Turbinia* was constructed. This little steamship, after much labour had been spent upon the design of suitable propellers, attained a speed of 33 to 34 knots. Later some particulars are given of the turbine equipment of the *Lusitania* and *Mauretania*, also a table of many noteworthy and typical turbine steamships.

Among the appendices is a list of British patents relating to steam turbines from 1784 to the end of 1905.

To all engineers interested in the design, construction, or operation of steam turbines, this book may be recommended as invaluable.

"The Central." Magazine of the Central Technical College Old Students' Association. Vol. V., No. 14. 40 pp. 10 in. by 6½ in. 2s.

NUMBER 14 of the magazine contains a concise and well-illustrated description of the City of Victoria and Hill District Waterworks (Hong Kong), written by the resident engineer, Mr. D. J. Jaffé, who left the College in 1896. An abridgement of the Paper communicated to the Royal Society by Professors Callendar and Dalby on the "Measurement of Temperatures in the Cylinder of a Gas-engine," and an original article by L. Calisch, entitled "Some Remarks on the Electrification of Railways," are also given. In the latter the author attributes the conservative attitude of British engineers towards electrification of suburban lines to the cheapness of fuel in this country, and to the keen competition of motor vehicles and tramways. The "Old Student Notes" should be particularly interesting to old Central men, and the Association is to be congratulated on the large amount of information which has been gathered from old students all over the world. An excellent portrait of Dr. G. T. Moody is included in this number.

Fowler's Electrical Engineers' Pocket Book, 1908. 679 pp. 6¼ in. by 4 in. (Manchester: Scientific Publishing Co.) Cloth: 1s. 6d., leather 2s. 6d.

In the latest edition of this well-known pocket book, the contents have been rearranged in sections, under distinctive heads, to facilitate reference to any particular subject. Much of a mechanical nature has been eliminated from the work to admit of a more detailed treatment of electrical subjects, and for the former information, the reader is referred to the companion volume—"Fowler's Mechanical Engineers' Pocket Book." The sections dealing with power transmission, polyphase motors, electric traction, and dynamo design have been carefully revised and enlarged. The new (1907) Wiring Rules of the Institution of Electrical Engineers are included in the end of the volume, where the Board of Trade and Home Office Rules relating to the application of electricity are also to be found.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published May 28th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from abroad.

1907 Patents

5,301, B. IGEWSKI. An electric furnace for metallurgical purposes. This furnace was fully described and illustrated in ELECTRICAL ENGINEERING, May 21st, page 777. One claim, one figure.

10,641, E. A. MITCHELL. A device for use on the cars of a surface-contact traction system, for the purpose of indicating when any stud is not disconnected from the main conductor when the magnetic influence of the collector is removed. A brush or collector consisting of several sections, the distance between the sections being less than the width of a stud, is trailed behind the car. If this brush touches a live stud, a bell rings on the car. Short-circuiting between stud and rail on rounding a curve is avoided by the sectioning of the brush, as alternate sections of the brush are connected to different warning circuits. Four claims, two figures.

13,543, J. S. HIGHFIELD. A coin-operated switch for use in small installations, where the cost of a meter is too high in comparison with the cost of the rest of the installation to make the connection of the consumer practicable. The insertion of a coin connects the consumer's installation to the supply mains for a definite period. The supply is cut off either by means of a clockwork or an electromagnetic device after the lapse of the defined period. The amount of current which the consumer can take is limited by a suitable device. Three claims, one figure.

15,451, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). This specification gives further details of the process of manufacturing tungsten and other filaments, which was described in ELECTRICAL ENGINEERING, May 14th, page 738. The plastic mixture of tungsten powder and cadmium-mercury-bismuth alloy is squirted through a diamond die at a temperature of from 100° to 150° C. The resultant wire is pliable and tough, and of a smooth silver-white appearance. The wire is cut into lengths and bent into loops, which are then baked in a vacuum. The mercury and cadmium are evaporated, but the bismuth remains. The bismuth is driven out by passing a low current through the filament for 10 or 15 seconds, and the residue is then sintered together by passing a current through the filament, equal in value to the normal running current of the filament, for 15 to 30 seconds. Three claims, no figures.

21,299, E. BELLINI AND A. TOSI. The system of directive wireless telegraphy with closed oscillation circuits, described in ELECTRICAL ENGINEERING, Vol. II., page 771, and also in the issue of March 5th, 1908, page 348. Four claims, five figures.

28,427, E. B. RAYMOND AND H. M. RAMP. In the manufacture of oil-tight casings for oil insulated transformers, it is usual either to use sheet-iron sides and a cast-iron base, the joint at the base being made with solder or babbitt metal poured into a groove in the casting, or to construct the sides and base in a single casting. In the former case the joint is rarely oil-tight, and in the latter case the casing is heavy and difficult to cast. According to the present invention the base is cast on to the sheet-iron sides, so that the edge of the sheet-metal is fused and amalgamated with the cast metal. Two claims, four figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Summaries of the more important of these patents will appear in our next issue.

1907 Patents

6,092, TAYLOR. Systems of electrical distribution.
8,562, PAWECK. Electro-deposition of zinc.
10,699, MARRIOTT. Pitch product for cable trenches.
10,719, MAYES, & FERRANTI, Ltd. Motor starters.
10,955, POTTER. Telephone switch mechanism.
11,271, MUIRHEAD. Hertzian wave telegraphy.
11,586, NICHOLLS & NICHOLLS. Contact breakers for inductor coils.
11,466, LA COUR. Starting, connecting up, and controlling the speed of combinations of induction motors.
11,476, KAY. Generators and motors.
11,594A, ALLGEMEINE ELEKTRICITÄTS GES. Electric motors for rolling mills.
11,979, DEUTSCHE BECK BOGENLAMPEN GES. Electrode for arc lamps.
12,253, BECK, AND DEUTSCHE BECK-BOGENLAMPEN GES. Alternating current electromagnet.
12,563, JULLIEN & DESSOLLE. Method of rendering electrolytic copper homogenous.
14,638, TAYLOR. Medical batteries.
15,602, LAKE (*American Railway Signal Co.*). Signalling systems for railway cars.
16,778, WRIGHT. Printing telegraph receivers.
18,259, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric heating devices.
18,670, MEYER. Transmitting signals by means of alternating currents.
18,742, HEYS (*Scott Electrical Co.*). Arc lamps.
19,546, CODD. Magneto-ignition apparatus.
19,697, VON KANDO. Suspension of electric motors for electrically-propelled vehicles.
20,202, SIEMENS BROS. DYNAMO WORKS, Ltd. (*Siemens Schuckertwerke Ges.*). Rotary converters.
20,814, BRITISH INSULATED AND HELSBY CABLES, Ltd., & ALLEN. Cable connecting devices.
21,167, PIRDSCHUN. Switches for electric circuits.
22,605, SIEMENS BROS. DYNAMO WORKS, Ltd. (*Siemens-Schuckertwerke Ges.*). Systems of electric power-transmission for driving ships' propellers.
22,808, POPPE. Contact breakers for internal-combustion engines.
23,239, BERGMANN. Electric switches.
24,023, CLYMER & WOODHOUSE. Electro-medical apparatus.
24,671, SIEMENS-SCHUCKERTWERKE GES. Arrangements on meters for determining the maximum consumption.
25,792, STRATTON, BEAVER, & CLAREMONT. Joint boxes for electric cables.
25,967, LINCOLN. Load equalisers for alternating current supply circuits.
27,284, LOUTZKY. Automatic reversing gear for motors.
27,385, COWPER-COLES. Electrodeposition of metals.
27,739, JANECEK. Arc lamps and electrodes.
28,451, HERRMANN. Method of lengthening the life of electric incandescent lamps.

1908 Patents

1,231, KAUFMANN. Manufacture of metallic paper or tinfoil substitute.
2,569, RAWLINGS & SMITH. Supporting incandescent lamps and reflectors therefor.
2,943, PICKARD. Oscillation receivers.
3,556, GELL. Automatic telegraphic instruments.
8,746, AUGER. Manufacture of incandescent filaments.
9,023, DENIÉPORT. Electric condensers.
9,552, BROWN. Block signalling apparatus.

Complete Specifications open to Public Inspection before Acceptance.

1908 Patents

7,586, JONES. Electrically-operated signals.
8,421, WOLFRAM-LAMPEN AKT.-GES. Filaments for incandescent lamps.
9,233, ALLEGEMEINE ELEKTRICITÄTS-GES. Process for extracting nitrogen peroxide from nitric oxide air mixtures.
9,569, JAEGER. Electric wire poles or masts.
10,211, POLLOCK & WERD. Insulators for telegraph wires.

Application for Amendment

Further particulars and instructions as to procedure in opposition to amendment will be found in the Official Journal of the Patent Office of May 27th.

23,988 of 1907. FRANCIS HARRISON seeks leave to amend his application for Letters Patent numbered as above, for "Process for producing tungsten metal combinations," by including C. H. DORMAN, electro-chemist, as an applicant for a Patent.

Expiring Patent

The following patent expires during the current week, after a life of fourteen years :—

11,069 of June 7th, 1894. ALEXANDER MUIRHEAD. Improvements in automatic transmitting apparatus for use with submarine cables. An adjustable revolving commutator or graduated cam, in a local circuit with an electromagnet, controls the movements of the contact-making levers so that the relative durations of the battery and earth contacts may be varied without stopping the mechanism. The commutator or cam is also utilised for the purpose of transmitting "curbing" currents.

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A SELF-SYNCHRONISING ROTARY CONVERTER

THE 600 kw. rotary converter which the British Westinghouse Electric and Manufacturing Co. have installed in the Cathedral Street sub-station of the Glasgow Corporation Electricity Department is of interest as embodying a method of starting up from the alternating side, by which the machine is self-synchronising when thrown upon the line. The set, which is illustrated, together with its transformer and starting gear, in Fig. 1, converts from 25-period, three-phase, 6,000-volt current to direct current at from 470 to 600 volts, for lighting and power supply.

Starting is effected from the alternating side, and the machine is self-synchronising when thrown on to the line. To start it, it is only necessary to close the high-tension switch and turn the hand-wheel of the controller (seen between the rotary and the transformer in the figure) first to the starting position and then to the running position. The set can be brought up to speed ready to supply direct current in from 30 to 40 seconds.

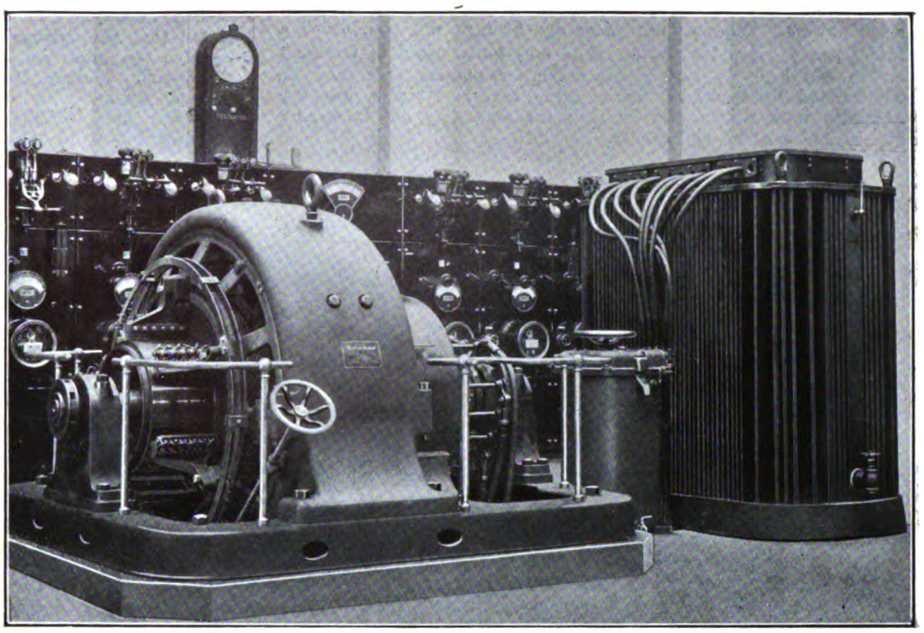


FIG. 1.—600 KW. WESTINGHOUSE ROTARY CONVERTER WITH SPECIAL STARTING DEVICE. CATHEDRAL STREET SUB-STATION, GLASGOW.

The machine is provided with an *amortisseur* specially designed to give a good starting torque. It is able to start and run up to synchronous speed with no more than one-fifth of the normal voltage on the slip-rings. This low voltage at starting, which is obtained from tappings on the transformer, is an important feature, as it enables the starting current to be kept down to the full load value, and there is no sparking or burning of the brushes during starting, such as commonly occurs when a high-voltage rotary is starting up from the alternating-current side.

The diagrams of connections in Fig. 2 shows the connections of the controller in the "off" position, starting position, and the running position. It will be seen that in the starting position only three phases at a reduced voltage are thrown on the slip-rings. The machine starts up, excites itself, and goes into synchronism. The controller is then thrown over to the running position, and if the polarity is reversed this can be rectified by momentarily exciting the shunt field from the station bus-bars.

The direct-current voltage can be varied over a range from 470 to 600 volts by means of the field-rheostat of the alternating-current booster, without affecting the power factor. The latter can be adjusted independently throughout the entire range of voltage by regulating the field resistance of the rotary. This booster consists of a small alternating-current generator, mounted between the slip-rings and the machine itself. No additional brush-gear or moving contacts are necessary, however, as the rotating armature of this generator is connected on one side to the slip-rings, and on the other side to the armature windings of the rotary. The fields of the booster are excited from the direct-current side of the rotary, and may be arranged with series turns to compensate automatically for load variations; or it may give a regulation curve similar to that of the generators with which it has to run in parallel.

The ability to vary the power factor and direct-current voltage independently is of great importance, as a leading current can be drawn from the line to compensate for lagging currents in other apparatus, or the power factor may be maintained at unity. This feature is only satisfactorily obtainable by means of the rotary converter or synchronous motor-generator. The rotary runs well in parallel with engine-driven direct-current generators, and will also act as a balancer on a three-wire system. The voltage-regulation is obtained simply by the adjustment of a field rheostat.

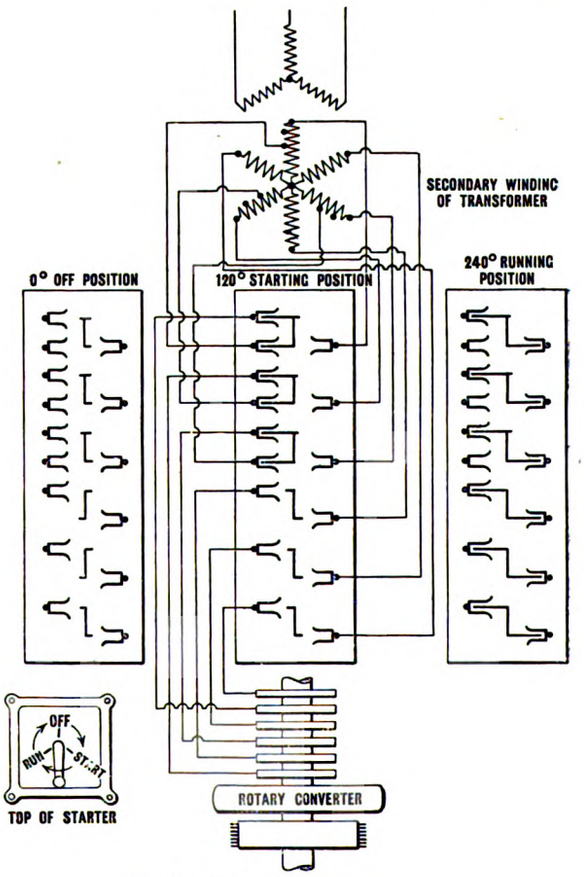
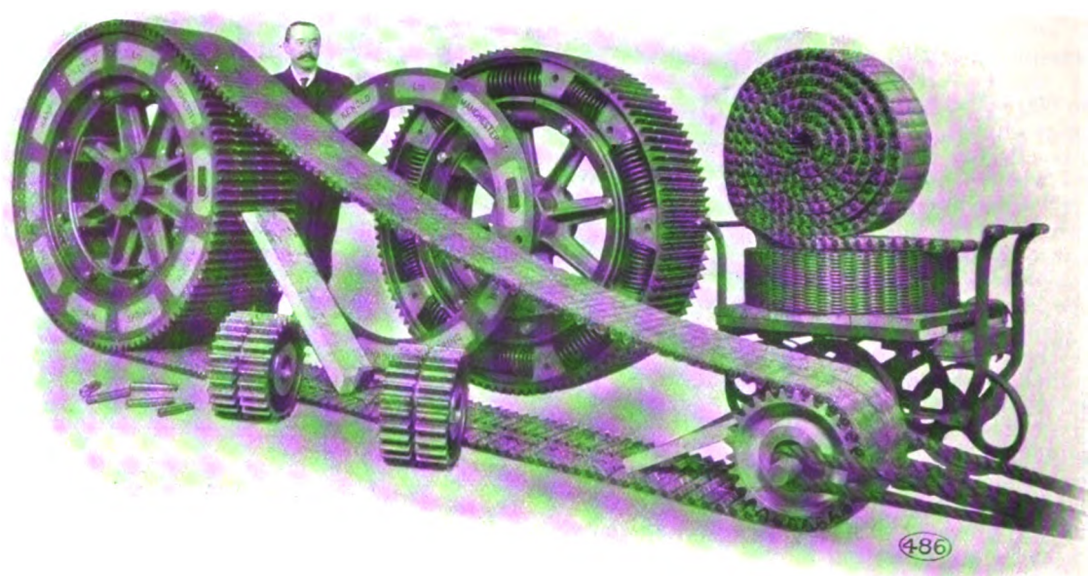


FIG. 2.—DIAGRAM OF CONNECTIONS.

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A LARGE CHAIN DRIVE

THE accompanying illustration represents the component parts of a large example of chain driving on the system of Messrs. Hans Renold, Ltd., of Manchester, and gives an idea of the advance that has been made recently in chain driving for large powers. Whereas ten years ago 50 h.p. was considered a fairly heavy drive for chains, it is now quite usual to transmit up to 200 h.p. by this means. Higher powers still may be transmitted by standard chains using several strands, but the difficulty with this method is that the load may not be evenly distributed over all the chains.



COMPONENT PART OF 200 H.P. CHAIN DRIVE.

The illustration shows two drives, each designed for transmitting 200 h.p. by two chains, and an even distribution of the load is assured by the special type of driven wheel. This wheel is of the compensating type, and consists of three main parts, viz. :—A boss with eight arms, two rings bolted to the arms, and two outer toothed rings, one for each chain. The outer and inner rings have projecting lugs, between which are fitted suitable springs. The toothed rings are independent of each other, and act separately on their own sets of springs, so that if one chain tends to take more load than the other it simply closes its set of springs until the load is equalised. In addition to this compensating effect the springs absorb irregularities in the load, so that there is less wear and tear, not only in the chain gear, but also in the electric motor, as the latter is better protected from vibration than it would be by a train of spur gearing. The cover is shown removed from one of the wheels in order that its construction may be seen; it will be noted that the springs are of two sizes, which are placed alternately; the larger set transmit the power and the smaller soften the recoil. Messrs. Hans Renold, Ltd., say that these are the largest spring wheels that have ever been made for chain driving. Each weighs about two tons. The drives are part of an installation to transmit over 500 h.p. for a coaling plant supplied by Messrs. Head, Wrightson & Co., Ltd., of Thornaby-on-Tees, for a tidal dock in Japan. The chains shown drive hauling drums from electric motors, and will be in use about 140 hours per week. The pinions have 28 teeth, and are 15¾ in. diameter; the large spring wheels have 108 teeth and are 60 in. diameter; the width being 17½ in. The driver wheel makes 286 revs. per min., and the driven 74, so the ratio is practically 4 to 1, and the chain speed 1,170 ft. per min. The chains are 1¾ in. pitch and 8 in. wide, the centre distance being 11 ft. 5 in. Each chain has a breaking load of 70,000 lb., and the total pull on the drive is 5,650 lb., giving a factor of safety of about 25 with the two strands.

THE NEW 25-VOLT TANTALUM LAMP

THE accompanying illustration represents the latest addition to the various sizes of tantalum lamps which Messrs. Siemens Brothers' Dynamo Works, Ltd., have put upon the market. The new lamp, which is made for voltages of 24 or 25 volts in the 8 and 16 c.p. sizes, has a specially strong filament, and is equally suitable for alternating and continuous currents, and can therefore be used on installations where small transformers are employed to reduce the supply voltage, or for taking advantage in the case of small isolated installations of the simplicity both in plant and wiring which can be obtained with a low voltage. They are also specially suited to train lighting. Like all the tantalum lamps they can be used in any position. As shown in the illustration, the bulb is similar in shape to that of the ordinary carbon filament lamp, but it is rather smaller in size. The price is 2s. each.



Newcastle Local Section of the Institution of Electrical Engineers.—At the final meeting of the section on Friday, May 29th, the report was read, and the officers given in the list in ELECTRICAL ENGINEERING, May 28th, page 804, were elected. The membership of the section now numbers 209. An informal discussion was afterwards opened by Mr. C. Turnbull on the subject of overload. This is reported on another page of this issue.

Telegraphs in China.—An American Consular Report submits the following information with reference to the Imperial Chinese telegraph lines, gathered from reports recently published :—At the end of 1906 the administration had a system of 22,419 miles of telegraph lines, with 34,473 miles of wires and a submarine cable of 946 miles; 379 offices, of which 62 were open for day and night service, and 317 for day service only. The number of instruments in actual use was 768. The staff of the head office in Shanghai numbered 67 and the general staff 3,175, while inspectors, linemen, &c., totalled 2,400. In addition there are many provincial lines, usually constructed by the administration, but worked and managed independently by the provincial authorities. The telegraph companies having connections with China are the Great Northern, Eastern extension, German, Dutch, and Commercial Pacific, while the French cable connects Touraine with Amoy, a German cable Shanghai with Kiachow and Chefoo, and a third cable, partly Chinese, Chefoo with Port Arthur. China also has frontier connections with Burma, Indo-China, and Russian Siberia.

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TEMPORARY RE-ESTABLISHMENT OF THE ANTWERP TELEPHONE EXCHANGE AFTER THE FIRE

AN article published in ELECTRICAL ENGINEERING on November 7th last described the total destruction by fire of the Antwerp Telephone Exchange. At a recent meeting of the Société Belge d'Electriciens, Prof. E. Piérard, read an interesting Paper, in which he gave a full account of the damage done and of the prompt steps that were taken to re-establish the telephone service on a temporary basis pending the completion of a new telephone exchange.

The exchange that was burnt down was situated in the "linen market," near the cathedral, and its construction by the Belgian Bell Telephone Co. dates back to the end of 1886. It occupied a large corner building, with the exception of the ground-floor, which was let as shops. The offices were on the first-floor, the protective apparatus and workmen's quarters on the second, and the switchroom on the third.

The switchboards were of the single-wire series multiple type, built up in detached sections to suit space and lighting, as the building had not been originally designed for a telephone exchange. There were 47 local and trunk positions. The building was surmounted by a derrick of the type usually employed in Belgium, angle-iron frames braced together by thinner horizontal angle pieces, which carried the insulator bolts. On this derrick terminated 4,528 bronze wires of 1·4 mm. diameter (No. 17) and 30 per cent. conductivity. These wires were led off in ten main routes, as shown in Fig. 1. It will be seen that, owing to the position of the exchange relatively to the centre of the system, the derrick was very unevenly balanced; it was therefore found necessary to counter-balance the excess of pull in one direction by erecting a central derrick.

The ultimate capacity of this arrangement had been reached, and for some years past the Administration had contemplated a new installation. To this end, a complete system of underground glazed ducts had been constructed, and 50 miles of lead-covered paper cable had been drawn in, mostly of 350 pairs. The site for a central building destined to accommodate the new installation was chosen, and the Administration of Telegraphs erected thereon two large buildings, separated by a courtyard; one was for a central telegraph station, the other for the telephone exchange. This building is about 150 ft. wide, 72 ft. deep, and 88 ft. high.

To facilitate the transfer from the old exchange to the new,

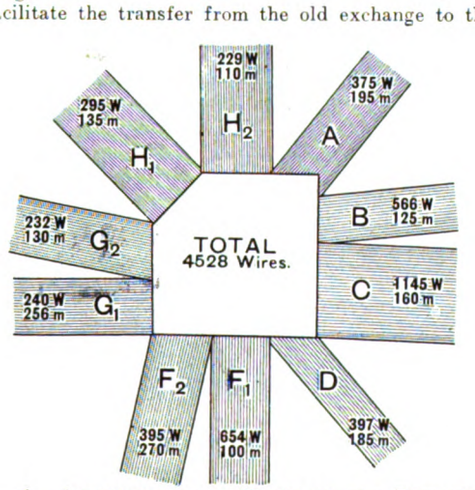
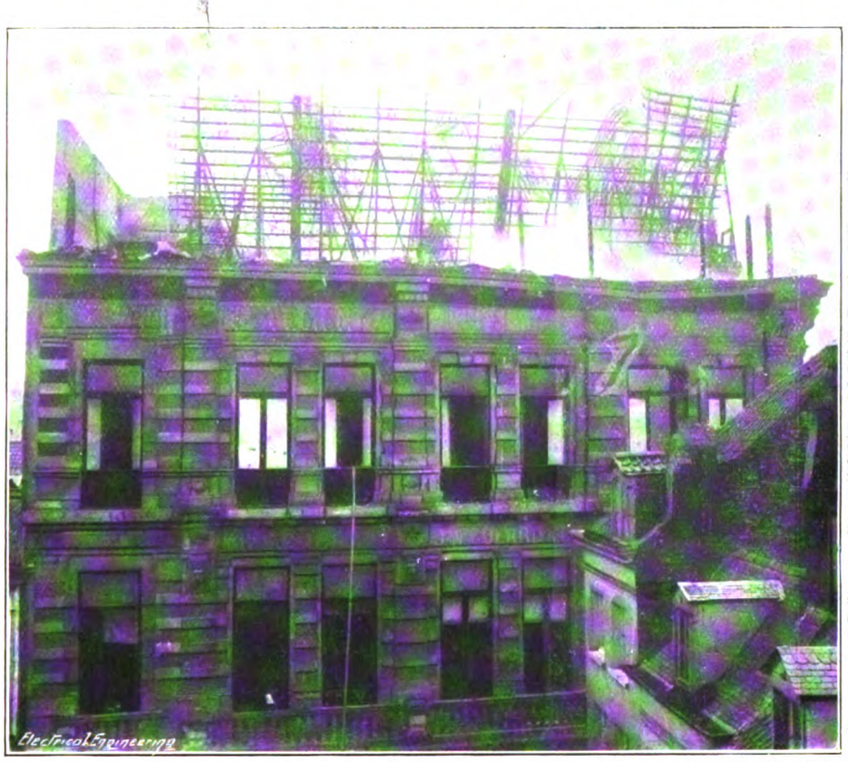


FIG. 1.—ARRANGEMENT OF WIRES ON THE DERRICK.
W = wires. m = metres.

distant about 1,000 yards as the crow flies, about 10,000 yards of 300 pair armoured cable had been laid underground.

Affairs had reached this stage, and an easy and methodical change-over was reckoned upon, when, on the night of October 28th—29th, between midnight and half-past six, the central office was completely destroyed by fire. Although the firemen arrived a few moments after the outbreak, they only succeeded in saving the first-floor—and that only partially—the old paraffined cotton cables and even the switchboards themselves had fed the fire with first-class material.

Fig. 3 shows the appearance of the derrick at about six o'clock on the morning of October 29th. Cascades of bronze wire hung from the roofs, clung to balconies and to the tram-



[Photo. by Van Eck.

FIG. 2.—THE FIRE.

way trolley and guard wires, and were inextricably entangled in the streets. Some idea of the obstruction produced around the exchange may be gained from the fact that about 11 tons of bronze wire were recovered. Fig. 4 illustrates the contortion of the iron bars of the derrick, which, on becoming overheated, were most fantastically bent and twisted.

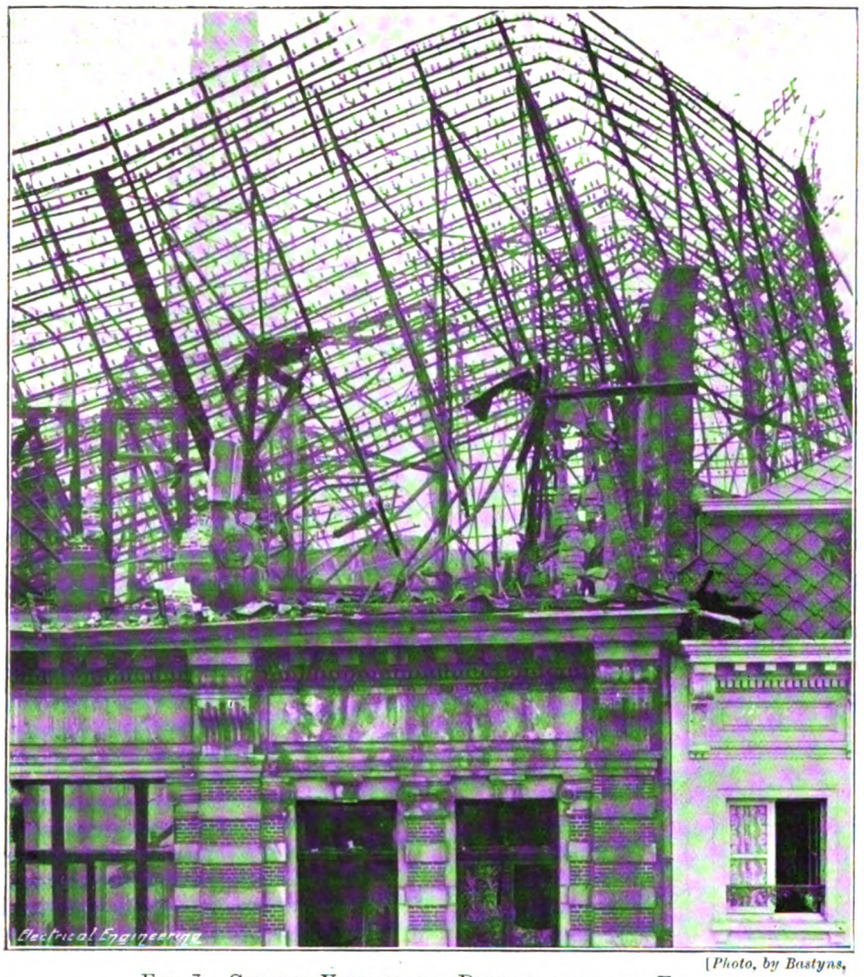
The first problem to be faced was the clearing of the main routes, and for this 146 men, collected from Antwerp, Brussels, and elsewhere, were set to work. As the streets could not be entirely closed to traffic, it is remarkable that no accident occurred in carrying this out. Around the central office the situation was even more dangerous. A stone pediment, surmounting one of the windows in the mansard roof, fell into the street and burst a gas main, thereby cutting off the supply from one portion of the town. Another work, not less important, consisted of immediately strengthening the nearest ridge-derricks, which, owing to the abnormal strain thrown upon them, threatened to give way and fall into the streets. These had to be securely stayed, and for this alone 2½ tons of iron-wire were used. From the main derrick 25 tons of iron were recovered.

The result of the fire was not only that the management found themselves suddenly deprived of their telephone exchange, but also that a gap of some 200 metres radius was left in the densest portion of the overhead system. On the same day it was decided (1) to erect close by an iron "ribbon" post from which wire stays could be run to the surrounding ridge-derricks, which had now become terminals; (2) to establish a provisional exchange in the large empty space on the first-floor of the new telephone building; (3) to set up central battery switchboards,

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which the Bell Telephone Manufacturing Co., of Antwerp, were making for the intended new installation, but to adapt them to magneto earth-circuit working, so as not to interfere with the existing 4,400 telephone stations.

To convey the lines to the new building they had to be jointed at the terminal ridge-derricks to india-rubber wires or cables. On the necessary permissions being obtained, these



[Photo. by Bastyns.

FIG. 3.—GENERAL VIEW OF THE DERRICK AFTER THE FIRE.

were led into the lofts and connected to protectors, the latter being in air-tight cast boxes containing 50 or 25 pairs of 3-ampere fuses with mica-carbon lightning arresters and self-induction coils to protect the cables. From these boxes are run the armoured paper cables connecting with the existing underground work. The necessary armoured cable for this purpose was not, however, in stock and would have taken a considerable time to make. Arrangements were consequently made with Messrs. Felten & Guilleaume, the contractors for the cables for the new Antwerp underground scheme, to withdraw the cables already laid as described above, and this was done chiefly at night. In all 31 protection boxes of 50 pairs and two of 25 pairs were installed. The I.R. cables connecting these to the derricks have a total length of 1,900 metres, and the armoured cables going to the trenches measure 2,186 metres. Each of these cables contains 300 pairs, thus giving 600 single wires. They end on the second-floor of the central office on cable-heads, which had been fitted before the fire, whence I.R. wires run to the temporary distributing frame erected immediately underneath on the first-floor.

The cable-heads are composed of rectangular boxes, of which the two opposing vertical sides are of ebonite and the two others cast-iron, and inside which the wires are spread out after the cable has passed through an air-tight gland. The ebonite partitions of the box are provided with the necessary number of terminals, to which are joined the conductors of the cable, the whole being then filled up with melted paraffin and the lid closed. The terminals are connected externally by the wires going to the switchboards.

Naturally, it was not practicable to follow out the plan above described in the case of all the subscribers. An important group of these were situated immediately around the new exchange, and on the side farthest from the old one. It would, therefore, have been illogical to run back to the old exchange and return towards their starting point. Also, owing to the fortunate circumstance that the new office, being very high, overtopped the buildings around, it became easy to join up a large number of lines to three ridge derricks on the roof, carrying 945 wires. By cutting these wires, doubling the insulators, and running in to the exchange, 945 subscribers' circuits were obtained fully equipped. The wires ending on the opposite side were connected by aërial wires to circuits coming from the direction of the old exchange, and by this means 1,797 subscribers were easily joined up. As in the case above mentioned, these circuits were protected by 3-ampere fuses, lightning arresters, and 0·5 ampere heat-coils. The protection boxes are joined to four 300-pair cable-heads, from which start armoured cables ending in four similar cable-heads in the cross-connecting room. In view of the temporary nature of the installation, an intermediate distributing frame was dispensed with.

Prompt steps were taken to re-establish the inter-urban and international trunk lines, and this was accomplished in two or three days so far as the Post Office and other public offices were concerned.

Starting from the main distributing frame the Bell Telephone Manufacturing Co.'s work commenced. An ingenious plan was devised for utilising the metallic circuit central battery boards for earth-circuit magneto-call working, in such a manner that jacks, relays, and lamps should eventually form part of the final arrangement. This is illustrated in Fig. 5. From an ordinary magneto station the line L, after passing through the distributing frame, comes on to the multiple jacks J, and ends on the local jack j. The rings of all these jacks are connected together and to the cut-off relay R with earth-winding. The armatures V_1 V_2 of this relay are, when at rest, in contact with wires joining on one side V_1 to the armature V_3 of the line relay r, and on the other side V_2 to the long row of jacks j, J. When the subscriber turns the handle of his magneto, the relay r attracts the armature V_3, and this closes a circuit from the 11-cell storage battery B through the winding Rp of the pilot relay, the 120-ohm 12-volt line lamp, L, a 60-ohm resistance, the armature V_1, and the relay r. The latter retains

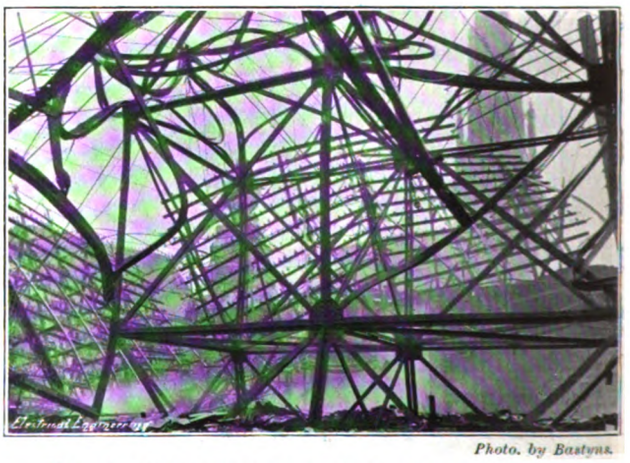


Photo. by Bastyns.

FIG. 4.—CONTORTION OF SOME OF THE IRON-WORK.

V_3 energised, at the same time that the line lamp L glows, announcing the subscriber's call. A current splits also by V_2 over the subscribers' line, but as it is constant it may be dis-

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regarded. Between the pilot relay and the line lamp is another shunt circuit conveying the current to the 24-volt 120-ohm pilot lamp, the other side of which is joined to a switch C, which can be turned to earth (as shown) or to the earthed relay (lower position). It will be seen that, on the relay acting, the bell, S, is actuated by the ringing generator. Whatever the position of C the pilot lamp lights at the same time as the line lamp. The lamp and pilot relay are common to all the lines served by one operator. At Antwerp, 120 to 140 lines, according to traffic, terminate at the position. If matters rested here, the working would be imperfect and might even break down if a relatively large number of subscribers called simultaneously. The 30-ohm winding of the pilot relay is traversed at the first call by a current of more than 0·1 ampere, giving rise to a loss of voltage of 3 volts. With each supplementary call a fall of 3 volts results, so that very soon the lamps glow insufficiently and the relays do not work. This difficulty is overcome in the following manner:—When the calling current passes through the 30-ohm coil of the pilot relay, as we have just seen, the armature, V_4, being attracted, sends a current from the battery through the second (250 ohm) winding of the pilot relay. The latter in turn attracting its armature, V_5, shunts the 30-ohm winding by another of 0·38 ohm, so that the joint resistance falls to about one-hundredth of the original, and the loss of voltage between the battery, and L falls in the same proportion. This complicated triple-wound relay has recently been replaced by a simple single-wound one of 1·25 ohm minimum; the resistance being slightly greater, three are fitted per operator's position.

When the operator answers the call by inserting the answering plug F_1 (fixed on a three-way cord) into the local jack j, the tip 1 of the plug makes contact with the short spring 1, the barrel of the plug 2 with the long spring 2 joined to the line wire, and the sleeve 3 with the bush of the jack j. The sleeve is, by means of the flexible cord, connected to the negative pole of the battery through resistances of 40 and 83·5 ohms. A current, therefore, flows through the cut-off relay R, and its armatures are attracted; the relay r becomes inert, its armature is released, and the line and pilot lamps are extinguished. On opening the listening key Ce, the operator shunts the subscriber's line by a two-microfarad condenser, her receiver and one of the three windings of an induction coil (the other side to earth), the primary of which, containing the microphone m and a 165-ohm self-induction coil, is fed by the battery.

On receiving the number from the subscriber, the operator makes the "engaged" test in the usual way by touching the bush of the multiple jack of the wanted subscriber with the tip 1 of the calling plug F_2. If the number is engaged, the bush is connected to the negative pole of the battery and a current flows through the tip of F_2 and the key Ca, Ce to earth by the third winding of the induction coil, producing by induction a "click" in the receiver. If, on the contrary, the line asked for is disengaged, the bushes of all the jacks are at earth potential and the operator hears no sound. It will be noticed that a 260-ohm relay is inserted in one of the wires connecting the ringing generator to the ringing keys Ca. Its armature closes the battery circuit of a lamp, and this "calling pilot lamp" glows. If, owing to a break in the circuit, the lamp does not glow, the operator knows that the line is out of order. A drop indicator D, inserted in the speaking circuit, shows the finish of the conversation. By the combination of sections comprising ten operators' positions of 120 subscribers, 26 of 140 subscribers, a section for transmitting telegrams to and from subscribers, an intermediate section of three positions, and the one-third end sections are included in the suite.

Two batteries of eleven Tudor accumulators of 3,600 ampere-hours' capacity have been installed, which can be charged through a large white marble power-board from two groups of motor-generators, of which one is held in reserve. The motors are supplied with current at 220 volts by the Antwerp Electricity Co., and at full load take 110 amperes; the generators give out 600 amperes at 30 volts, and the voltage can be increased to 38 for charging the cells. The calling is done by means of two small induction motor-generators. One is fed from the accumulators at 22 volts, the other, serving as a reserve, is supplied at 220 volts by the Antwerp Co. Both give out 2 amperes at 75 volts with a frequency of 16.

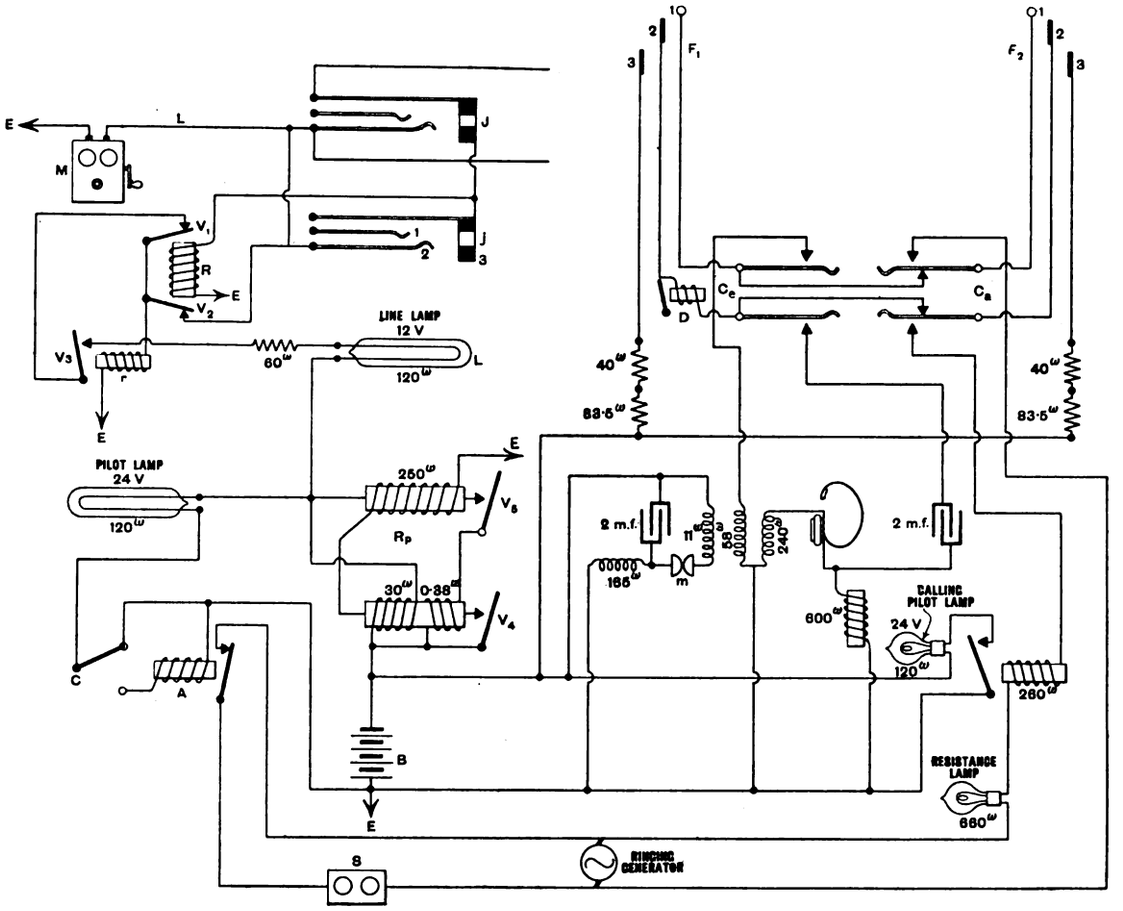


FIG. 5.—CONNECTIONS OF SUBSCRIBERS' BOARD.

The following figures give some idea of the extent of the work of mounting, testing, and adjusting. There are 77,400 jacks, 5,046 lamps, 1.219 keys, and 10,002 relays. The total length of cables between the distributing frame and the switchboards is 1200 metres that of the I.R. wires, 12,00 metres; 8,904 cable ends were cut and soldered, representing a length of 60,800 metres, and necessitating over 687,800 joints. The Bell Company had 150 persons working day and night. On Sunday, December 1st, the temporary exchange was brought into use without a hitch. The interruption to the service had lasted exactly 33 days, and the working of the system is found to be more satisfactory than that of the old exchange.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ltd.	10	7	7	10¼—11	
Do. 4½% Cum. Pref.	10	4½	4½	9⅛—10⅝	
Do. 6% Cum. Second Pref.	10	6	6	10½—11	
Do. 4½% Debenture, Red.	Stock	4½	4½	10⅛—105	
Bromley (Kent) E. L. & Power Co., Ltd.	5	5*	5*	4½—5	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	94—97	
Brompton & Kensington E. S. Co., Ltd.	5	10	10	9⅛—7½	−¼
Do. 7% Cum. Pref.	5	7	7	6¼—7¼	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4	97—100 xd	−2
Ch. Cross, W. E. & City E. S. Co.	5	5	5	3¼—3¾	
Do. 4½% Cum. Pref.	5	4½	2½	4⅛—4⅜	
Do. 4% Deb. Red	Stock	4	4	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½	3¾—4¼	
Chelsea Electric Supply Co., Ltd.	5	4½	4½	3—3⅛	−⅛
Do. 4½% Deb. Red	Stock	4½	4½	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6	9—10	−¼
Do. 6% Cum. Pref.	10	6	6	12—13	
Do. 5% Deb. Red	Stock	5	5	124—127	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	102—105	
Cty of Durham E. P. Dis. Co.	5	4	2½	2½—3	
Do. 5% Pref.	5	5	5	3¾—4¼	
County of London Elect. Sup. Co. Ltd.	10	5	5	7⅞—8⅛	−⅛
Do. 6% Cum. Pref.	10	6	6	10⅜—10⅝	−⅛
Do. 4½% Deb. Red	Stock	4½	4½	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	97—100	+1
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	⅛—1	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	65—75	
Folkestone Elec. Supply Co., Ltd.	5	5½	5½	4¼—5¼	
Do. 5% Cum. Pref.	5	5	5	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½	6—6¼	−¼
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½	90—93	
Kensington & Knightsbridge E. L. Co.	5	10	10	7—8	
Do. 4% Deb. Red	Stock	4	4	96—99	
Kens. & N'tng Hill E. L. Cos. Db. Rd.	Stock	4	4	97—101	
London Electric Supply Corporation	3	4	2½	⅜—1⅛	−⅛
Do. 6% Pref.	5	6	6	4¼—4⅝	−⅛
Do. 4% 1st Mort. Deb. Red	Stock	4	4	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	8	6½	4⅜—4⅝	
Do. 4½% Cum. Pref.	5	4½	4½	4⅜—4⅝	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D	100 & 500	4½	4½	96—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4½	7¼ 8¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	8½	5¼—6	
Do. £2 Pm.	5	8	8½	5¼—6	
Do. 5% Pref. (fully paid)	5	5	5½	5¼—5½	
Do. 10/- Pm.	5	5	5½	5¼—5½	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7½	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7½	5¾—6¼	
Do. 4% Deb. Red.	Stock	4	4½	94—98	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10½	7¼—8¼	
Do. 7% Non-Cum. Pref.	5	7	7½	6¾—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	¼—¾	
Do. 4% Deb. Red	Stock	4	4½	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4½	2¼—2⅞	−⅛
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅝—⅞	
Do. 7% Cum. Pref.	1	7	7½	1 1/16—1 1/16	
Do. 4½% 1st Deb. Red	Stock	4½	4½	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5½	1—2	
Do. 5% Cum. Pref.	5	5	5½	1⅞—2¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10½	7¼—8	
Do. 4½% Cum. Pref.	5	4½	4½	4¾—5¼	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4½	88—91	
Central London	Stock	4	3½	81—84	+1
Do. 4% Preferred	Stock	4	4½	90—92	
Do. Deferred	Stock	4	2½	64—67	+2
Do. 4% Debentures	Stock	4	4½	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4½	81—84	
City and South London Cons.	Stock	2⅝	4 1/16	40—42	+1
Do. 4% Perp. Deb.	Stock	4	4½	100—103	
Do. 5% Perp. Pref. 1891	Stock	5	5½	113—116	
Do. 5% Perp. Pref. 1896	Stock	5	5½	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5½	110—113	
Great Northern & City Pref. "A"	10	4	11 1/16d.	¾—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4½	6—7	
Do. 4% Perp. Deb.	Stock	4	4½	87—90	
Mersey Cons.	Stock	nil	—	1—3	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1½	43½—44½	
Do. 3½% Preference	Stock	3½	3½	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½	75—78	
Do. 3½% Convertible Pref.	Stock	3½	3½	73—76	
Metropolitan District	Stock	nil	—	14—15	+1½
Do. 6% Perp. Deb.	Stock	6	6½	114—119	+4
Do. 4% Deb.	Stock	4	4½	70—75	+1
Do. Perp. Extension Pref. (5%)	Stock	nil	—	23—28	+3
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5½	39—43	
Whitechapel and Bow 4% Deb.	Stock	4	4½	103—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-	⅜—⅝	
Do. 5% Cum. Pref.	1	5	5½	⅜—⅝	
Do. 4½% Deb. Red.	Stock	4½	4½	88—90	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½	93—96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅝	−⅛
Do. 6% Cum. Pref.	10	6	6½*	3⅝—4⅛	−⅛
Do. 5% Perp. Deb.	Stock	5	5½	91—95	+3
Do. 4½% 2nd Deb.	Stock	4½	4½	71—75	+3
City of Birmingham Trs. Co., Cm. Pf.	5	5	5½	4¼—4¾	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4½	97—100	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%	%		
Dublin United Trams Co.	10	6	6½*	12½—13½	
Do. 6% Pref.	10	6	6½	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½	94—97	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1½	—	⅜—1⅜	
Do. 4% Deb.	Stock	4	4½	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5½	91—94	
London Street Tramways Co.	4	4/9	4/6	1 3/16—1 1/16	
London United Trs., Ld., Cm. Pf.	10	5	5½	7—8	+½
Do. 4% 1st Mort. Deb. Red	Stock	4	4½	80—85	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	1/16—⅛	
Do. 5% Cum. Pref.	1	5	5½	1⅛—1⅜	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½	94—97	
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—½	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅛—1	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	½—⅝	
Do. 3½% Mort. Deb.	100	3½	3½	89—92	
Potteries Electric Traction Co. Ltd.	1	4	4½	¾—1	
Do. 5% Cum. Pref.	1	5	5½	⅜—½	
Do. 4½% Deb. Red	Stock	4½	4½*	91—94	
Provincial Tramways Co. Ltd.	10	3½	4½	4⅜—5⅛	
Do. 6% Cum. Pref.	10	6	6½	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6½	¾—1	
Do. 4% Deb. Red	Stock	—	4½	77—81	+1
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5½	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	1—1¼	
Do. 6% Cum. Pref.	5	nil	—	3¼—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	59—62	+1
Do. 6% Pref. Ord.	Stock	6	30/-*	104—106	+2½
Do. Def. Ord.	Stock	1¾	1%	16½—17	−¼
Commercial Cable Co., 4% Deb. Red.	Stock	4	4½	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4½	3¼—3½	
Do. 10% Cum. Pref.	5	10	10½	8—9	
Do. 4½% Debs.	50	4½	4½	100—103	+½
Direct United States Cable Co. Ltd.	20	4¼	4/-*	13½—14	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½	100—102	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4½	100—102	+½
Do. do. (Mauritius Sub.)	25	4	4½	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12⅜—13¼	
Do. 4% Mort. Deb. Perp.	Stock	4	4½	100—102	
Eastern Telegraph Co.	Stock	5⅜	7½	130—135	+1
Do. 3½% Pref.	Stock	3½	3½	83½—86½	+½
Do. 4% Mort. Deb.	Stock	4	4½	100—102	
G. N. Tel. Co. (Copenhagen)	10	20	20½	27—29	−1
Indo-European Telegraph Co. Ltd.	25	13	65/-	52—55	−1
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	+⅛
National Telephone Co., Ltd., Pref.	Stock	6	6½	108—110	
Do. Deferred	Stock	5½	6½	109½—111½	
Do. 6% Cum. 1st Pref.	10	6	6½	10½—12½	
Do. 6% Cum. 2nd Pref.	10	6	6½	10½—12½	
Do. 5% 3rd Pref.	5	5	5½	5⅛—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	99—101	+½
Do. 4% Deb. Red.	Stock	4	4½	101½—103½	
Western Telegraph Co., Ltd.	10	7	7½	12¾—13⅜	
Do. 4% Deb.	Stock	4	4½	100—102	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅛—⅜	
Do. 6% Cum. Pref.	1	6	6½	⅝—⅞	+3/16
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅝—3¾	
Do. 6% Pref.	1	6	7½d	1 1/16—1 1/16	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	5¾—6¼	−⅜
Do. 6% Cum. Pref.	5	6	6½	5¾—6¼	+½
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	93—98	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	1/16—1 1/16	
Do. 4% Mort. Deb. Red	Stock	4	4½	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	1/16—1/16	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	70—75	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½	55—60	
Callender's Cable and Const. Co., Ld.	5	15	15/-	9⅜—10⅜	−⅛
Do. 5% Cum. Pref.	5	5	5%	5¼—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	107—109	+½
Consolidated Electrical Co., Ltd.	1	3	3½%	⅛—⅜	
Crompton & Co., Ltd.	3	5	5%	1⅜—1⅝	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5½	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1 1/16—1 1/16	
Do. 6% Cum. Pref.	1	6	6½	1—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	+1
Edison & Swan United "A." £3 paid	5	4½	2/6	⅜—¾	
Do. do. (fully paid)	5	4½	4/2	1½—2⅜	
Do. 4% Deb. Red.	Stock	4	4½	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5½	85—87	
Electric Construction Co., Ltd.	2	—	—	¼—⅜	
Do. 7% Cum. Pref.	2	7	—	1¼—1½	
Do. 4% 1st Mort. Deb.	Stock	4	4½	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5½	7⅜—8⅛	
Do. 4% 1st Mort. Deb. Red	Stock	4	4½	87—89	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15½	10½—11⅛	
Do. 4½% Cum. Pref.	5	4½	4½	4⅜—5⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	104—106 xd	−2
I. R. & G. P. Co., Ltd.	10	10	10½	15½—16½	
Do. 4% Deb. Red.	100	4	4½	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	29—31	
Do. 4% Deb. Bds. Red	100	4	4½	101—103	
Willans & Robinson, Ord. Shres	1	nil	5½	⅜—1⅛	
Do. 6% Cum. Pref.	5	nil	6½	3⅜—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	70—74 xd	−2

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LONDON ELECTRIC POWER BILLS

OUR report last week ended with the proceedings of Tuesday, May 26th, when the case for the Stepney Borough Council against the Bill was being heard.

WEDNESDAY, MAY 27TH.—(FOURTEENTH DAY.)

STEPNEY (*continued*).

Mr. W. C. P. TAPPER, the Borough Electrical Engineer, was cross-examined, and he admitted that in comparing the price that the Administrative Company had proposed to charge Stepney with the prices chargeable under the present Bill, he had taken the maximum prices instead of the proposed charges to authorised distributors, but he was still of opinion that they would show a substantial loss to the Borough Council when the cost of distribution was added to the price paid the power company. Other questions by Mr. Clode were to the point that in his estimates Mr. Tapper had assumed that he purchased current at 25 per cent. load factor and sold at the same load factor, thus making no allowance for diversity amongst the various consumers' loads. Mr. Tapper said the load factor on the Stepney works was 25 per cent., to which Mr. Clode retorted that obviously the consumer's load factor was less.

ST. PANCRAS AND SHOREDITCH.

Mr. COURTHOPE MUNROE, in presenting the case for these two boroughs, dealt first with St. Pancras. He gave the history of the undertaking, in which the capital expenditure amounts to £500,000. Last year no less than £18,000 had been paid in relief of rates. The prices for power were 1d. per unit, or the original terms proposed by the Administrative Company, viz., £4 per kw., and 0·5d. per unit. There were 443 power consumers, and of the 6,670 h.p. in the borough the Council supplied one-half. One and a half million units were sold last year for power purposes, and the average load factor of the power consumers was 20 per cent.

With regard to Shoreditch, the average power consumer was 5 kw., and the load factor 15 per cent. The charges were £4 per kw., and 0·75d. per unit up to 75,000 units, and £4 and 0·5d. per unit for all consumption over.

In St. Pancras Messrs. Maple and Messrs. Chappell had been mentioned; but Messrs. Maple, who had a steam plant generating at 1¾d. per unit, had persistently refused an offer from the Borough Council at 1d. per unit, and Messrs. Chappell, on the other hand, were taking a supply from the Council at 1d., and in consequence of the Council's electricity department having materially assisted the company in the installation a letter of thanks was written. It appeared that Messrs. Chappell had signed the circular mentioned by Mr. Conradi (ELECTRICAL ENGINEERING, May 28th, p. 827), under an impression that they would get a supply at ½d. per unit. Counsel then mentioned a number of consumers who had elected to be charged at £4 per kw., and ½d. per unit, but, when their account was presented, they found that the cost worked out at very much higher than 1d. per unit on the flat rate. They had all been put back upon the 1d. scale. The whole secret of the matter was low-load factors, and such consumers would be no better off under the Bill. On the question of competition under the clause which allows 20 per cent. of the energy for power to be used for lighting, counsel said that this 20 per cent. for lighting at power rates had been offered to power users by the Council, with the result that the price for lighting had been considerably reduced. The firms in Shoreditch upon the list put in by Mr. Conradi had in all cases refused a supply from the Borough Council, even at £4 per kw. and ½d. per unit, for the reason that it would not pay them to scrap their plant. In Shoreditch, also, the 20 per cent. clause was in operation, and in some cases the price for lighting was reduced from 4d. to 1½d. per unit. In all these circumstances, he asked for a clause on the lines of that put in by Croydon, cutting St. Pancras and Shoreditch out of the area.

The CHAIRMAN asked Mr. Munroe if he had any observations to make in the event of the Kitson clause being in the Bill in substitution of the clause now in.

Mr. MUNROE thought it would only defer the competition. It would bring the Council before the Board of Trade in the case of every consumer. His argument was that the company should not be allowed to come in unless they were going to give a *bonâ-fide* benefit to somebody. His own view was that the Board of Trade, under the Kitson clause, would only have regard to the price.

Lord SAUNDERSON pointed out that the clause was wider than this, as it directed the Board of Trade to have regard to all the circumstances of the case.

Mr. SYDNEY BAYNES, Electrical Engineer to the St. Pancras Borough Council, confirmed the statements made by counsel. The average load factor of the power users there was 6 per cent., and only four had a load factor of over 20 per cent. Extensions at St. Pancras for generating plant cost about £10 per kw. without land or buildings, and on the overload capacity of the plant the cost was £7 10s. per kw. From his calculations, the Council would obtain no benefit by taking a supply from the power company. He placed no value on the figures of the promoters, because it would be about four years before the promoters could give a bulk supply. In this period, having in mind the fact that during the past four years the costs at St. Pancras had been reduced by ½d. per unit, it was reasonable to assume that some further improvement would be made during the next four years.

In cross-examination, Mr. Baynes stated that the total income of the undertaking was £72,000, of which about £7,000 was for power. With regard to competition, he thought it possible that the power company would be able to do the Council injury by offering transformed alternating current for power purposes, whereas the Council could only supply direct current. He stated that his total costs were 1·194d. per unit, and felt unable to give a reply as to whether it would pay the Council to take current from the power company at 0·5d. as he did not know what the distribution expenses would be. As a matter of fact, he thought that under no circumsances would the Council take a supply from any power company. His view of the creation of this company was that it would cause continuous dissatisfaction amongst their consumers.

Mr. C. NEWTON RUSSELL, Electrical Engineer to the Shoreditch Borough Council, said the capital expenditure upon the undertaking was £350,000, and the latest extensions at their new works cost £12 10s. per kw., including land and buildings. At present there were 6,067 h.p. of motors in the borough, and of this 64 per cent. was on the Shoreditch mains. The average size of the motors was 7 h.p., the smallest was ⅛ h.p., and the largest 120 h.p. The average load factor was 15 per cent. His opinion was that it would not pay them to take energy from the power company at the maximum prices, and although it might pay them at the present time to take at the estimated prices, it was to be remembered that the promoters could not give a supply for about three years, by which time the Shoreditch undertaking would be considerably improved. As a matter of fact, for the purpose of comparison, the promoters had taken figures relating to the boroughs which were nearly two years old whilst their own estimates were for three years ahead, so that there were five years between the two sets of figures which were being compared. Many firms in Shoreditch, he said, were under the impression they would get electricity for ½d. under the Bill.

In cross-examination, witness said the total costs at the present time were 1·19d. per unit. He admitted that if the Council were offered a supply at 0·45d. per unit, as business people they would seriously consider it.

In answer to the Chairman, Mr. Russell thought a sliding scale, limiting the amount which a power user might use for lighting would be a solution of the difficulty in connection with the 20 per cent. clause.

HAMMERSMITH.

Mr. SNOWDEN, counsel for the Hammersmith Borough Council, said that to get the supply of power to London concentrated in one spot was a dangerous position, and one which the London County Council did not permit, for instance, in regard to the Franco-British Exhibition. Here an auxiliary supply had to be taken from the Notting Hill Electric Lighting Co., and every alternate lamp was supplied from the second source.

Mr. G. G. BELL, the Engineer to the Council, said that the works occupied a site of four acres, but only one-third was occupied with buildings. The capital expenditure was between £200,000 or £300,000. At present the power supply amounted to 2,400,000 units, and the number of consumers was 176, but of this output, 1,900,000 units were supplied to fourteen consumers, and these were the very consumers which the power company would compete for. He criticised certain of the promoters' estimates. For instance, the amount for repairs he considered much too low, whilst in the second stage of the power company's undertaking, when the promoters had doubled the quantity of coal burned, they had only doubled the cost of repairs. Considering that the boilers would be worn to a considerable extent by then, this was not a correct estimate, and repairs would be much greater in proportion. On the question of charging on the basis of a sum per kilowatt of maximum demand, and so much per unit, Mr. Bell said this system had been charged in Hammersmith ten years ago, but, owing to friction with consumers, they had had to abandon it, and a flat rate was adopted. Mr. Bell had also prepared some tables to show that on the promoters' figures there would be no advantage in taking a supply from the power company, and these were handed in. The gross return on the gross liabliity of the undertaking was only 8 per cent., out of which renewals at the rate of 3·6 per cent. had to be deducted. He mentioned this as showing the small margin of profit upon which they were now working, and as indicating the weakness of their position for carrying on a keen competition with the power company.

Cross-examined by Mr. Clode, witness said the diversity factor in Hammersmith was about unity, and he thought this was about the diversity factor anywhere. He failed to see how it could be taken higher. At present their charge for power was 1d. per unit, irrespective of the load factor.

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London County Council.

Mr. FREEMAN, K.C., speaking on behalf of the London County Council, said that the Council was extremely anxious that no Bill should be passed which had not a reasonable and sound chance of success and of solving this question once and for all. If such a Bill were introduced, the Council would not stand in its way as opponents, but would only desire to stand in their proper position as safeguarding the public interest on the one hand, and the interests of those who had already spent large sums of money in the business on the other hand. Mr. Merz's Bill of 1905 was an entirely new way of looking at this question, and had been a considerable surprise to all persons connected with the electrical industry. He might say that Mr. Merz's Bill came as a startling proposition, and was one which the London County Council was not then prepared to accept, but as the result of the Parliamentary inquiry which took place upon that Bill, everybody had come to the conclusion that the proposition to give a supply in bulk from one large central station was the only way of dealing with the problem.

Having given the history of Mr. Merz's Bill of 1905 and the two London County Council Bills of 1906 and 1907, Mr. Freeman dealt specifically with the London and District Electric Power Bill. In view of the report of the Select Committee of the House of Commons of 1906, and the subsequent attitude of the London County Council, he said that the Council felt that they could not take up a position of hostility, and that the proper thing was to consider the Bill carefully on its merits, the County Council was strongly of the opinion that further delay should not take place. But as the Bill now stood it was open to very considerable objections, and he would have to ask that it should be modified in numerous very important respects. He could not criticise the area, because it was the area suggested in their own Bills; he did not criticise the site of the generating station, because it was the same as that in the London County Council Bill of last year, and he did not criticise the engineering details because to all intents and purposes they were the same as their own. In fact, listening to the evidence of Mr. Hammond and Mr. Parshall, he was almost tempted to believe that they were dressed in Mr. Rider's clothes, because all their facts and evidence was based upon the information they had gained as engineers to the Council; but the County Council had no objection to this, because they wanted everything that was best for the public interest. With regard to the question of finance, the Council thought if the Committee were satisfied that the financial support of the Bill was such as would reasonably ensure the promoters getting their money on proper terms, and being able to carry out the work, they did not desire to stand in the way at all. At the same time he would remark that the financial evidence was a very long way short of that behind the Administrative Company's Bill, and behind that of a public authority. The Council was satisfied with the maximum prices in the Bill. Coming to the clauses he desired to criticise, in the first place the Council thought there should be strong provision in the Bill to prevent it acting as a block Bill to other schemes. The promoters said they could get their money easily and could push forward the scheme, and he would ask that a substantial amount of money should be obtained within twelve months, and a substantial commencement of works be made within two years instead of the five years in the Bill. In his cross-examination of the promoters' witnesses, he had mentioned the sum of £1,000,000 as being the amount which should be raised within twelve months, but, as the promoters had practically guaranteed capital to the extent of £600,000, he would be willing to accept that. Dealing next with Clauses 61, 62, 63, and 64, he pointed out that Clause 61 limited the standard dividend of 8 per cent. In Clause 62, if the profits exceeded the amount applicable to dividends, the promoters might invest the excess in an insurance fund, provided that that fund did not exceed one-twentieth of the paid-up capital. But there was no obligation upon them to make that fund, and if they did, it was not to exceed one-twentieth. By Clause 63 the promoters were enabled to create a reserve fund, to which there was no limit whatever, because they were able to put aside such as sum as they might think fit. If the insurance fund had to be created out of divisible profits before they paid their dividends, it would not have been open to the objection, but as the clause now stood the company could go on creating a reserve fund to any extent they pleased, which would act detrimentally to the public interests in certain circumstances which might arise. Clause 64 dealt, he said, with the surplus profit, and it divided them into three parts. One-third was to form a sinking fund, the second third was to go towards the reduction in the price of electrical energy, and the remaining third went towards increasing the authorised dividends on the capital of the company. This clause was an unusual clause, and in the opinion of the London County Council extremely objectionable. At the same time he admitted that it had appeared in one other Power Bill, but in one only—the Cleveland and Durham Power Bill. There was a perfectly well-recognised means of dealing with surplus profits, which occurred in gas and other Acts, and acted fairly as between the trading company and the public, namely, the well-known sliding-scale clause, by which the profits were increased in relation to the decrease in price. So far as the present clause was concerned, the company got one-third of the extra profits, and the consumer one-third instead of two-thirds, as in the gas Acts, whilst the remaining one-third went to the sinking fund, which ultimately came into the hands of the purchasers at the end of 42 years, in reduction of the price to be paid for the undertaking. In other words, the benefit which would immediately arise to the consumer under the sliding-scale clause would be taken away from him as regards a part, and held over ultimately for the benefit of posterity 42 years hence.

THURSDAY, MAY 28TH. (FIFTEENTH DAY.)

In answer to a question, the CHAIRMAN intimated that the Committee would hear the other two Bills before coming to a decision with regard to this one. We give below the text of the purchase clause as it now stands. It will be seen that it has been modified, but the negotiations with the London County Council for a compromise have fallen through.

THE PURCHASE CLAUSE AS MODIFIED BY THE PROMOTERS.

Clause 65.—The undertaking of the company shall be liable to purchase by any County Council or Joint Committee of County Councils, Body of Trustees, or other public authority or body who may be authorised by Parliament to purchase the undertaking (hereinafter called "the purchasing body"), subject to the following terms and conditions (that is to say):—

(1) (*a*) The purchasing body may, on giving not less than twelve months' previous notice in writing to the company of their intention to acquire the undertaking, purchase the same at the expiration of forty-two years from the thirty-first day of December one thousand nine hundred and eight, upon the terms of the purchasing body paying to the company a sum equal to the amount expended by the company upon the undertaking, and properly chargeable to capital account at the date of the purchase as certified from time to time by the auditor appointed by the Board of Trade under the provisions of the Principal Acts, together with such a sum (if any) as would be required to make up the aggregate amount of the dividends paid by the company up to the date of purchase to six per centum per annum upon the capital from time to time paid up after deducting from the aggregate of those sums the aggregate amount of the value of the investments and moneys representing the sinking maintenance and renewals, insurance, and reserve funds provided for by this Act; or

(*b*) The purchasing body may, on giving not less than twelve months' previous notice in writing to the company of their intention to acquire the undertaking, purchase the same at the expiration of any period of ten years, subsequent to the expiration of the said period of forty-two years upon the terms of the purchasing body, paying to the company a sum equal to the amount properly expended by the company upon the undertaking and chargeable to capital account at the date of the purchase, as certified from time to time by an auditor appointed as hereinbefore, provided after deducting therefrom the aggregate amount of the value of the investments and moneys representing the sinking, maintenance, and renewals, insurance, and reserve funds provided for by this Act;

(2) No allowance shall be made to the company for compulsory purchase, or for goodwill, or for the prospective or future value of the undertaking;

(3) In the sixth and in every succeeding year after the company commence to supply electrical energy under the provisions of this Act, they shall, before arriving at the profits of the undertaking available for dividend, set apart to form a fund (in this Act called the "maintenance and renewals fund") such sums as the said auditor may determine to be necessary to maintain the buildings, plant, mains, and apparatus of the company in an efficient and proper working condition, and to renew the same when necessary, and the company shall out of such fund maintain and renew the said buildings, plant, mains, and apparatus accordingly;

(4) If the company consider any determination of the said auditor to be incorrect or unreasonable, they may appeal thereon to the Board of Trade, whose decision shall be final;

(5) For the purposes of this section any sums so expended by the company in such maintenance and renewal shall not be deemed to be chargeable to capital account;

(6) The purchasing body shall also pay to the company for the materials and stores on hand at the date of purchase a price to be agreed on, or in the case of difference to be determined by an arbitrator to be appointed by the Board of Trade, and in addition the value of the debts due to the company the amount of the cash in hand or at the bankers, and securities for money other than those representing the sinking, insurance, maintenance, and renewals and reserve funds provided for by this Act, and the company shall discharge all debts due by the company at the date of purchase, and all liabilities with respect to any debenture stock or mortgage debt of the company;

(7) The expression "undertaking" shall, for the purpose of this section, include all rights of generating, purchasing, using, transmitting, transforming, distributing, supplying, and utilising energy, and all other rights, powers, authorities, and privileges of the company, and all such property real and personal (except investments and moneys representing the sinking, insurance, maintenance, and renewals and reserve funds provided for by this Act), and except, as aforesaid, all other interests

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and rights into and out of the property real and personal, and obligations and things in action as may be in the possession of the company or belong to them immediately before the date of purchase, and all books, accounts, and documents relating thereto, but subject to all liabilities and obligations of the company other than the debts due by the company and the liabilities with respect to the debenture stock and mortgage debt of the company;

(8) As from the date of purchase the undertaking shall be transferred to and vested in the purchasing body, and such body shall have, and may exercise, all the rights, powers, authorities, and privileges of the company, and shall to the exclusion of the company, be subject to all the duties, obligations, agreements, and liabilities of the company in like manner as if they were the company, except the debts due by the company at the date of purchase and the liabilities with respect to the debenture stock and mortgage debt of the company.

Mr. FREEMAN, continuing his speech for the London County Council, next dealt with this purchase clause. He said that, although there had never been a legal decision, the purchase terms of the Electric Lighting Acts had a definite meaning which had been construed in analogous cases. Under the clause proposed by the promoters, the decision as to the purchase price was to be put upon the auditor, anterior to the period when the actual purchase would take place, in order to make certain that investors would get their money back; in other words, the auditor had to certify each year the capital expenditure, and this sum was to be the purchase price at the end of 42 years. Mr. Fitzgerald had stated that this introduced a clearness into the clause, but he thought this so-called clearness was a mistake, and it was much better to keep to the words of the Electric Lighting Acts, namely, "the then value," or some words equivalent, and if Mr. Fitzgerald preferred, words which would indicate the meaning of "then value" could be inserted. It had been stated on behalf of the promoters that no purchase clause had appeared in any other power Act, but it must be remembered that no such area as London existed elsewhere. All the provincial power Acts included large tracts of country which were mainly pure country, for the areas of the larger local authorities had been struck out. The first Bill dealing with London had a purchase clause, and the purchase clause at first proposed by the promoters of the Administrative Bill was very much on the lines of the present one, but asked for 50 years instead of 42. To this the London County Council strongly objected, and for very much the same reasons that they were objecting now, but the clause was altered to the one in the Electric Lighting Acts. The contention of the London County Council was that the clause in the Electric Lighting Acts was intended to avoid "scrap iron" value, and was meant to ascertain the value of the electrical plant, of the buildings, and of the whole concern ready *in situ* to carry on business, but that the purchase price was not to be multiplied by so many years in order to arrive at the prospective profits of the undertaking. The clause did not mean that the machinery should be valued at so much a pound as old iron, nor the buildings at so much a ton for stone and bricks. Analogous to the Electric Lighting Acts was the purchase clause of the Tramways Act of 1870, and the famous decision given in 1895 with respect to the London and also the Edinburgh tramways laid down the principle which he had just explained as the basis of the valuation. The decision of the House of Lords in this matter was that, having ascertained the value of the rails and the various component parts of the undertaking, an amount was deducted for depreciation, but then it was held to be fair to the company that they should be repaid for the Parliamentary promotion expenses, the amount paid to local authorities, and so on. An important difficulty would arise under the promoters' clause in dealing with plant which had been superseded by something so much better before the life of original plant could have been said to have expired. Mr. Maltby for the promoters has suggested that this should be placed to suspense account, but in the modifications suggested by the promoters in the purchase clause there was no suggestion of this sort. Mr. Maltby had also suggested taking expert advice with regard to arriving at the true capital expenditure and the necessary amount which ought to have been set aside for renewals, repairs, maintenance, &c., but inasmuch as the auditor would have to bear the expense of such expert advice himself, it was conceivable that he would not go to the highest authorities.

His next point was with regard to making up the dividends to 6 per cent. by the purchasing authority if this amount had not been earned during the life of the company. As he had pointed out in cross-examination, if the company had only paid 4 per cent., the sum necessary to make this up to 6 per cent. for 42 years would be £3,750,000, and Mr. Maltby, the promoters' witness, had admitted that this would almost amount to prohibition of purchase, and had expressed the opinion that in that event the purchase could be deferred for ten years when the dividends would not have to be so made up. If this was the intention of the promoters, he thought it a curious way of drafting the Bill, and not a proper way of presenting it to the Committee. Why should the promoters be secured 6 per cent.? It would open the door to all sorts of careless management. Dealing with the period of purchase, he suggested that a provision should be made that this might take place in 1931 when all the existing companies were purchasable, provided that the power company were properly compensated for their goodwill as between 1931 and the 42 years in the clause. Mr. Parshall had stated he did not see anything untair in this, and so far as he knew, the promoters did not dissent. As to the body which should purchase, at present this was left entirely vague, and he thought it would be much better that something definite should be put in the Bill. He therefore suggested that the clause should be altered to read that the purchasing authority should be the London County Council, or such other body as Parliament might authorise. If the clause remained as at present in this respect, there would be nobody to move Parliament in the matter, and further he pointed out that the suggestion that the London County Council should be the purchasing authority was in accordance with the Report of the Select Committee of 1906. He also suggested that whatever authority was entitled to purchase, should be allowed to purchase in stock or annuity, and not necessarily in cash, for the reason that it would be very inconvenient to have to raise such a large sum of money at one time. This method had worked with the utmost success in the case of the Metropolitan Water Board.

Mr. FITZGERALD pointed out that originally all the water companies, with the exception of the New River Co., were to be paid in cash, and that the arrangement to pay them all in stock was only arrived at after private negotiations.

The CHAIRMAN asked Mr. Freeman if he wished it to be optional on both sides.

Mr. FREEMAN said that he wanted it optional upon the part of the purchasing authority to pay in stock or cash.

The CHAIRMAN: Then you lay down the terms on which the purchase should take place.

Mr. FREEMAN then dealt with the Kitson clause. He said that, in the present case, the Kitson clause had been thrown over for one which it was claimed had a certainty, but it did not seem to have commended itself to anybody. All the local authorities were dissatisfied with it, and the London County Council did not appreciate or approve of it. The Council did not think that the Power Company should be allowed to supply the larger consumer without any consultation with the authorised distributor. Of course, they did not complain as to railways, canals, &c., which ran through a number of districts, but they did not see why a consumer within the district who required 250 kw. should be able to take a supply on different terms to a man below. The arrangement proposed by the promoters of allowing the authorised distributor to give a supply at an increase of 1 per cent. above the price offered by the power company for every 10 kw. below 250 kw. did not take into consideration the varying circumstances of the different authorities. This was a matter which could not be decided by any fixed rule, but could only be tested by reference to an absolutely impartial tribunal such as the Board of Trade. Therefore, the Council preferred the original Kitson clause, to which there was no valid objection so far as they knew. At the same time, there was a modification or addition which it was thought necessary in the public interest. By the clause the local authority were put in a position to take supply at a reasonable price, but it ought to go further and stipulate that having obtained it at a reasonable price, they should also distribute it at a reasonable price. This was very much in the nature of an addition which was in the County Council Bill, and was one which they considered would complete the clause. He would also suggest that, in the reference to the arbitrator in the Kitson clause, he should be specifically instructed to take into account the capital expenditure upon the undertaking of the authorised distributor.

The CHAIRMAN asked Mr. Freeman whether he had considered the difficulty or impossibility of obtaining the money for the scheme with a too stringent purchase clause. This he said was at the bottom of the whole matter.

Mr. FREEMAN replied that the County Council did not wish to interfere nor to make any suggestions which in their opinion would wreck the Bill. They thought they were not asking more than was necessary in the public interest, and that none of the suggestions made would make it impossible to raise the money.

Mr. FELIX CASSEL, K.C., chairman of the Parliamentary Committee of the County Council, confirmed the views expressed by Mr. Freeman in his speech. On the question of the terms of purchase, the Council objected to the repayment of the whole capital expenditure, for the reason that they might have to pay for some plant which either did not exist at all or which was practically of no value. A particular case in the mind of the Council was the horse tramways of London. In this case the whole cost of the horse track and rolling stock stood in the books, as well as the capital cost of the electric tramway, and, of course, there was no asset representing the cost of the horse tramways. The Council felt that it might have to pay, so to speak, for the inventions of the next 42 years.

The CHAIRMAN: Would not this involve raising new capital on the part of the company, and surely the point would arise during the discussion when the company came to Parliament for new capital powers?

Mr. CASSEL said this would not alter the terms of purchase, although some arrangement might be made then. But the Council felt safer with the terms of the Electric Lighting Acts.

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In cross-examination, Mr. Cassel agreed that the Council desired a bulk scheme passed this session if possible, provided the interests of the authorised distributors were safeguarded, and also the interests of the public, as the purchasing authority.

Mr. Cassel's cross-examination was not concluded, as he had to keep an important public engagement, but subsequently, in view of the cross-examination of Mr. Haward, it was decided not to ask any further questions.

Mr. H. E. HAWARD, Controller of the London County Council, said he had had to advise the Council upon all questions of purchase in relation to tramways, &c. He had considered the purchase clause in the present Bill, and regarded the basis of purchase laid down as a very unsatisfactory one from the public point of view. He saw no means by which the decisions of the auditor under the clause could be upheld or enforced, and he thought it would be much more satisfactory if the purchasing authority had some voice in the matter. The same effect was produced under the Electric Lighting Acts; it frequently happened that the decisions of the Board of Trade auditor were not acted upon, and the Council in this matter also considered that there should be some means for enforcing the auditor's decisions.

Mr. FITZGERALD, for the promoters, said that on a question of dispute in the matter referred to, any person or body, such as the London County Council, could get the Attorney-General to make an application to the courts.

Mr. FREEMAN, for the County Council, said this would be a most clumsy and roundabout way of doing it; and, in addition, he was not at all sure that the County Council could move in the matter in the way suggested. The Council certainly had no statutory powers to spend money on setting the Attorney-General in motion.

Mr. HAWARD, continuing his evidence, supported generally the arguments adduced by Mr. Freeman. Incidentally he said that the view of the Council was that the terms of the Electric Lighting Acts were more favourable than those of the Tramways Act of 1870. As to the difficulty of raising capital if these terms were applied, he did not think this would be so, and mentioned that £12,000,000 had been raised by companies in London upon these terms, and £40,000,000 by companies throughout the country. Even assuming that there was a certain amount of capital which would not be repaid, a very small insurance fund would cover this. For instance, an insurance fund of 21s. per cent. would repay the whole of the capital in 42 years on the 3½ per cent. table, and assuming that this fund was not started until 12 years after commencement, a fund of 38s. per cent. would repay the whole of the capital. Assuming that one quarter of the capital expenditure would be lost—a large proportion—the sinking fund would be very small, viz., about 5s. per cent. if started from the commencement. With regard to payment in stock or cash, he was in favour of the purchasing authority having the option of either, and mentioned as precedents the purchase of the water companies, the purchase of the National Telephone Co., and also of the Indian railways. In the latter cases, purchase could take place by stock or annuities.

At the close of the examination in chief, the Chairman, having ascertained that the Council had advanced £5,000,000 to local authorities for electric lighting, asked what would be the fate of this sum if in a few years a new invention was made which rendered it advisable to scrap the whole of the present plant.

Mr. HAWARD said that, of course, the whole of the capital in question would not become obsolete, but, assuming that a large proportion would, the Council would probably allow the local authorities to charge to capital account the difference between the outstanding debt on the superseded plant and the cost of the new plant. This was on the assumption that the new plant would enable the undertaking to make a much larger profit than before.

The CHAIRMAN suggested that it might not necessarily allow a larger profit to be earned, although the price to the consumer would be less.

Mr. HAWARD did not care to express an opinion of what the policy of the Council would be in these circumstances. Certainly each case would have to be decided on its merits.

In cross-examination by Mr. Fitzgerald, witness admitted that, under the limitations now proposed by the County Council, no company had ever raised a penny of capital from the public. Another point in the same line of argument was that in the London County Council's Finance Committee's report on the Council's Bill of 1907, it was stated that money would be more easily raised by a public body, and yet it was later on stated that there was every probability of a loss upon the undertaking during the first few years. From this Mr. Fitzgerald argued that, with much more stringent financial conditions in the ordinary course, made more stringent by the proposals of the Council, it seemed to be expected that the company could raise capital and make the undertaking a remunerative one, where the Council did not expert to do so itself. Witness agreed that the terms upon which the existing companies had raised their capital were somewhat different to those now proposed to be put upon this company, but at the same time the power company had many advantages over the pioneer companies. They now had the benefit of the most up-to-date knowledge, and a better knowledge of the conditions in London. Mr. Fitzgerald put it that none of the existing companies had the sliding-scale clause limiting the dividends in relation to the price, and, further, in comparison with the existing companies, the power company would not have the advantage of what had hitherto been the most profitable form of supply to the companies, viz., lighting.

Mr. Fitzgerald then went to the point relating to the auditor obtaining expert advice in relation to the amounts set aside to renewals and so on, referred to the Electric Lighting Clauses Act, which lays it down that the whole of the expenses of the auditor should be paid by the undertaker. Mr. Haward did not think that the Clauses Act would allow the auditor to take outside advice at the expense of the undertaker.

Mr. FITZGERALD next dealt, in his cross-examination, with the statement that tramway purchases took place upon worse terms, if anything, to those of the Electric Lighting Acts. He asked Mr. Haward if he was aware that since the decision of the House of Lords in 1895, no tramway Bill had been promoted without different terms to those of the Act of 1870, owing to the inability to raise capital under the terms of that Act. Witness was not aware of this. Further, it was put to him that the Light Railways Act provided for no purchase at all. He replied to this that it was within the powers of the Light Railway Commissioners to insert a clause at their discretion, but Mr. Fitzgerald met this by reading the terms of such clause, viz.: "Fair market value as a going concern without addition for compulsory purchase."

Coming to the desire of the County Council to be the purchasing authority, Mr. Fitzgerald put it to witness that a similar suggestion had been made in regard to the water question, which was over a similar area, but it had not been carried out, mainly owing to the opposition of the local authorities outside London. He asked what would be his position if the London County Council now pressed this request and all the local authorities outside opposed it? Was he likely to get the Bill through Parliament at all? Mr. Haward thought he could hardly be expected to answer this question.

FRIDAY, MAY 29TH.—(SIXTEENTH DAY.)

The CHAIRMAN stated he would be glad if counsel for the local authorities would refrain from further arguments or evidence on the question of competition, and restrict themselves to any new points not yet put before the Committee.

Middlesex County Council.

Mr. ERSKINE POLLOCK, K.C., for the Middlesex County Council, in putting the case for that authority, objected, on general grounds, altogether to any portions of the County of Middlesex being included in the Bill, and he also strongly protested against the London County Council being the purchasing authority in the County of Middlesex. The view of the Middlesex County Council was that the existence of two power companies already in the county was a sufficient area for constituting Middlesex a separate unit for bulk supply. If, therefore, it was deemed necessary that further bulk supply powers should be granted over an area greater than London, then so far as Middlesex was concerned, these powers should be granted to the County Council or to a company with powers to the Council to purchase in 30 years. Another objectionable feature of the present Bill was the powers which the London County Council would have in the event of that body purchasing, for breaking up the roads and bridges in Middlesex in connection with laying mains. He knew of no precedent of one County Council having such powers in the area of another county. Further, in the event of the London County Council making a loss, the ratepayers of London would surely urge that this should be spread over both sets of ratepayers, to which Middlesex would strongly object. On the other hand, if the undertaking was very successful, the London County Council would only be entitled to relieve the rates in their own county. Middlesex would then rightly complain that the price of electricity was being kept up for the benefit of the London rates. Dealing with the policy which had decided the area, he denied that it was that the fringe of London was becoming the manufacturing area of London, and contended that the distance had been decided upon the economical limit of transmission. The portion of Middlesex taken in by the Bill, he said, represented three-quarters of the population, two-thirds of the rateable value, and about half the total area. Middlesex, if excluded from the Bill, would not be without a bulk supply, for the North Metropolitan Electric Power Supply Co. was supplying from Brimsdown and Willesden, whilst the Metropolitan Electric Supply Co., was also supplying from its Willesden station. The former company was giving a most important bulk supply to the Middlesex County Council tramways, and it was the existence of these two companies which weighed with the Middlesex County Council in urging upon the Committee that they were in a far different position to that of most of the opponents to the Bill. He also pointed to the fact that Parliament had never hitherto granted competing bulk supplies, and mentioned the Clyde Valley and Caledonian Power Bills, and the Tyneside and County of Durham Bills, in both of which instances, competition had been practically asked for, and had been refused.

In answer to a suggestion by Lord Welby, that the purchase difficulty might be got over by allowing the Middlesex County

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Council to purchase the portion of the undertaking in that county, Mr. Pollock thought the complications would be too great to allow of a satisfactory solution.

The CHAIRMAN pointed out that as the Bill stood, the London County Council could not purchase without another Act of Parliament.

Mr. POLLOCK thought that rather than jeopardise their right of purchase without further reference to Parliament, the London County Council would prefer that Middlesex should be struck out.

Mr. CLEASE, for the London County Council, asked the Committee not to accept this view.

Mr. JAMES BIGWOOD, Chairman of the Parliamentary Committee of the Middlesex County Council, detailed the arrangements between the County Council and the North Metropolitan Electric Power Co., in relation to the tramways, whereby the roads were widened and the track laid by the Council, and the undertaking then leased to the Metropolitan Electric Tramways Co., which was supplied with current by the North Metropolitan Co. He expressed the opinion that the whole of Middlesex should be taken or no portion at all, but their opinion was that the county was sufficiently catered for in the matter of electric supply at the present time.

In answer to Lord Lytton, Mr. Bigwood agreed that their objections to the Bill, so far as purchase was concerned, would only arise in 42 years' time. Generally speaking, if Parliament saw fit to give bulk powers over the whole of Middlesex to another company, in competition with the two existing companies, the Council would have no objection, but they did not want the best portion of the county taken.

In answer to the CHAIRMAN, witness stated that although the County Council had no project in view for a bulk supply scheme, yet they would rather promote one than have the county cut into in the way proposed in the Bill.

The Committee adjourned at one o'clock.

MONDAY, JUNE 1ST.—(SEVENTEENTH DAY.)

WESTMINSTER CITY COUNCIL.

Mr. BLENNERHASSETT, opposing on behalf of the City of Westminster, pointed out that there was no municipal electrical undertaking in that area, but their opposition was for the reason of preserving the rights of purchase which the Council had in respect of the various companies supplying there. These rights were regarded as a very important and valuable asset, in view of the favourable terms of purchase under the Electric Lighting Acts. The Westminster Borough Council's purchase powers enabled them to acquire the generating station of the Central Electric Co., which was outside the area of Westminster, and he maintained that the objects of the Council could be obtained without any injury to the main objects of the Bill. The promoters' evidence was to the effect that the main business of the Bill was to supply in bulk to the authorised distributors if they desired it, and with this he did not propose to interfere. But the Council strongly objected to the power company being enabled to supply direct to power consumers, and he asked the Committee to say that under the exceptional circumstances of Westminster, the power company should have no powers to supply for power, except for railways and canals, without the consent of the local authority. By the Administrative Bill London was divided into an "industrial" and a "non-industrial" area, and Westminster was placed in the latter, to which the Kitson clause did not apply. Another clause which was of the utmost importance to Westminster was the clause which allowed of the transfer of electrical undertakings, subject to the sanction of the Board of Trade. In the event of one of the companies supplying in Westminster being acquired by the power company, the transfer should not take place without the consent of the local authority, for without this provision, the purchase rights of the Council would be rendered inoperative. Under the present Bill it was stipulated that no works, except those exclusively used for the supply in the local area, could be acquired by the local authority. This would give the power company the opportunity of so inextricably mixing up the whole matter, that it would be practically impossible to decide what works were exclusively used in Westminster, for instance. This could easily be done by scrapping the local generating stations and supplying from Barking, and the provisions of the Bill left it open for the existing companies and the power company to arrange matters so that the rights of the Westminster City Council to purchase would be absolutely negatived.

Mr. PHILIP PILDITCH, Chairman of the Law and Parliamentary Committee of the Westminster City Council, in confirming the views already expressed by Mr. Blennerhassett, said that the Council had powers to acquire the whole of the Westminster Co.'s undertaking, and also that of the St. James's & Pall Mall Co. They could, moreover, acquire the major portion of the undertaking of the Kensington & Knightsbridge Co., a small portion of the London Electric Supply Corporation's undertaking, the greater portion of the Charing Cross Co.'s undertaking, and a small portion of the Metropolitan Electric Co.'s undertaking; whilst, in addition, they had the right, under the Central Electric Supply Co.'s Act of 1905, to acquire that company's power station in Grove Road, although it was in Marylebone. The general view of the Council was not in opposition to the principle of bulk supply, provided the authorised distributors were not forced in any way to take a supply.

Questioned by Mr. Talbot, for the promoters, witness admitted that the question of purchase was already in a most confused condition, but the Council was hoping for legislation which would smooth the path. He also agreed it was within the bounds of possibility that the Council would be forced to leave out of the purchase question those companies which were only partly in the Westminster area, and to purchase only the companies which were supplying solely within Westminster.

Mr. JOHN HUNT, Town Clerk to the City of Westminster, also gave evidence. His cross-examination by Mr. Clode was directed to the fact that under the Administrative Bill of 1907, if the consent of the local authority to the purchase of a local company was unreasonably withheld, the Board of Trade should be appealed to. Therefore, the local authority did not have sole right of determining, as had been suggested by counsel, for Westminster. Further, although the Board of Trade had been objected to in respect of the Kitson clause, yet it had been accepted in the other instance.

In answer to Lord Lytton, Witness said that the inducement to the power company to buy up local companies was that when the local authority eventually purchased, the power company could, under the Electric Lighting Act of 1888, claim compensation for severance.

ISLINGTON.

Mr. GERALD SANDER, counsel for the Islington Borough Council, said the sum of £449,000 had been spent upon their electrical undertaking, and that the buildings had been erected which would accommodate 40,000 kw. He admitted that the cost per kw. was at present high, but as the plant was increased to the maximum capacity of the buildings, this would be reduced to £22 per kw., which, if he read the promoters' tables correctly, would be less than their figures, by £10 per kw. Of course, this was by reason of the expenditure already incurred on buildings. The average price of coal in Islington, also, was 11s. 7d. per ton, which was lower than the figures put in by the promoters. He challenged the contention of the promoters that the Electric Lighting Acts gave no monopoly, and argued that it was upon a reading of the Acts that a local authority should be immune from competition subsequently, that the large capital had been expended upon the electrical undertaking in Islington. Dealing with the canvassing which has been carried on in Islington, counsel stated that of the 317 power consumers in the borough, the Council now supplied 206, and of the total horse-power in the borough, viz., 3,448, the Council was supplying 1,804 h.p. There were no large consumers. He complained that after Mr. Parshall had stated that a large number of important witnesses were to be called from Islington to testify as to the unsatisfactory electric supply, not one had been called, and the only inference to be drawn was that no such dissatisfied consumers existed. On the contrary, he had letters from numerous consumers to the effect that they were quite satisfied. He would therefore ask the Committee to take no notice of this evidence for the promoters. Dealing with the tables put in by the promoters with regard to the Islington undertaking, he criticised the load factor assumed three years hence of 20 per cent. During the past 24 years, the load factor in Islington had only increased from 16·4 to 16·8, and what justification was there for assuming that there would be the large jump from 16·8 to 20 per cent. within the next three years. Again, the cost to the Islington Council would be about 2d. per unit, taking power from the power company, after adding the distribution costs.

Mr. ALBERT GAY, Electrical Engineer to the Islington Borough Council, was then called to confirm the statements made by Mr. Sanders. When the generating station was completed, the total cost per kw. would be £22 10s. per kw. and even allowing the promoters 25 per cent. for reserve above their 60,000-kw. capacity, their cost per kw., including transmission, would still be higher than the figure above-mentioned. The promoters, he said, had also taken the costs of Islington for 1906, viz., 1·6d. per unit, and compared with their figures, which were to apply three years hence. He estimated that the costs at Islington would in three years' time have dropped to 1d. per unit. The supply of power in Islington at 1d. paid very well, for they regarded power supply as a by-product. Seeing that the plant would be lying idle without the power supply, he calculated that the cost of energy for power supply was 0·35d. per unit. Therefore, he made a very good profit.

Under cross-examination, Mr. Gay said that the power business in Islington brought in a revenue of £5,000 per annum, out of £52,000 for the whole business. At present the quantity of coal per unit generated was 10 lb. The total costs per unit for 1907–8 were 2·52d.

EALING AND BARNES.

Mr. READER HARRIS, K.C. for these two authorities, asked for exclusion from the area of the Bill, although he was willing to allow the company's mains to pass through, or they might supply for railway purposes or to the local authority in either case. Both areas were purely residential, and no less than four-fifths of the land was restricted by covenants from being built upon for manufacturing purposes. Ealing was already in the bulk area of the Metropolitan Electric Supply Co., and the Bill of the electric lighting companies did not include it. The same

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arguments he applied to Barnes, and summed up the position that the power company could be of no benefit to the districts on the one hand, and, on the other, that boroughs offered no inducement to the power company.

CITY OF LONDON.

Sir RALPH LITTLER, K.C., drew attention to the special circumstances of the City of London. They had never adventured into municipal trading, and while they expressed no opinion for or against, they believed that in their present position it was undesirable. The City had, he reminded the Committee, the option of purchasing the portions of the City of London and the Charing Cross Co.'s undertakings, relating to the area as early as 1914. Apart from the possible interference with these rights of purchase, counsel objected to the interference with the City streets which the laying of the mains would involve, and said that the small cost of going round the City instead of through it was no justification for the indescribable nuisance of breaking up the streets for laying mains. He did not merely ask that the Corporation should give its consent to the promoters' laying mains in the City, he put it higher than that, he wanted them absolutely excluded from the City of London.

Opposition by the Westminster, St. James's, Kensington, and Notting Hill Companies.

Mr. M. PRYOR, Chairman of the Sun Life Assurance Co., and a director of the St. James's & Pall Mall Electric Lighting Co., said he had gone into the financial aspects of the Bill. He said he did not think the time was favourable for raising large sums of money for such purposes, because the market had been very much perturbed by the unfavourable results of previous London enterprises, especially of the London underground railways. He was a member of the Committee which was formed to reorganise the finances of the Underground Electric Railways Co. of London. Very few issues of large amounts of money had been made during the past year without heavy underwriting, and he did not think the promoters could start their undertaking without resort to underwriting at the hands of a well-known firm, and, so far as he could discover, no well-known firm was behind the promoters. Generally, he thought that London enterprises were not in favour at present in the money market.

In cross-examination, Mr. Pryor agreed that in certain circumstances a bulk supply scheme for London would be useful, and that the money market was improving.

In answer to the Chairman, witness expressed the opinion that if all three Bills were passed the tendency would be for the existing companies to refrain from issuing new capital until they saw what the power company was doing. In the event of the latter failing to carry out its obligations, this might be a serious matter for the user of electricity.

Asked for his opinions upon the purchase clause, Mr. Pryor said that repayment of the capital expenditure was not the way to encourage thrifty management. One of the great difficulties in the way of raising capital which the existing companies had had to encounter was the likely effect of the terms of purchase under the Electric Lighting Acts. This had discouraged investment, and the public were obliged to pay very much more for electric light than they would have if the companies had had reasonable security to offer. As a comparison between the purchase terms proposed by the promoters for 42 years and 52 years, the former of which provides for making the dividends up to 6 per cent. and the latter do not, he characterised them as improvident and very liberal respectively.

TUESDAY, JUNE 2ND.—(EIGHTEENTH DAY.)

Sir ALEXANDER KENNEDY, F.R.S., Consulting Engineer to the Westminster Electric Supply Corporation, expressed the opinion that the Bill of the London and District Electric Power Co. could confer no benefit upon the non-industrial district in the West End of London. The four companies which he represented had expended the sum of £650,000 upon their distributing mains and low-tension feeders. The power company apparently did not intend to supply power consumers in that district, as he saw no provision in the promoters' estimates for dealing with distribution in the West End of London. The companies therefore asked to be excluded from the Bill, just as they had been cut out of the industrial area of the Administrative Bill. That Bill had only taken powers to supply the authorised distributors in bulk, but the present Bill proposed to supply local authorities, so that there would be competition with the West End companies for street lighting. Dealing with the clause which provides that the authorised distributors should supply at 1 per cent. above the price of the power company in respect of each 10 kw. below 250 kw., Sir Alexander took the case of a 240-kw. consumer. The Bill laid it down that such a consumer should be supplied at 1 per cent. above the price charged by the power company, but in the case of the Westminster Co. the cost of distribution, not including management or directors' fees, but merely upkeep and maintenance of mains and meters, and also depreciation, was 20 per cent. of the total revenue of the company. He failed, therefore, to see how the 1 per cent. mentioned in the Bill could cover this. Criticising the figures of the promoters, Sir Alexander Kennedy said he had prepared tables upon the assumption that Mr. Hammond had substantially over-estimated the future generating costs to the West End companies if their works were extended. On the other hand, Mr. Hammond had under-estimated the cost of generating the heavy peak load, which, it was suggested, the companies should take from the power company in, say, 1915. The result was that the estimated saving of £19,000 was altered to a loss of about £800. Generally, he regarded the idea put forward by the promoters, of the authorised distributors either scrapping their plants or only working them during the peak load, was an impracticable one in the present position, at any rate, of the West End companies. His view was that the large number of small stations which now existed in London gave a greater security of continuity of supply, for, apart from the danger of a breakdown on the system of one large bulk undertaking, the general policy of such a power company was to load up its plant to the maximum throughout the whole day, and so to reduce the reserve to a minimum, whereas, under the conditions obtaining in small local areas, the stand-by had necessarily to be considerable, and thus continuity of supply was ensured.

In his cross-examination by Mr. Talbot, K.C., Sir Alexander Kennedy agreed that the attitude now taken by the companies in past years in respect of Power Bills had been uniformly ignored by Parliament. On the question of competition, he said that the companies which he represented had over 1,000 consumers for heating, whose maximum demand was about 1 kw., and, under the 20 per cent. clause, a very considerable amount of private lighting could be undertaken. Mr. Talbot next put to witness the statement of the Chairman of the St. James's Co. at its Annual General Meeting, that if the power supply of that company increased considerably beyond the present limits of about 12 per cent. of the total output, the price would have to be raised, but Sir Alexander disagreed with this statement, and pointed out that the Chairman of the St. James's Co. was not an engineer. There was certainly no intention of raising the price for power. On the question of the possibility of dealing with large power consumers without affecting the lighting consumers, Sir Alexander Kennedy said that in the West End there was only one consumer over 250 kw., and he was thrown on and off without affecting the lighting in the least. There had been no complaints. Mr. Talbot said he thought they were getting into a rather personal question, but he personally could not give evidence. (The inference was that Mr. Talbot privately is upon the Westminster mains, and that the pressure regulation is not all that could be desired.) Sir Alexander suggested that if Mr. Talbot had made a complaint, he could cross-examine the Manager of the Westminster Co. upon the point.

In answer to the Chairman, witness said he wished to have the Kitson clause modified, so as to prevent the power company from supplying for lighting to a power user.

Under continued cross-examination, Sir Alexander Kennedy argued that the promoters in their estimates had not taken any account of extra capital expenditure between now and the time when the power company would be supplying, say, during the next five years. Further capital must be incurred by the authorised distributors in order to cope with the increasing demand, and the capital charges on this plant would have to be met, and must be taken into account when, and assuming, the bulk supply was taken.

Mr. TALBOT pointed out that the margin of plant now available would be sufficient to carry the companies on until the bulk supply was ready, but Sir Alexander dissented from this view.

In re-examination, Sir Alexander said that the introduction of metallic filament lamps largely increased the number of small power users, who could obtain all their lighting from the power company under the clause which allowed a supply of 20 per cent. for this purpose.

Mr. L. H. HORDERN, Manager of the Westminster Co., dealing with the 20 per cent. clause, said that this allowed the use of eight 8 c.p. lamps for each kilowatt of power, and, of course, two or three times as much candle-power with metallic filament lamps. The connections for power on the Westminster Co.'s mains were actually greater in 1907 than the connections for lighting, viz., 1,722 kw. for power, against 1,296 for lighting. Under the 20 per cent. clause, if the power company secured the power load they would get almost the whole of the lighting supply to the power users. Ninety-four per cent. of the Westminster Co.'s power users were under 10 kw. He regarded the system of charging so much per kw. per annum and something per unit as an impracticable one for small consumers. The consumers would not know until the end of the year what his bill would be, as it depended upon the maximum demand. Under the Power Bill a consumer taking one kilowatt would have to pay £4 10s. per annum, whereas the average receipts from such a consumer was 18s. per annum. The number of units sold by his company per £1 of capital expenditure was only 12, so that economy of supply depended more on economy of capital expenditure than reduction in generating costs, and the consolidation of the existing interests was the best way to bring about this result. The investment of a further £6,000,000 in the business would not tend to decrease the cost to the consumer.

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In cross-examination, Mr. Hordern stated that he was not afraid of competition on fair lines.

The HON. SYDNEY HOLLAND, addressing the Committee on behalf of the four companies mentioned above, said that the promoters had to prove that the supply of electrical energy in London was unduly expensive, and that the demand had been thereby restricted. In presenting the case for the promoters, too much stress had been laid upon the fact that two Committees of Parliament had already decided that it would be a good thing to have a central bulk supply scheme. But the conditions had vastly improved since the introduction of Mr. Merz's Bill in 1905, at which time undoubtedly the existing companies had devoted themselves mostly to the supply of light. Since then they had developed the supply for power enormously, and he thought his claim that the conditions had changed was strengthened by the absence of any of the promoters of the Administrative Bill, either in the promotion of another Administrative Bill—there was now a clear field without the intervention of the County Council or in co-operation with the promoters of the London and District Bill. Further, where was the evidence of any dissatisfaction on account of the high price? There was absolutely none: the only evidence put forward, viz., the support from the firms, the list of which was put in by Mr. Conradi, was dependent upon modifications in the Bill, to which the promoters have given no indication of agreeing. Dealing with the finance, Mr. Holland compared this with the finance of the Administrative Bill. There were 64 gentlemen of the highest standing supporting the latter Bill, but none of the promoters of the present Bill were gentlemen of the standing which was required in launching an undertaking of the magnitude proposed by the Bill. On the general provisions of the Bill, he commented upon the limitations under which the existing companies suffer, from all of which the power company was to be exempt. The power company was under no obligation to supply, and he suggested, if the Bill was passed, that the power company should be obliged to supply the small consumer at the prices in their tables, and also be obliged to lay distributing mains. If this were done, the whole scheme would fail, because there was no money in the estimates for doing this. With regard to the suggestion that the existing authorities should scrap their stations, he doubted whether their liability to their debenture holders would enable them to do this. He asked that the areas of the companies which he represented should be struck out of the Bill.

The "Eight Company" Opposition.

The joint opposition of the Brompton & Kensington, Charing Cross, Chelsea, City of London, County of London, London Electric, Metropolitan, and the South Metropolitan Light & Power Companies was then heard.

Mr. JAMES FALCONAR, Chairman of the Mersey Railway Co., and Chairman of the Company which promoted the Administrative County of London & District Electric Power Bill, was first called to explain the reasons why this Bill had not been proceeded with in the present session. He explained that he had no interest in any of the Bills; he had taken no part in the present proceedings, and had not even seen any of the three Bills now under consideration. The reason why they did not proceed with a Bill this session was that after a full consideration of the conditions they were satisfied that there was no reasonable prospect of a commercial success even if they should succeed in getting a Bill. The situation in regard to the supply of electric power had changed materially since 1905, from the commercial point of view, when the average price charged for power was about 2d. per unit. The original conclusions of the Administrative Co. was that they could supply power profitably at about ¾d. per unit, and at the same time compete effectively with the existing authorities. But circumstances had now altered in this respect, so far as the authorised distributors were concerned, viz., they were now prepared to supply power at 1d. per unit, and this struck the promoters of the Administrative Bill as being a much more effective competition than in 1905. They also knew that many of the existing companies had made agreements with the best consumers for long periods of years, and therefore the best business would not be available to the power company for some time. The situation in regard to bulk supply had also altered materially. The agreements with the companies and local authorities in the 1905 Bill were upon terms which could not be repeated at the present time. These terms guaranteed that the price should be lower than the then generating costs. In 1905, these were perfectly safe terms by reason of the high average costs of generating, but in the intervening three years the authorised distributors had greatly improved their methods of generation, and their costs of generation were now so low that it would not be safe for the Administrative Co. to come under an obligation to supply upon terms more advantageous than the present costs. Consequently, the company had been wound up, it having been decided that there was no business available for such a company under existing conditions. He agreed that there was a large field in London for the supply of electric power, but the whole difficulty to-day was the competition with the existing authorities.

Under cross-examination by Mr. Talbot, witness stated that he was asked by Sir Alexander Kennedy a few days ago to give evidence. The promoters of the Administrative Bill had considered the question in August, and again in October, last year, before deciding unanimously not to proceed further. Mr. Talbot suggested that the meetings were not quite unanimous, and that Mr. Samuel Insull, of the Chicago Edison Co., was in favour of going forward. Mr. Falconar admitted that Mr. Insull regretted having to drop the project, and said he was unaware that Mr. Insull had authorised two of his assistants—and had provided them with materials—to come to London to give evidence in favour of the present Bill.

Mr. TALBOT: Was there any suggestion at the meetings that it would be better to wait until next year? One promoter certainly expressed that opinion, in the hope that the political difficulties would disappear, but the reason which prevailed was the want of business.

Replying to the Chairman, Mr. Falconar said that if only the political situation had been under discussion, he thought they would have proceeded.

Mr. JOHN CONACHER, General Manager of the Metropolitan Electric Supply Co., examined by Mr. C. A. Cripps, K.C., said that the capital invested in all the electric supply companies in London was £14,686,706, and councils £5,755,000. He detailed the restrictions under which the existing companies now work, and made special reference to the purchase clause.

The CHAIRMAN inquired whether in their own Bill the companies proposed to modify the purchase terms of the Electric Lighting Acts.

Mr. CRIPPS said that so far as the Joint Committee undertaking was concerned, they asked that the terms should be modified, but so far as the individual companies were concerned, the terms of the Electric Lighting Acts would apply.

Mr. CONACHER, continuing his evidence, said that the London companies, in conjunction with the local authorities, had made a careful canvass in order to ascertain the amount of power in the area, and instead of there being 500,000 h.p. or 600,000 h.p., as suggested by the promoters of all power Bills, there were only 209,000 h.p., and of this 46 per cent. was already being supplied by the existing electrical undertakings. Mr. Conacher also drew attention to the effect of metallic filament lamps, which he said were unknown in 1905, and therefore this was a factor which came before the Committee for the first time since the electric power problem in London came up for consideration.

LOCAL NOTES

ABERDEEN: *Sale of Incandescent Lamps.*—In consequence of a communication from the Electrical Contractors' Association, who represented that it was against the provision of the Aberdeen Electricity Act, the sale of incandescent lamps by the Corporation is to be discontinued.

M.E.A. Meeting.—It has been decided that no official representatives be sent to the Nottingham Convention of the Incorporated Municipal Electrical Association.

ACCRINGTON: *M.E.A. Meeting.*—The Electricity Committee have authorised a delegate to attend with the Engineer the annual Convention of the Electrical Association at Nottingham in June.

AUSTRALIA: *N.S.W. Tramways.*—The report of the Chief Commissioner, Mr. T. R. Johnson, upon the working of the New South Wales Government railways and tramways for the quarter to March 31st, 1908, shows that the revenue upon the tramways amounted to £264,318, an increase of £28,180 over the quarter of last year, and an expenditure of £196,256, an increase of £28,449. The number of passengers carried was 45,000,000, an increase of nearly 5,000,000.

Broken Hill (N.S.W.).—A poll of the ratepayers is to be taken to decide whether electric lighting shall be introduced into the streets or not.

BATH: *Tramways.*—Notice is given of an intended application to the Light Railway Commissioners by the Bath Electric Tramways, Ltd., for an Order under the Light Railways Act, 1896, to amend the provisions of the Bath and District Light Railway Order, 1901, with regard to fares, rates, tolls, and charges which may be charged, demanded, or collected in respect of the company's light railway or some part thereof, to increase such fares, rates, tolls, or charges, or some of them, and to authorise the company to fix stages upon the light railway in respect of which fares may be taken.

BELFAST: *Cavehill and Whitewell Trams.*—At the monthly meeting of the Corporation, the 1st inst.—Sir Robert Anderson, Lord Mayor, presiding—the question of the agreement with the Cavehill and Whitewell Company was discussed at considerable length, and finally the resolution of the Committee, which agreed to give a through service from Glengormley to Castle Junction, all fares on the city lines to go to the Corpora-

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tion, and all collected on the company's lines to go to it, was approved of by a majority, and the details were left to the Committee. The Corporation reserved the right of purchasing the undertaking at any time within five years, at a sum not exceeding £60,000.

BLACKBURN: *Electric and Tramway Accounts.*—The Blackburn Electricity and Tramways Department issued their annual reports on Saturday. The latter undertaking had made a net profit of £804, nearly £300 more than in 1907, up to which period there had been a loss since the undertakings were taken over by the municipality in 1899. Out of the profits and a sum of £2,000 transferred from the rates, the deficiencies of the two previous years were wiped out, and for the first time there was a surplus of £517. During the year 10,877,155 passengers travelled on the cars, the receipts amounting to £56,748 6s. 2d. The parcel system had steadily grown, the receipts being £220 more than 1907. Two cars had been fitted with top covers at a cost of £130 each; improved destination indicators and mechanical bells had been fixed on the cars for £467,; roller shutters had been fixed to six new single-deck cars at a cost of £60; and the sum of £110 had been incurred in erecting an open car-body, the cost and renewal of trolley wire on Preston New Road being £80. This expenditure comes out of revenue, whilst £544, the amount expended in heating the shed and erecting the new boiler-house, along with £700, the cost of depôt extension, and £4,045, paid on account of contract for new cars, had been capitalised. In respect to the mileage run in Accrington, the Blackburn Corporation have received £817 15s. 10d., and the arrangement was working satisfactorily, and was beneficial to both Corporations. The Electricity Department's revenue reached £35,000, an increase of £2,700, representing an advance of 8 per cent., effected by the concession of £320 made to the Street Lighting Department; whilst the capital expenditure had only increased by 4 per cent. during the same period. The expenditure, exclusive of capital charges, showed an advance of £25,000, accounted for by the increased price of coal and maintenance of buildings, machinery, and mains. The advance of approximately 25 per cent. in the price of coal represented an increase in annual expenditure of about £1,200. Still, the actual coal cost per unit has remained at the same figure, due to the employment of extensions sanctioned by the Committee, and to further economies. The number of units sold for all purposes reached 4,142,011, an increase of 8 per cent. on the previous year's sales. The net profit for the year was £1,483, compared with £1,528 in 1906-7 and £277 in 1905-6.

New Type of Tramcar.—A new single-decked tramcar, built by the Corporation's own workmen upon the underframe of the old water-sprinkling car. It was given a trial trip on Friday last. It is of the "toast" rack type, open at both ends, with a light covering, and will accommodate 46 passengers.

The question whether Corporation officials should be permitted to take paying pupils has again been discussed by the Blackburn General Purposes Committee. The practice has never been formally sanctioned by the Town Council. Objection was recently raised to Mr. Wainwright, electrical engineer, taking a pupil of the kind, and the matter has been in abeyance since. It was decided that the practice should be sanctioned to the present officials, but that it will be understood that new officials should not enjoy this privilege.

BRADFORD: *Tramways.*—A deputation from the Leeds Corporation Tramway Committee is to meet a special sub-committee of the Bradford Corporation Tramways Committee, in order to further discuss the through running of tramways between Leeds and Bradford.

BRAY: *Electricity Accounts.*—In our last issue (page 831) reference was made to a statement that the electricity undertaking was working at a loss of £1,000 per annum. That this is incorrect would appear from the following figures taken from the accounts for the last year. The total cost of working is given as £2,923, excluding capital charges. The net revenue was returned as £3,463. As, however, £929 was required for sinking fund, &c., the final loss for the year was £390. It should, however, be pointed out that no allowance has been made in these figures for depreciation, but it is stated that the plant has been fully maintained out of revenue.

BRIDLINGTON: *Electricity Accounts.*—The annual report records an increase in output of 29,391 units and of revenue of £412, making a total of £4,462, in spite of the extensive adoption of metal filament lamps. The gross profits have increased from £2,076 to £2,175, although the price paid for coal had risen from 8s. 6d. to 11s. 6d. per ton.

BRISTOL: *Damage by Lightning.*—It is reported that during a severe thunderstorm at Bristol on Saturday, a gas main in the earth was struck by lightning, split, and set fire to.

DURHAM: *Cables Across the Wear.*—The River Wear Commissioners have granted an application from the Durham Colliery Electric Power Co., to place two steel wire-armoured electric cables across the river Wear near North Biddick Colliery.

EALING: *Tramways.*—The Town Clerk is summoning another conference of local authorities with regard to the noise of the tramcars.

EASTBOURNE: *Electricity Accounts.*—It was stated at a recent meeting of the Council that the gross profits on the undertaking for the past year were £24,695, as compared with £22,404 for the previous year, in spite of an increase in the expenditure of about £2,000, mainly due to the increased price of coal.

EPSOM: *Proposed Extension.*—The Urban District Council, at its last meeting, was informed that loans amounting to £35,440 had been expended in mains extensions, &c., and in order to meet liabilities and provide for further extensions, the Lighting Committee recommended that application be made to borrow £1,500. Of this sum, it was stated, £1,200 would be available for future extensions. After some discussion the question was referred back.

EXETER: *Tramway Accounts.*—The annual report records an increase in the total passengers carried of 5,655,000 to 3,754,030. The year's working has resulted in a deficiency of £132 after meeting all capital charges. £78 had been spent during the year on the car-shed. The receipts have declined from 10d. to 9½d. per car-mile.

GLASGOW: *Telephone Deficit.*—At the meeting of the telephone sub-committee last week a statement was presented showing that the deficit on the telephone undertaking, including interest due to the Corporation loans fund, amounts to £16,000. Treasurer Stevenson moved that the preliminary expenses in connection with the telephone department be paid out of the common good, and that the balance of the deficiency be made out of the police assessments. An amendment that the whole of the deficiency be made out of police assessments was seconded, and the original motion carried. When the minutes came before the joint meeting of the City Finance Committee and the Special Committee on Telephones, an amendment that the whole of the deficiency in connection with the transfer of the telephone undertaking to the Government be paid out of the revenue of common good was carried, and it was agreed to recommend that the liquidation of the deficiency be spread over a period of five years.

Tramways.—The traffic returns show that from June 1st, 1907, until May 25rd, 1908, the number of passengers carried upon the Corporation tramways was 221,934,616, as against 220,405,902 in the corresponding period of the preceding financial year. The receipts amounted to £886,932, an increase of £14,066. The system now comprises 89½ miles of double track.

GLOUCESTER: *Electricity Accounts.*—The City Council has agreed to the recommendation of the Finance Committee to transfer £1,200 from the waterworks account toward making up the debit balance of £1,412 on the electricity revenue account.

GREYSTONES (IRELAND): *Electricity Supply.*—The following resolution has been passed by the Wicklow County Council:—"That the Greystones Electric Light and Power Company, not having complied with the conditions required with the leave given provisionally by the County Council at last meeting, this council hereby withdraws the leave and permission then given."

KENDAL: *Electricity Accounts.*—The accounts of the municipal electricity department for the year ending March 31st, 1908, show a deficit of £749. The total receipts were £1,077, and the expenditure was £1,826, including sinking fund and interest.

LANCASTER: *Tramways.*—During April there was a profit of £28 upon the municipal tramways undertaking. This is the first time there has been a balance over ordinary working expenses since the system started.

LEYTON: *Electricity Accounts.*—The report of the District Auditor upon the electricity undertaking, presented at the last meeting of the Urban District Council, shows that the gross profit on the year's working was £11,106, and the amount charged as interest on loans and repayment of principal, £10,170, leaving a profit as shown by the books of £936. The auditor refers to one or two matters of detail in connection with the administration. As to coal the auditor says it is invoiced to the Council at colliery weights, and the consumption of coal per unit generated, which is given as 6·22 lbs., is based upon these weights. If calculated upon the actual weights the consumption is about 6·44 lbs. per unit, which appears to be very high. In regard to the results of the working of the undertaking, the auditor points out that no account has been taken of interest and redemption of debt accrued, but not payable during the year. There ought to have been charged to the tramway revenue account, in addition to the accrued charges for tramway loans, a proportion of the accrued charges for loans for purposes of street widenings. The cost of these widenings has been charged when payable on a uniform basis of one-third to tramways and two-thirds to district fund. A gross profit of £3,801 was shown on the year's working of the tramways undertaking; £9,814 was charged for redemption of loan debt and interest, leaving a loss, as shown by the books, of £6,012. The deficiency on the working of the undertaking from its acquisition to March 31st, 1907, was £9,326. In commenting on the report the engineer remarked that the consumption of coal per unit was not a criterion of its economical use: the true criterion was the cost per unit.

The Electrical Engineer presented a report as to the breakdown which occurred at the electricity works on Good Friday.

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owing to one of the new armatures burning out. As the other set was running also, the burn out temporarily disabled it in an unusual and unexpected manner. After a little time had been spent in trying to get the armature to work again, the engineer coupled up with West Ham and Walthamstow, in order to get the tramcars moving. The supply was off for about two hours. Ultimately the trouble was located and rectified.

LONDON: *New Electric Ambulance Station in the City.*—A new electric ambulance station was opened last week at the new city police quarters in New Street, Rose Alley, Bishopsgate. One ambulance vehicle, similar to that described in ELECTRICAL ENGINEERING, Vol. I., page 653, is at present in use at the station, but accommodation is provided for two.

London County Council Tramways.—The new line from Hammersmith to Harlesden, which passes the Wood Lane entrance to the Franco-British Exhibition, was opened for traffic last Saturday. This line is the first to be worked on the overhead trolley system by the Council.

Camberwell New Tramway Route.—The Tramways Department of the London County Council has notified the Borough Council of its intention to commence at once with the construction of the tramways lines from the present terminus at Dulwich Library in Lordship Lane to Dartmouth Road, Forest Hill. The lines will be constructed upon the conduit system.

Paddington.—The negotiations between the Metropolitan Electric Supply Co., and the Borough Council, with regard to the proposed removal of the company's generating station, and the suggested reduction in the price charged for current were in abeyance for some time in consequence of the company's assessment appeal being pending. Since the decision in the appeal, however, negotiations have been reopened, and the General Purposes Committee of the Borough Council state that they hope soon to be able to present a report upon the matter. From a report issued by the Guardians it appears that the total expenditure on lighting last year was £1,356, divided as follows:—£802, gas; £554, electric light. In the preceding year the figures were £805 gas, £507 electric light. The other figures since electric light was introduced were as follows:—1898-9 (1) gas, £697; (2) electric light, £219; 1899-0, (1) £754, (2) £245; 1900-1, (1) £779, (2) £431; 1901-2, (1) £794, (2) £478; 1902-3, (1) £731, (2) £533; 1903-4, (1) £819, (2) £540; 1904-5, (1) £765, (2) £515; 1905-6, (1) £733, (2) £471.

MAIDSTONE: *Municipal Electrical Association Convention.*—Mr. E. E. Hoadley has been appointed the official delegate to attend the convention of the Incorporated Municipal Electrical Association, to be held from June 30th until July 3rd, in Nottingham.

Tramway Routes.—The Light Railway Committee of the Corporation held a conference last week with a number of traders in the town with reference to an extension of the tramways in the north ward, to which considerable objection has been taken. The traders along the line of route proposed by the Council object to the proposal so strongly that they have urged the construction of a new street to take the tramways, on the ground that the cost of this would be considerably less than widening the thoroughfare originally decided upon. After considerable discussion, and as no agreement could be come to, the meeting was adjourned for a week.

MANCHESTER: *Tramway Staff Medical Inspection.*—The Tramways Committee has decided that applicants for appointment on the general traffic staff of tramways undertaking must undergo medical examination, and Dr. Stuart, of Newton Heath, has been appointed medical officer to the department.

MEXBROUGH: *Tramways.*—A good deal of excitement was caused in Mexbrough on Monday by a tramway stud which had remained "live," by which two horses and a dog received severe shocks.

NOTTINGHAM: *Electricity Supply.*—The report of Mr. H. Talbot, which was submitted to the City Council last Monday, records extensions to the mains during the year of 1·68 miles, making a total of 55·94 miles. The lamp connections have increased during the year from 321,240 to 349,699, and the motors connected have increased by 99 h.p., being now 841 in number, with an aggregate output of 3,418 h.p. 11,116,855 units have been sold, of which 4,112,648 were for lighting, 1,799,208 for power, and 5,294,979 for traction. This shows an increase of 1,586,739 over last year's figures. The total costs, including capital charges, have declined from 1·70d. to 1·63d. per unit sold, notwithstanding an increase of 25 per cent. in the price of coal.

SUNDERLAND: *Tramways.*—The net profit upon the Corporation tramways for the year ended March 31st, 1908, amounted to £10,101. The traffic receipts were £68,797, a decrease of about £4,000 over the receipts of the previous year. The sum of £3,348 has been put to the relief of rates.

WALTHAMSTOW: *Electricity Supply.*—A report presented by the Electrical Engineer to the Urban District Council shows that during April the units generated totalled 271,453 (lighting, 165,388; traction, 106,070), this being an increase of 23,011 units as compared with the corresponding period of last year. In March there were 249,442 units generated (lighting, 168,749; traction, 80,693), an increase of 18,056 units as compared with the quantity generated during March, 1907. During the current year 1⅞d. per unit is to be charged for current used by the tramways undertaking. This is subject to revision at the end of the year.

WARSAW: *Tramway System.*—Electric trams are being substituted for the horse-driven trams, which were introduced in 1881. The system includes a power-house with three turbo-generators of 1,800 h.p. each, and 180 tramcars. The syndicate which manages the system is to pay the city £40,000 per annum and 5½ per cent. on the invested capital of £700,000. The remaining profits are to be divided equally between the city and the syndicate. The concession to the syndicate extends up to the year 1922.

WEST BROMWICH: *Electricity and Tramway Accounts.*—The annual report of the electricity undertaking states that there has been a decrease of £61 in the total revenue, which now stands at £12,971. The number of units sold was 1,824,887, an increase of 25,534 over last year's figure. The gross profit is given as £6,914, leaving a net surplus of £2,030 after deducting capital charges. The figure shows a decrease of £593 from last year. In the Tramway Department, a surplus of £309 has been produced, which is available to reduction of the outstanding deficit to £1,092.

YORK: *Electricity Accounts.*—The accounts of the electricity department for the year ended March 31st, 1908, show a balance of £7,697. To this sum has had to be added £19 in order to make up the amount due for sinking fund and interest. The deficit upon the electricity undertaking to date, £4,927; the total capital expenditure is £125,254. The receipts during the past year amount to £15,824, and the expenditure, not taking into account interest and sinking fund, was £8,127.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ACCRINGTON.—The Electricity Committee have discussed the making of a reservoir for condensing water, and the Borough Surveyor has been instructed to prepare plans and estimates for early consideration.

BECKENHAM.—A recommendation by the Education Committee that electric light should be installed in the boys', girls', and infants' schools at a cost of £225, has been adopted.

BLACKBURN.—The Board of Education have approved of the erection of two higher elementary schools on the Blakey Moor site of Blackburn, to accommodate 300 boys and a similar number of girls. Both will be lighted with electricity.

Messrs. J. Parkinson & Sons, Ltd., builders, of Blackpool, have received the contract for the rebuilding of the Blackburn Theatre Royal, which will be lighted by electricity.

BRADFORD.—Tenders are invited for the electric lighting installation at the Town Hall extension. Particulars from City Architect, Whitaker Buildings, Brewery Street, Bradford. Tenders by June 10th to Town Clerk.

CARLISLE.—Tenders are invited for an electric lighting installation at the Carlisle Girls' New Secondary School. Full particulars from the Consulting Engineer, Mr. W. J. Hide, 42 Produce Exchange Buildings, 8 Victoria Street, Liverpool, and tenders to the Secretary, Education Department, The Courts, Carlisle, by June 5th.

CLEETHORPES.—Tenders are invited for the erection of a wireless telegraph station. Particulars from District Surveyor of Coastguard Works, 28 Pavement, York, or Director of Works Department, Admiralty. Tenders by June 12th.

COLNE.—Tenders are invited for (1) induction motor generator and high-tension transformer; (2) high- and low-tension switchgear; (3) high-tension lead-covered paper insulated cable. Full particulars from Mr. A. G. Cooper, the Electrical Engineer (fee £1 1s., returnable), and tenders to the Chairman of the Electrical Committee by June 15th. (See an advertisement this week.)

COPENHAGEN.—H.M. Consul at Copenhagen has forwarded a copy of the conditions and specifications relating to tenders for the supply of 4,000 to 5,000 electrical meters. Delivery to take place between August, 1908 and 1909. Tenders should be marked "Tilbud paa Maalere," and should reach Direktøren for Belysningsvaesnet, Raadhuset, Copenhagen, before midday on June 10th next.

DEVONPORT.—Mechanical stokers are to be installed at the Corporation's power station.

ILFORD.—Tenders are invited for surface condensing plant and cooling tower, steam and feed pipes, boiler feed pump, &c.,

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and extensions and alterations to main switchboard. Full particulars from Mr. A. Shaw, Electrical Engineer to the Council, Electricity Works, Lea Street, Ilford, and tenders to the Chairman of the Urban District Council by June 10th.

LONDON: *Fulham.*—In order to improve the lighting of the South Branch Library, the Borough Electrical Engineer has been instructed to change all the 8-c.p. lamps in the reading-room and lending department to 16-c.p. lamps, to instal three 35-watt metal filament lamps in the reading-room, suspended over the reading tables, 12 to 15 ft. from the floor, and to fix one drop pendant with one 50-c.p. lamp in the entrance hall in place of the present three-light fitting.

Poplar.—In order to meet an increased demand from the London and India Dock Co., the Borough Council is to lay new cable and ducts, at an estimated cost of £357. Existing cable, &c., of the value of £215 is to be reclaimed, so that the net capital cost will be £121. It is proposed to erect a new sub-station in East Ferry Road, on a site to be leased from the Millwall Dock Co.

Stepney.—Tenders are to be invited for annual supplies of meters, demand indicators, time switches, and arc lamp carbons, and for about 12,000 tons of coal—a proportion of Welsh smokeless and a proportion of hard bituminous steam coal (large and small).

MAIDSTONE.—The erection of an Entz reversible booster and a battery for the supply to the tramway has been decided upon. The existing battery at the electricity works is to be replated with larger plates.

MALVERN.—Tenders are invited for the supply, delivery, and erection of a 50-kw. steam alternator exciter, &c. Particulars from Mr. W. J. Baker, Engineer and Manager, and tenders to the Clerk by June 29th. (See an advertisement this week.)

MYSORE.—The steam pumps at the Mysore Waterworks are to be converted to electric driving.

NORWICH.—Tenders are invited for: (1) Supply and erection of a water tube boiler, with mechanical stoker, economiser, &c.; (2) wiring supplies (not cables). Particulars from the City Electrical Engineer, and tenders to the Chairman of the Electricity Committee by June 9th.

SPAIN.—*The Gaceta* of May 22nd contains a copy of a law authorising the Spanish Government to call for public tenders for the construction and installation of the new submarine telegraph cable from Cadiz to Teneriffe, thence to Gran Canaria, Palma y Gomera, from the latter island to Hierro, from Gran Canaria to Fuerteventura and from thence to Lanzarote. Tenders are to be invited during the course of the present year, and the total cost, not to exceed 5,000,000 pesetas (about 172,413*l.*), is to be distributed over two years. Local representation is necessary.

ST. HELENS.—An application is to be made to the Local Government Board for sanction to borrow £10,426 for extensions to the electricity undertaking.

WEDNESBURY.—The sanction of the Local Government Board has been received to the following loans:—(*a*) £275 to defray excess expenditure on electricity meters up to March 31st, 1907, a period of five years being allowed for the repayment; (*b*) £1,346 to defray excess expenditure on electricity mains up to March 31st, 1907, a period of 25 years being allowed for repayment; (*c*) £1,200 to meet prospective expenditure on electricity mains and services, a period of 25 years being allowed for repayment.

WIGAN.—It has been decided to re-model the Wigan and Pembroke electricity station in accordance with the recommendation of the Electrical Engineer, and application is to be made to the Local Government Board for sanction to borrow £36,345.

WILLESDEN.—Tenders are invited for the supply and erection of a 300-kw. converting plant. Full particulars from Mr. J. G. Bruce, the Council's Electrical Engineer, Salusbury Road, Kilburn, and tenders to the Chairman of the Electricity Committee by June 18th. (See an advertisement this week.)

TENDERS RECEIVED AND ACCEPTED

ACCRINGTON.—At a meeting of the Town Council on June 1st, the Mayor reported having visited the Brush Company's works in company with the Town Clerk and Electrical Engineer, and after inspecting workmen's time sheets and wage lists they had unhesitatingly placed the order for the two single-deck cars. During the progress of construction of these cars, the Council foreman, Mr. Pilling, was instructed to pay periodical visits to the works at Loughborough, for supervision and inspection.

AUSTRALIA.—The Australian *Mining Standard* states that the Adelaide Tramway Trust has accepted the tender of Messrs. Smith and Tymms for the construction of 54 miles of permanent way, forming what is known as the "inner system" of the Adelaide Electric Tramway Service. The amount of the tender has not been officially disclosed; it is said, however, to be over £160,000, though slightly below the estimate made by the engineer. The contractors undertake to complete the first section, namely, the North Adelaide service, by the end of November, and the whole system within 18 months from date of the contract. The total amount of works in contemplation, and for which tenders will be called in sections, will cost about £600,000, the present being, so far, much the largest amount in one tender.

The New South Wales Postmaster-General's Department has accepted the following tenders:—1,000 common battery wall telephone sets, at £2 9s. 6d. each, R. B. Hungerford, Sydney; 100 common battery table telephone sets, at £2 11s. 9d. each, James Paton & Co., Sydney; 440 yards cable telephone, brass sheathed rubber, 208 pairs, £480, the Union Cable Co., Ltd., Sydney; 8¼ miles of cable, paper insulated, 104 pairs, lead-covered, 12½lb. conductors, £309 per mile; 10 switchboards for 100 metallic circuits, at £45 18s. 7d. per switchboard, R. B. Hungerford, Sydney; 4 miles of cable, paper insulated, 52 pairs, lead-covered, 20lb. conductors, £252 per mile; 3¾ miles, 39 pairs, £193 per mile; 5½ miles, 26 pairs, £149 per mile; 2½ miles, 13 pairs, £90 per mile, British Insulated & Helsby Cables, Ltd., Melbourne.

BEXLEY.—Following tests of sections of the steam pipes at the Urban District Council's electricity works is to be carried out, in order to effect improvement, at an estimated cost of £425. Messrs. Babcock & Wilcox are to substitute new piping for the whole of the piping on the superheated range, and a Sugden superheater is to be substituted for one of existing Schmidt superheaters, the cost estimated being made up of £280 for steam piping, &c., and £145 for the new superheater. At the last meeting of the Urban Council a complaint was made that the work should have been put out to public tender, but it was explained that the Electric Lighting and Traction Committee was informed that if that were done the cost would be a great deal more. It was also stated that no firm would tender owing to the odd lengths and sizes required. The estimated cost was based on Messrs. Babcock & Wilcox's quotation. Twelve pairs of destination indicators, costing £6 per pair, are to be obtained for use in connection with the tramways to Woolwich.

DERBY.—The tender for the supply of bitumen cable, at £471, of Messrs. Johnson & Phillips, has been accepted subject to the approval of the Council.

LEYTON.—At the last meeting of the Urban District Council the Electrical Engineer reported that it was necessary to increase the plant at the generating station. In order to get in another traction dynamo without the costly expedient of another traction set, he proposed to set back the large Willans engine of the lighting side of the station, and interpose a traction dynamo of 440 kws. capacity between it and its present dynamo. This would enable the engine to be used either on traction or lighting. The Lancashire Dynamo and Motor Co. had offered to divert a dynamo of suitable size to the Council's use, and to complete and erect it in working condition by July 24th, for £550. The British Westinghouse Co. also offered a dynamo for £672, but this machine is too large to go in the space available. The Council has accepted the offer of the Lancashire firm, and of Messrs. Bertram Thomas, at £86 7s. 3d., for a switch panel and extension of the switchboard.

As a result of experiment with mechanical furnaces for burning slack coal, one made by the Underfeed Stoker Co., Ltd., is to be purchased for £454, and the company will take payment monthly, according to the saving effected, agreeing to restore the boiler to its present position if no saving is effected.

In connection with the conversion of public arc lamps, the Oliver Arc Lamp Co. will allow 17s. 6d., without the globe, for each old type arc lamp of their make displaced by their flame arc, and will allow 2s. 6d. for each globe returned to them. They will undertake without charge to enlarge the magazine of the six flame lamps of their make which are already in use. The cost of a lamp, with weatherhood, contact gear, and winch, including the 17s. 6d. allowance, will be £10 8s. 6d. The Engineer having reported that the flame arc lamps erected on trial by the Oliver Co. were burning reliably and steadily, the Council has decided to use the lamps of this company for the conversion of 24 lamps in the High Road, Leyton.

The Urban District Council received the following tenders for the supply and maintenance of telephonic communications and electric call bells to firemen's residences (25 bells and 4 telephone circuits):—National Telephone Co., £54 10s. per annum; Stuart & Moore, £48 10s. per annum; Headland & Headland, installation of new system, £220 15s., maintenance, £11 per annum, existing system maintenance, £18 per annum. The Council has decided to enter into a seven years' agreement with Messrs. Stuart & Moore, the system to be handed over to the Council at the end of seven years in thorough working order.

LONDON: *Bermondsey.*—The Borough Council has received the following tenders for plant extension at the electricity works:—Boiler: D. Adamson, £2,455; Babcock & Wilcox (provisionally accepted), £2,025. Ed. Le Bas, £1,290. Steam Dynamo: tenders were received from fourteen firms, all of them submitting a number of alternative tenders. The tender of Siemens Bros.' Dynamo Works for a Siemens' dynamo, with

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Howden engine, at £4.828, was provisionally accepted. Messrs. Deane & Beal's tender for £3,374 for an evaporative condenser was accepted provisionally, although several firms tendered lower prices for condensers with cooling towers.

St. Pancras.—The Board of Guardians has accepted the tender of J. C. Christie, Mansell Street, Aldgate, E.C., for the supply of one gross of incandescent electric lamps at 8s. 6d. per dozen. Two other quotations were obtained at 9s. 6d. per dozen respectively.

Southwark.—The Borough Council has received the following tenders for an induced draught plant (which is to be installed at the electricity station, in order to overcome difficulty experienced in maintaining steam—especially during the period of maximum load—in consequence of which the Electrical Engineer has been unable to get the boilers blown down for cleaning and repairs during the winter months):—James Howden & Co., (1) fan £325, (2) motor £347, (3) total £672; Sturtevant Engineering Co., (1) £255, (2) £235, (3) £470; Davidson & Co., (3) £395; Musgrave & Co., (1) £140, (2) £264 15s., (3) £404 15s.; General Electric Co., (1) £125, (2) £219 10s., (3) £344 10s.; Crompton & Co., (1) £177 10s., (2) £278, (3) £455 10s.; Buffalo Forge Co., (1) £125, (2) £222 10s., (3) £347 10s.; Pooley & Austin, (1) £155, (2) £242, (3) £397; Baxter & Gaunter, (1) £168, (2) £261 10s., (3) £405 10s.; Electrical Ordnance Accessories Co., (3) £485; Electrical Construction Co. (provisionally accepted), (3) £330; Lancs. Dynamo & Motor Co., Ltd., (1) £180, (2) £263 15s., (3) £443 15s.; Bumsted & Chader (1) £188 10s., (2) £266 10s., (3) £455; Mathews & Yates, (1) £152, (2) £222 10s., (3) £374 10s.; Mather & Platt, (1) £160, (2) £295, (3) £455; Siemens Bros. & Co., Ltd., (3) £417; J. Crawford, (1) £164 10s., (2) £303, (3) £467 10s.; Heenan & Froude, (1) £194, (2) £225, (3) £419. The Electrical Engineer's estimate for plant was £475, including the necessary structural work and flue connections. It is proposed to carry out the necessary fixing and fitting of the machinery and cutting away and building up of brickwork, at an estimated cost of £145, with the staff of the electricity station, under the Engineer's supervision.

MIDDLESEX.—At the meeting of the County Council on May 28th, the Light Railways Committee reported that the contract for the construction of the tramway, High Road and Church Road, Willesden, had been completed by Messrs. Dick, Kerr & Co., the contractors, at a cost of £54,926. The estimated cost of the works was £46,500. The additional expenditure of £8,426 was made up of extras in respect of excavation, and concrete works to drains, special works to properties (compensations), &c., &c. By far the largest items were for extra concrete to secure good foundations for the track work and roadway. When the works were in progress it was found necessary to fill in concrete to a much greater depth in certain portions of the road than was anticipated, owing to bad foundations.

WALTHAMSTOW.—The Urban District Council has accepted the following tenders for the supply of plant for the generating station:—Siemens Bros.' Dynamo Works, Ltd., two engines and dynamos, £5,595; Babcock & Wilcox, Ltd., boiler-house plant, £7,420; Ledward & Beckett, Ltd., condensing plant, £2,270 10s.; Alphons Custodis Chimney Construction Co., chimney, £856; Johnson & Phillips, Ltd., switchboard, £641 15s.; Paterson Engineering Co., Ltd., water softening and purifying plant, £425. Tenders for the two sets of engines and dynamos, in addition to the tender of Siemens Bros.' Dynamo Works, Ltd., were received from the General Electric Co., Ltd., British Thomson-Houston Co., Ltd., Electric Construction Co., Ltd., and Dick, Kerr & Co., Ltd. The Light Railways Committee has decided to accept the tender of Estler Bros. for the supply of 14 sets of patent block system signals, with lamp attachments, at £19 10s. per set.

COMPANIES' MEETINGS AND REPORTS

ANGLO-PORTUGUESE TELEPHONE.—The annual report records a gross revenue of £39,695, and expenses amounting to £21,506. Royalties to the extent of £1,105 were paid to the Portuguese Government, leaving a gross profit of £17,085, out of which, after payment of debenture interest, sinking fund, and income tax, there remained a net profit of £15,089, which, with the addition of £3,655 brought forward from last year, gives £16,745 available. An interim dividend of 3 per cent. was paid last November, and a final dividend of 5 per cent. is now recommended. £5,000 is to be placed to reserve, and £3,745 carried forward. A continuous improvement of the company's business is reported.

CAVEHILL & WHITEWELL TRAMWAYS.—The report for the year ended December 31st last, states that the unfavourable weather conditions and the strike of dock labourers and carters in Belfast have had an adverse influence upon the traffic receipts. The total receipts, including the profit from the Belle Vue Gardens, amounted to £4,430, and the working expenses (including £1,151 paid to the Corporation for current at 2d. per unit) amounted to £3,377, leaving a profit on working of £1,053, from which must be deducted debenture and other interest, leaving a net profit of £139, which it is proposed to carry forward. The revision of fares which was put into operation in October last has had satisfactory results. In May, 1907, the directors entered into an agreement for the sale of the company's lines to the Corporation subject to the Corporation obtaining the necessary powers to purchase. The promotion of an Act of Parliament for that purpose was approved by a large majority of ratepayers, but the Bill was successfully opposed in the House of Commons. The directors are now endeavouring to arrange with the Corporation for the much-needed through service of cars. The report concludes with the statement that the statutory powers possessed by the company confer upon it inalienably for ever the sole right of running tramcars along the route occupied by its lines, without power to the road or any other authority at any time either to purchase the line or impose a rent.

DURHAM COLLIERIES ELECTRIC POWER.—The report for the two years from March 31st, 1906, attributes the losses shown by the profit and loss account, to interest on debentures, and temporary loans required in consequence of the subscribed share capital being insufficient to meet the cost of completing the undertaking. £150,000 five per cent. first mortgage debentures were issued last year. Agreements have been entered into with the Newcastle-on-Tyne Electric Supply Co., by which that company is to operate the undertaking for a period of 42 years, but in order to carry this into effect the frequency of the plant has had to be changed from 40 to 50 cycles per second, which entailed great expense in alterations to both the generating plant and the consumers' plant. The Newcastle company, however, paid £6,000 as compensation for the delay. The gross profits for the two years have only amounted to £2,200, and after payment of prior charges the debit balance is £11,900. The fact, however, that the Newcastle company are now working in harmony with the undertaking, and not as competitors, is favourable to future developments. A considerable sum of money is required to enable the company to discharge its present liabilities, and extensions of mains and plant are required. It is therefore proposed that an issue of £100,000 six per cent. second mortgage debentures should be created, and that £50,000 of these should be issued with the least possible delay. Mr. A. W. Tait has been elected to a seat on the board. At the meeting held on Tuesday, Sir Douglas Fox, who presided, referred to the arrangements for working in harmony with the Newcastle Co., and said that at the present time the load was between 10,000,000 and 11,000,000 units per annum, and was increasing rapidly. The report was adopted, and the resolution to issue further capital was approved at an extraordinary meeting which followed.

FELTEN & GUILLEAUME LAHMEYERWERKE.—According to the balance-sheet for the year 1907, the gross revenue from manufacture, shares in other companies, and other resources amounted to 15,444,748 marks, as against 15,022,820 marks in the previous year. The net profit was 6,585,622 marks, which is allotted as follows:—308,204 marks to reserve fund; 10 per cent. dividend, absorbing 5,275,000 marks; workmen's fund, 90,000 marks; officials' pension fund, 150,000 marks; directors' share in profit, 327,215 marks; carried forward to next account, 435,202 marks. Last year's dividend was 11 per cent. The contracts and orders obtained exceeded considerably those in the past year, this being due to the cable works, as the amount represented by the dynamo works had diminished slightly. On the other hand, the machinery and plant delivered and installations erected was 16 per cent. higher than in the preceding year, and the improvement showed particularly in the dynamo works; there was a 10 per cent. increase in the cable works and 33 per cent. in the dynamo works. The latter was due to the large number of orders obtained in the previous year, and still uncompleted in the year under review, so that the number of orders on hand at the conclusion of last year is somewhat smaller. During the year under review 9,330 machines were made at the dynamo works, with a total output of 385,000 h.p., as compared with 8,070 machines with 265,000 h.p. in the preceding year. The reason that a diminution of 1 per cent. has been made in the dividend is partly that the profits from associated companies have fallen off and partly due to a three-weeks' strike in the spring of last year at the dynamo works, in addition to which the uncertain industrial future and the money market conditions were also taken into consideration. The number of officials and workmen rose from 10,470 at the end of 1906 to 11,760 at the end of 1907. Of these 6,535 are employed at the cable works and 5,225 at the dynamo works. The report states that the price of raw materials, especially of metal, diminished considerably in the year under review. On the other hand, new contracts made by the company show that there is a considerable deterioration in the condition of the markets. The tariffs in foreign countries continue to occasion difficulties, and special reference is made to the preferential treatment accorded by some of the British colonies to Great Britain. Other difficulties are anticipated on account of the new British Patents Act, and the possibility that the Government of the United States may pass a similar measure.

HONG KONG ELECTRIC.—The annual report gives the balance at credit of profit and loss accounts as $159,637, of which $3,000 is absorbed by directors' fees. A 10 per cent. dividend and a bonus at 2 per cent. is recommended, and it is

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proposed to write off $71,920 for depreciation, to pay a bonus to the staff amounting to $5,395, and to carry forward $9,321. The lamp connections are given as over 47,400 8-c.p. lamps, and 85 arc lamps and 24 electric lifts are being maintained by the company. Two new 300-kw. Diesel alternators have recently been erected.

MADRAS ELECTRIC SUPPLY.—The report states that the construction of the generating station is not so far advanced as the Board expected, owing to delays in obtaining the necessary bricks and other materials. The plant, machinery, and appliances are, however, ready for installing in the station. The mains in the compulsory area have been laid as required by the terms of the license, with the exception of a small length, the materials for which were diverted to extensions required for the supply of some intending consumers. The contracts for the tramway generating plant, the feeders, and the erection and equipment of the sub-station, necessary for the supply to the tramways, have all been let, and it is hoped that the commencement of tramway supply will be made at the beginning of next year. There are a number of consumers already connected with the mains, with an equivalent of 3,686 lamps of 8 candle-power. These are being supplied from the small temporary plant, and it is not considered advisable to make further connections until the permanent machinery is at work. Applications have been made to the Government for extensions of the license to enable the company to supply current in Fort St. George, and to the Port Trust in Madras. The meeting will be held on Wednesday, June 10th.

SAO PAULO TRAMWAY LIGHT AND POWER CO.—The annual report records an increase of net earnings from $1,368,162 to $1,395,873. $100,000 has been placed to contingent account. The quarterly dividends of 2 per cent. and one of 2½ per cent. have been paid.

URBAN ELECTRIC SUPPLY.—The report of accounts for the year ended December 31st, 1907, shows a gross profit of £36,433, and, after deducting the London expenses, there is a balance of £34,640, which has been carried down to net profit and loss account. After adding £633 interest received on deposit, and deducting other items, amounting together to £12,761, there remains a profit balance of £22,512, which falls short by £9,987 of the amount of £32,500, also appearing, required to meet the 5 per cent. guaranteed dividends on the issued capital of the company. This deficit, being the debit balance as shown in the accounts, has been duly provided by Edmundsons' Electricity Corporation, Ltd., under their contract. A provision has been made of £1,612 for depreciation of stock of wiring goods and fittings, and also of £462 7s. 6d. for depreciation of plant and machinery under the terms of the agreement with the contractors. At the meeting yesterday the report and accounts were adopted.

WEST AFRICAN TELEGRAPH CO.—The report and accounts, referred to on page 797 of our issue of May 21st, were adopted at the general meeting last Thursday. Lord Tweeddale, who presided, said that there had been a considerable falling off in the receipts from Portuguese traffic, and a further diminution of the amount received, due to diversion of traffic owing to interruption of the lines of other companies. A portion of the St. Thomé, Loanda, cable has been renewed during the year. A final dividend of 2 per cent. is to be paid, making 4 per cent. for the year.

WEST INDIA AND PANAMA TELEGRAPH.—The half-yearly report for the year ended December 31st last records an increase of revenue from £34,203 to £37,262, and a rise in expense from £21,611 to £23,028. By the inclusion of £1,014 brought forward and interest on investments, there is an available balance of £16,995. A dividend of £1 6s. per share on account of dividends accrued to December 31st, 1907, is proposed, leaving a balance of £557. The cable-ship, *Henry Holmes*, has been overhauled during the year.

The Institution of Civil Engineers.—The Council of the Institution of Civil Engineers propose to award annually a prize to be called the Indian Premium to the Author, being a corporate member of the Institution in practice in India, of the best Paper received during the year on a subject connected with Indian engineering. This special award, which, when made, will be irrespective of any other recognition of the merits of such Paper which the Council may accord to it in the ordinary course, is derived from the proceeds of certain trust funds conveyed to the Institution on the closing of the Royal Indian Engineering College, and will be of the value of about £33 annually. The Council further propose that the income of a legacy of £1,000 bequeathed by the late Mr. L. F. Vernon-Harcourt to the Institution be applied, in general accordance with the testator's wishes, to provide for a biennial lecture on some subject relating to rivers, canals, or maritime engineering to be delivered before meetings of students of the Institution in London, and before such of the provincial associations of students as the Council may determine from time to time. The Council recently have accepted, on behalf of the Institution, a legacy of £1,000, bequeathed by the late Mr. F. W. Webb, to be applied to establish a "Webb Prize," to be awarded by the Council once in every three years, or oftener, as the Council may think fit, for the best Paper submitted to the Institution on "Railway Machinery," or upon some branch of railway machinery which may be prescribed by the Council.

ELECTRIC CABS IN BERLIN

A RECENT issue of *Motor Traction* contains an article in which some information is given regarding the petrol and electric cabs in Berlin. According to this article there is in Berlin a practically uniform rate of pay for the drivers of the different companies, and a uniform rate for both petrol and electric cabs. The large electric cab companies are paying to their drivers 1s 6d. per day as pay, and twenty per cent. of the revenue of the day. Experience with electric cabs in Berlin has shown that only very large and well-managed companies are profitable. Electric cars of several types are running, including N.A.G., Kriéger, Scheele, Löhner-Porsche, B.E.D.A.G., Maxim, and Hagen cars. The average daily receipts are about 35 shillings, which corresponds to a distance of about 68 miles.

The electric cabs of the B.E.D.A.G., Maxim, and Siemens Schuckert types have a weight of 30 to 36 cwt. empty. On an average 290 watts per mile are discharged from the battery, which weighs about 12 cwt. It has been found that the accumulator efficiency is under 70 per cent. (mostly about 62 per cent.), and that therefore about 450 watts per mile are used. The following table of expenses per annum is given :—

	£	s.	d.
Charging current according to the Berlin Supply Tariff	74	5	0
Cost of battery maintenance and renewal (150 discharges before renewal of plates is necessary)	82	10	0
Tyres	115	10	0
Repairs to electric gear	20	0	0
Repairs to chassis (including boxes damaged by acid vapours)	7	10	0
Re-varnishing of body (which by the constant charging of battery suffers more heavily than the body of a petrol cab)	7	10	0
Time of drivers during repairs	36	0	0
Cleaning of car	6	0	0
Garage (dearer on account of battery rooms)	20	0	0
Oil	1	0	0
Insurance	15	0	0
Taximeter expenses	5	0	0
Sinking fund on price of car (£500), including two batteries	50	0	0
Interest on capital	20	0	0
Total ...	£458	5	0

The practically level streets of Berlin, 90 per cent. of which are asphalted, are very favourable to the efficient driving of electric cabs, but in spite of this it remains a fact that only good drivers with first-class economical cabs, belonging to large companies, are at present successful.

Board of Trade Standard Ampere.—A note appeared under the heading, "Electrical Science" last week giving an account of a comparison that Messrs. T. Mather and F. E. Smith had made between the Ayrton-Jones standard current weigher at the National Physical Laboratory and the Board of Trade standard ampere. Electrical engineers will be interested to know that in the original Royal Society Paper in question it was also stated that the Board of Trade standard ampere is equal to the international ampere as defined by silver deposit within one part in 10,000—that is, within 1/100 part of one per cent. In view of the approaching International Congress, in which the discrepancies between units and standards may be discussed, this is of even greater importance than that the difference between the Ayrton-Jones ampere standard and the Board of Trade ampere is 1/30 of one per cent.

Proposed Electrification of Railways in Alsace and Lorraine.—According to the *Elektrotechnischer Anzeiger*, the Metz Chamber of Commerce has presented a memorial to the railway authorities in Strassburg, concerning the electrification of the railways. The memorial recommends the introduction of a more frequent service of light trains on all the branch lines. Of the twenty-two lines concerned, about two-thirds run through the valleys of the Vosges Mountains, which contain many textile, woodwork, and other factories. The remaining railways connect the valleys of Lorraine with the main line. The service is particularly suitable for electric traction, as a quick and frequent service is required, and the distances between stops are short. In Alsace plenty of water-power is available, and in Lorraine cheap power could be generated from blast-furnace gases.

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MISCELLANEOUS CITY NOTES

BRUCE, PEEBLES & CO.—It is reported in the *Financial Times* that a scheme for the reconstruction of Messrs. Bruce, Peebles & Co. has been approved by a committee of creditors and shareholders, and will be presented to the court for sanction. Under the scheme holders of the £75,000 of debentures of the company will rank first, then the unsecured creditors will receive 7s. 6d. in the £ in new debentures (ranking after the old debentures) and 12s. 6d. in the £ in fully-paid shares of the new company to be formed. The present preference shareholders are to be asked to take three new shares of £1 each for every £5 they hold in the old company, and to pay 10s. per share in cash, they receiving the £1 shares fully paid. The Ordinary shareholders are to be asked to take one new share of £1 for every £5 held in the company on condition that they pay 10s. per share in cash, the £1 share being then issued to them as fully paid.

MARCONI'S WIRELESS TELEGRAPH CO., LTD.—A prospectus has been issued offering for subscription 250,000 seven per cent. cumulative participating preference shares of £1 each. The directors and their friends have already applied for 50,000 shares of the present issue on the terms of the prospectus. There are no debentures. The preference shares are entitled to a cumulative preferential dividend of 7 per cent. per annum, and after payment of a dividend of 10 per cent. per annum on the ordinary shares, the holders of the preference shares have the right each year to participate *pari passu* with the ordinary shares in any surplus profits which it shall from time to time be determined to distribute. The preference shares carry equal rights of attending meetings and voting with the ordinary shares, and the right to rank in priority to all other shares for the repayment of capital, and *pari passu* with all other shares in any excess after repayment of capital. A good deal of information as to the operation of the company was given in the last annual report, which was printed at some length in ELECTRICAL ENGINEERING of April 30th (page 665). The money to be raised by the issue of the participating preference shares now offered for subscription is required, among other purposes, for the further development of the Marconi system, for working capital, and in particular to meet the expenditure and engagements that have been necessary and which have still to be incurred for the final completion of the Transatlantic stations at Clifden (co. Galway) and Cape Breton (Canada), by means of which wireless telegraph communication is now carried on between the United Kingdom and America. It is intended at once to bring up to the same level of efficiency as the Irish-Canadian stations mentioned the two long-distance stations at Poldhu in England and Cape Cod in the United States of America. Up to the present the Transatlantic Wireless Telegraph Service has been conducted at speeds varying up to 24 words a minute, but with a comparatively inexpensive modification of certain parts of the existing apparatus, an average speed of at least 30 words a minute should be attained, and, further, it is expected that it will be possible to send and receive simultaneously at this speed, so that 60 words per minute may be dealt with.

There have been considerable extensions in the maritime service, and the net receipts by the Marconi International Marine Communication Co., Ltd., and its associated companies from this source for 1907 is given as £37,504. The Poldhu station has been supplying a daily press service to such of the Atlantic liners as are fitted with long-distance apparatus. The receipts of the Poldhu station from this source alone during the two years ending February 29th, 1908, amounted to over £13,000. The agreements with various British, Colonial, and Foreign Government departments, &c., have resulted in considerable sales of apparatus, and involve payment to the associated companies of sums representing a fixed minimum of £13,444 per annum. Mr. Marconi has agreed to act as chief engineer to the company for not less than three years. It is stated that in May, 1908, 10,000 fully paid up £1 shares were allotted to Mr. Henry Cuthbert Hall in consideration of the relinquishment and discharge of the company from all claims and demands, whether for salary, commission, or otherwise, which were then in dispute.

WESTERN TELEGRAPH CO.—The directors have declared the third quarterly interim dividend of three shillings per share, free of income-tax, for the year ending June 30th, 1908, being at the rate of 6 per cent. per annum. The dividend will be payable on June 24th.

A Combined Trolley and Battery Automobile.—According to the *Electric Railway Review*, experiments are being made, under commercial conditions in Pittsburg, with a five-ton electric delivery which can be propelled either by its own batteries or when running along tramway routes by taking current from the overhead line by means of an ordinary trolley. The vehicle is provided with four 2½ h.p. motors which are used in series on the trolley line or in parallel on the 42-cell battery. The gearing permits of a speed of 22 miles per hour when on the tramway track, which is fast enough not to interfere with the tramway traffic, and the battery can propel the car at 8 miles per hour. A smaller car on the same principle has been in use for parcels delivery for two years.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C. inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted Tuesday night, was £59 5s. to £59 15s. per ton (last week £59 to £60 per ton).

DISSOLUTION OF PARTNERSHIP.—Joseph D. Jones and Bennet J. Boddington, carrying on business as electrical engineers at 150 Finchley Road, N.W., as J. D. Jones, Boddington & Co., have dissolved partnership. Debts by J. D. Jones at 150 Finchley Road, N.W.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—Ernest Goacher, Gateford Road, Worksop, Electrical Engineer, has been adjudicated bankrupt.

A meeting of the Industrial Storage Battery Syndicate, Ltd., will be held at 20 Mildmay Chambers, 82 Bishopsgate Street, London, E.C., on July 1st, at 12 noon, to hear the liquidator's account of the winding up.

Albert Lord, trading as an electrical engineer, under the title of Lord Brothers, at 134 Deansgate, Manchester, has been adjudicated bankrupt.

The liabilities of Ernest Albert Gresham, of 6 Harehills Avenue, Leeds, late of Westborough, Scarborough, Yorks, electrical engineer, are stated at £103 16s. 8d., and the assets are estimated at £19 1s. 9d.

Walter Wardle, electrician, of 14 Osborn Road, Levenshulme, Manchester, has been adjudicated bankrupt.

LONDON ELECTRICAL FITTINGS CO.—The name of the London Electrical Fittings Co., of 15 and 16 Newman Street, Oxford Street, has been changed to "Galsworthy, Ltd."

APPOINTMENTS AND PERSONAL NOTES

Mr. H. R. Forbes Mackay, the new City Electrical Engineer at Sydney, Australia, was, says the *Australian Mining Standard*, welcomed on his arrival last month by a dinner, which also partook of the nature of a farewell to the retiring Electrical Engineer, Mr. T. Rooke.

Mr. F. Spencer, late manager of the Halifax Corporation Tramways, has been presented with a roll top desk by members of the Town Council as a mark of appreciation of his services.

NEW PUBLICATIONS

"Telephones: Their Construction, Installation, Wiring, Operation, and Maintenance." By W. H. Radcliffe and H. C. Cushing. (London: Crosby, Lockwood & Son.) Price 4s. 6d.

"Radio-Telegraphy." By C. C. F. Monckton. (London: Archibald Constable and Co., Ltd.) 6s.

Institution of Electrical Engineers.—The following is the result of the ballot for new members at the annual general meeting on Thursday:—*Associate Members:* G. B. Barham, W. T. Bower, W. Buchanan, H. Burge, E. C. Churchward, E. H. Cockshott, J. G. Doran, J. I. Gear, J. W. Hogg, G. E. Mason, J. A. O'Brien, W. B. Packham, F. E. Saunders, W. P. Scott, W. A. Scott, F. G. Sherwood, H. E. Sutton, A. S. Tresilian, E. B. Trimmer, W. E. Vidal.

Bournemouth Tramway Disaster.—The inquest on the victims of the tram disaster of May 1st was resumed on Wednesday, May 27th. A report of the proceedings at the inquest on May 13th and 14th was given on page 764 of our issue of May 21st. The inquest was then adjourned until the 27th on account of the illness of the driver. As the driver is still unfit to attend, the coroner, Mr. F. Lefroy, after mentioning that the conductor, ticket inspector, and all the drivers who were on duty on May 1st would be called as witnesses, further adjourned the inquest until June 11th.

Water-power Stations in Spain.—Three water-power stations at Leizaran, Quintana, and Puentelarra respectively, the first two with a capacity of 4,000 h.p. and the last 8,000 h.p., supply the town of Bilbao on the Bay of Biscay with electric energy for light and power. The four three-phase Siemens-Schuckert generators at the first-mentioned station are driven by 1,000 h.p. Pelton-wheel turbines running at 375 r.p.m. They generate at 3,000 volts 50 cycles, and this pressure is raised to the transmission pressure of 30,000 volts by four groups of single-phase transformers, the three in each group of which are connected in star. The second station contains four 1,000 h.p. Francis turbines and the third contains four 2,000 h.p. units. The stations are respectively 49, 38, and 35 miles distant from Bilbao, in which town a sub-station with a capacity of 6,800 k.v.a. has been built. The town of Basconia has a 1,700 k.v.a. sub-station, and smaller sub-stations are situated at St. Sebastian, Vitorio, Arrigorriogo, and Mirando.

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PARLIAMENTARY INTELLIGENCE

EDINBURGH CORPORATION (TRAMWAYS, &c.) PROVISIONAL ORDER CONFIRMATION BILL was read a third time, and passed in the House of Lords on Tuesday.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY.—This Bill came before the Unopposed Committee of the House of Lords on Wednesday, and was ordered to be reported for third reading. As already announced, the Bill deals with the re-arrangement of the capital of the company. At present, under an agreement, the profits in respect of each half year available for dividends may be applied first in payment of the 4 per cent. accumulated preference dividend on £3,200,000 capital, and, secondly, in payment of a 4 per cent. accumulated dividend on the remaining capital. Any balance is to be divided amongst the holders of the two classes of shares. It is now proposed to cancel this agreement, and to convert a certain number of £10 shares into 4 per cent. preference shares, and to convert the remainder of the £3,200,000 capital into preference shares at any time.

METROPOLITAN ELECTRIC TRAMWAYS.—All opposition to this Bill has been withdrawn. It has been referred to the Unopposed Committee of the House of Commons.

Electric Lighting Provisional Order Confirmation Bill, No. 2, was read a third time and passed in the House of Commons on Friday.

PROGRESS OF ELECTRICAL BILLS.—The South Wales Electrical Power Distribution Bill was read a third time in the House of Lords on Tuesday, and a first time in the House of Commons on Wednesday last week.

The Bristol Tramways Bill was read a third time in the House of Lords on Tuesday, and a first time in the House of Commons on Wednesday last week.

The Wolverhampton Corporation Bill was read a first time in the House of Lords on Tuesday.

The Doncaster Corporation Bill was read a third time in the House of Commons on Tuesday, and a first time in the House of Lords on the same day.

Electric Lighting Provisional Order Confirmation Bill, No. 1, was read a first time in the House of Lords on Tuesday.

Electric Lighting Provisional Order Confirmation Bill No. 2 was before the Unopposed Committee of the House of Commons on Thursday, and was ordered to be reported for third reading. We gave particulars of this Bill in our issue for May 14th.

Electric Lighting Provisional Order Confirmation Bill No. 1 was read a first time in the House of Lords on Monday.

TELEGRAPH (CONSTRUCTION) BILL.—On the order for the second reading of this Bill, objections were raised to the powers the Bill would confer upon the Post Office which might result in the marring of rural scenery. The Postmaster-General said that the object of the Bill was that the Post Office authorities should have power to obtain way-leaves for telephone and telegraph lines against the obstructing of unreasonable individuals. He would consider later an amendment relating to the lopping or falling of trees. The Bill was then read a second time.

NEW COMPANIES

BANKFOOT POWER CO.—This company was registered on May 28th, with a capital of £40,000 in £1 shares, to erect a generating station at Bankfoot, near Crook, Durham, for utilising the gases and waste heat produced by coke ovens, to be erected by Pease and Partners, Ltd., and for generating electrical energy for distribution and sale; to adopt agreements with Pease and Partners, Ltd., and the Newcastle-upon-Tyne Electric Supply Co., Ltd., and to carry on the business of suppliers of electrical energy in all its branches. The subscribers are:—A. Pease, F. Stobart, T. Y. Greener, J. A. Parker, F. S. Newall, J. T. Merz, R. P. Sloan, and M. Short. No initial public issue. The number of directors is not to be less than three nor more than six; the first are J. T. Merz, F. S. Newall, and R. P. Sloan (nominated by the subscribers for the "Newcastle" shares), and A. F. Pease, F. Stobart, and T. Y. Greener (nominated by the subscribers for the "Pease" shares). Remuneration as fixed by the company. 20,000 shares are issued to the Newcastle-upon-Tyne Electric Supply Co., Ltd., and 20,000 to Pease and Partners, Ltd. Registered office: Collingwood Buildings, Collingwood Street, Newcastle-on-Tyne.

OXFORD TRAMWAYS SYNDICATE.—This company was registered on May 21st, with a capital of £55,000 in £1 shares, to adopt an agreement with the City of Oxford Electric Tramways, Ltd., to acquire, hold, or deal with any stocks, bonds, debentures, shares, or securities in the said company, or any other company formed for the purpose of constructing, financing, or working all or any of the tramways authorised by the Oxford and District Tramways Act, 1907, and to carry on the business of railway and tramway owners, electric light and power suppliers, electrical engineers, metal workers, contractors for the supply of electrical plant, manufacturers of and dealers in apparatus used in connection with the generation, distribution, accumulation, and employment of electricity, &c. The subscribers are:—W. J. Park, P. R. Reeves, S. Jordan, A. W. R. Stuart, C. J. Lissenden, W. Eacott, R. Bott. No initial public issue. The number of directors is to be four; two to be appointed by the National Electric Construction Co., Ltd., and the remaining two by the City of Oxford and District Tramways Co., Ltd. The first are B. Bernheim, 41 Lansdowne Road, Kensington, and W. B. Cownie, 4 Queen Anne's Chambers, Westminster, appointees of the Construction Co., and Sir Robert Buckell, of Oxford, and Colonel R. F. Webb, 6 West Cromwell Road, Kensington (appointees of the said Tramway Co.). Registered office:—Queen Anne's Chambers, Westminster.

REX ELECTRIC & GENERAL SUPPLIES, LTD.—This company was registered on May 23rd with a capital of £3,000 in £1 shares, to carry on the business of electrical and general engineers, contractors, manufacturers of electrical and mechanical appliances for lighting, power, and traction, importers and exporters of economic, domestic, scientific, curative, and pastime electrical appliances, dealers in electrical goods and accessories, &c., to acquire the goodwill of the Wholesale Electrical Supply Department of D. Santoni & Co. (1906), Ltd., formerly carried on at 15-17, Beauchamp Street, Brooke Street, E.C., and to adopt an agreement with D. Santoni. The subscribers are:—D. Santoni, F. Welti, W. Harbutt, J. Mortimer, R. Muirhead, L. Gros, A. Brown. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first. Qualification, £1. Remuneration, £25 each per annum (chairman, £75).

SANTONI ARC LAMP AND ENGINEERING CO.—This company was registered on May 15th, with a capital of £3,000 in £1 shares, to carry on the business of electrical and general engineers, contractors, manufacturers of electrical and mechanical appliances for lighting, power, and traction, importers and exporters of economic, domestic, scientific, curative, and pastime electrical appliances, dealers in electrical goods and accessories, and to acquire the business of the arc lamp department of D. Santoni & Co., Ltd., formerly carried on at 15-17 Beauchamp Street, Brooke Street, E.C. The subscribers are D. Santoni, G. A. Knapton, E. E. Tasker, A. Brown, L. Gros, K. Fredler, W. McIntosh Whyte. No initial public issue. The number of directors is not to be less than two nor more than five; the first are D. Santoni (managing director for ten years) and others to be appointed by subscribers. Qualification, £1. Remuneration, £25 each per annum (£50 extra for managing director).

SCAMPTON & CO.—This company has just been registered with a capital of £2,000 in £1 shares, to adopt an agreement with J. A. Scampton, and to carry on the business of advertising contractors and agents, dealers in electrical or other contrivances for advertising, stationers, printers, &c. The subscribers are:—J. A. Scampton, R. A. White, J. N. L. Peacock, S. G. Wood, A. E. Theaker, F. Lloyd, H. J. Hillier. No initial public issue. The number of directors is not to be less than two nor more than five; the first are J. A. Scampton and F. Lloyd (both permanent, subject to holding £100 shares). Registered office:—4-5 Warwick Court, Holborn, W.C.

SUN POWER CO. (EASTERN HEMISPHERE).—This company was registered on May 27th, with a capital of £500,000 in 1,500 founders' shares of 1s. each, and 299,925 ordinary shares of £1 each, to acquire any inventions relating to the utilisation of solar heat, and apparatus used in connection therewith, in particular to acquire the rights for the Eastern Hemisphere relating to certain inventions of F. Shuman, of Philadelphia, U.S.A., to adopt an agreement with the said vendor, as president, and on behalf of the Sun Power Co., of Tacony, Philadelphia, to manufacture and deal in sun or solar engines, and plant, works, apparatus and machinery of all kinds, including machinery and apparatus for refrigerating and ice-making, and for the production or supply of liquid air, electricity, light, heat, and power, to manufacture, create, generate, produce, and deal in and with ice, liquid air, electricity, light, heat, and power of any kind, &c. The subscribers are:—F. Shuman, F. Goswin, G. Despret, W. Seyrig, E. N. Shackle, V. Wilson, A. S. Pleus. No initial public issue. The number of directors is not to be less than three nor more than eleven; the first are F. Shuman, G. Despret, F. Goswin, W. Seyrig, and E. N. Shackle. Qualification, one founder's or £100 ordinary shares or stock. Remuneration (except managing director), £300 per annum, dividend. Each founders' share confers the right to participate in the profits of the company, to the same extent as 100 fully-paid ordinary shares.

Telegraph Traffic.—The Gibraltar-Tangier cable was put into working order again on May 20th, and on the same day communication between Rome and Constantinople was renewed. The cable between the Dardanelles and Constantinople was, however, interrupted for the purpose of carrying out repairs. The Ottoman Government announced similar restrictions to those in force during the Chio-Tenedos cable breakdown. The cable was, however, repaired on the 27th ult., and again interrupted on the 1st inst. On May 28th the cables between Sierra Leone and Accra and between Accra and Lagos broke down, but the former was quickly repaired on May 31st. The West India and Panama Telegraph Co. have been more fortunate recently in regard to interruptions to their cables, but the spell has been broken by the giving out of the cable between Demerara and Trinidad on the 30th ult. The last interruption of this cable took place in February, there being no other known break in any of the company's cables.

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PRIVATE TELEPHONE LINES CASE

Judgment Reversed

AN important case was heard last year (ELECTRICAL ENGINEERING, Vol. I., page 567), in which a large class of private telephone lines were judged by Mr. Justice Swinfen Eady to be liable to Post Office royalties. This judgment was appealed against (ELECTRICAL ENGINEERING, March 19th and April 16th, 1908), and judgment was given on Wednesday last week, reversing Mr. Justice Swinfen Eady's decision.

The decision affected those lines which, although known as private lines, are used for business purposes connecting up two or more firms, but not leading to the telephone exchange. It appears that until 1897 the National Telephone Co. paid royalties of 10 per cent. of the rental of these lines to the Postmaster-General in the ordinary course, but that, after that date, payment was refused by the company, who desired to test whether those lines were really subject to royalty. As the decision stands at present, they are not subject, but of course there will be an appeal to the House of Lords, and even if the case then goes against the Post Office the opinion is expressed in some quarters that there will be legislation to alter the law to meet the case in favour of the Postmaster-General's monopoly. Even if Parliament did amend the Telegraph Act in such a way, this could not be retrospective, so that the company was well advised to fight the case and appeal from the decision in the lower court, as the royalties which have accumulated in respect of such lines since 1897 would mean a very substantial sum. The question is not simply the construction of the Telegraph Act of 1869, and the famous case of the Attorney-General *v.* the Edison Telephone Co. in 1880, by which it was laid down that telephones are "telegraphs" within the meaning of the Act; for it is argued on behalf of the Post Office that even if such lines as these do come within the Postmaster-General's monopoly, the National Telephone Co. has contracted to pay royalty on them by the terms of their licence.

The case is now known in telephone circles as the A to B case, as this term has been used very much in the proceedings. The private lines may be divided into two classes, the first A to A lines, in which the subscriber has a line or lines connecting two or more instruments all for his own business, and used by himself or his employees, and the second class known as the A to B, in which private lines are employed by, say, two firms, A and B, for use between them for business purposes. In the latter category are lines connecting, for instance, the ticket agency of Keith, Prowse & Co., Ltd., with a number of theatres and hotels; private lines to fire brigade stations also come in this class, and there are a number of these in London to connect large buildings, &c., with fire brigade stations.

In the Telegraph Act the following cases are excepted from the Postmaster-General's monopoly :—

"(1) Telegrams in respect of the transmission of which no charge is made, transmitted by a telegraph maintained or used solely for private use, and relating to the business or private affairs of the owner thereof; and

"(2) Telegrams transmitted by a telegraph maintained for the private use of a corporation, company, or person, and in respect of which, or of the collection, receipt, and transmission or delivery of which, no money or valuable consideration shall be, or promised to be, made or given."

An interesting point is that, although the Appeal Court has reversed Mr. Justice Swinfen Eady's decision, it was not unanimous; the Master of the Rolls was of opinion that the decision should not be reversed, and Lord Justice Fletcher Moulton and Lord Justice Buckley held the opposite view.

Mr. Swinfen Eady, in giving his decision, had been guided almost entirely by the terms of the Telegraph Act, and the words, "for private use" in the two exemptions cited above, and had held that these words meant solely for the private use of the owner of the telephone, his family, and employees.

The MASTER OF THE ROLLS, in giving his decision, said that neither of the exceptions as given in the Telegraph Act were strictly grammatical, or easy to construe, but, contrary to Mr. Justice Swinfen Eady, he thought that the second exception met the present case. He attached importance, however, to the terms of the Telephone Co.'s licence, in Clause 2 of which leave is granted to use and work telephones "for the purpose of enabling any person with whom the company agree in that behalf to transmit direct from and receive at any office to and from any other person at any other office by means of spoken words (but not otherwise), and with the aid of such telegraphs as aforesaid telegraphic messages relating to the business or private affairs of such persons respectively or one of them." These words, he thinks, clearly and accurately give a description of an A to B line, and expressly exclude an A to A line.

In Clause 7 (1) the company agree to pay a royalty of 10 per cent. of the gross amount payable by any person in respect of the purchase, or hire, or maintenance, or working, or user, or right of user, of, or permission to use, "any telegraph or telegraphs of the kind or description hereby licensed." He was, therefore, of opinion that, although the lines were, under the Act itself, exempt from the Postmaster-General's monopoly, the company had agreed by the terms of their licence to pay royalty on them.

LORD JUSTICE FLETCHER MOULTON, dealing first with the exceptions in the Telegraph Act, said that the first insists that the messages must relate to the business or private affairs of the owner of the telephone, but does not insist that no "consideration" shall be given for the collection, receipt, or delivery of the message; whereas the second exception does not insist that the telegram shall relate to the business or private affairs of the owner, but requires that no consideration shall be given for the collection, receipt, or delivery. He is, therefore, of opinion that so far as the Telegraph Act is concerned, the owner of such lines is at liberty to deal with such messages when received just in the same way as he could with a message sent by himself without the intervention of the telegraph, provided the message is sent by himself, and that no charge is made for transmission. He may also permit this telephone to be used for the conveyance of other messages, but in that case no charge must be made for the collection, receipt, or delivery. He thinks, therefore, that a private telephone between, say, a firm and their bankers or customers, for the convenience of their business, in which no charge is made for the messages, is within the exception, and he thinks it makes no difference whether the lines actually belong to the users or are leased by them. Incidentally, however, Mr. Justice Fletcher Moulton divided the A to B private telephone into two classes, one of which he thinks does not come outside the exemption in the Act: "If A establishes a private telephone to B for the purpose of B's business, and B only uses it for the purposes of A's business, or by gratuitous permission of A to contribute nothing towards the construction, hire, or maintenance of the line so as to give himself a right to use it, the arrangement is within the exemption. But if A and B jointly maintain a telegraph for the purpose of communication between one another on the business or private affairs of either of them, each having thereby the right so to use the telegraph, it is outside the words of the exemption." As, however, the particular cases in the present instance do not come within this latter description, he is of opinion that they are all exempted from the monopoly, and the only question to decide, therefore, is whether royalty is due on them under the terms of the licence. In the licence there is a sub-clause (No. 7, sub-section 3) providing that where money is payable to the company, partly for telephones exempted from the Postmaster-General's monopoly, and partly for those not exempted, the Postmaster-General may apportion the sum so payable between two classes. It is clear, said Mr. Justice Fletcher Moulton, that the Post Office is only to receive the latter portion, and he cannot conceive that there should be a provision of this kind unless it had been the intention of the parties that only those telephones which require licences should be held to be licensed, and only the money payable in respect of them should be payable for such licence. He was, therefore, of opinion that the judgment of the Court below was erroneous, and that the appeal should be allowed.

LORD JUSTICE BUCKLEY concurred with Lord Justice Fletcher Moulton, being of the opinion that the National Telephone Co. were not accountable to the Postmaster-General for royalties in respect of the lines in question.

The appeal was accordingly allowed.

A *verbatim* report of the judgment, occupying about four columns, will be found in *The Times* of last Thursday.

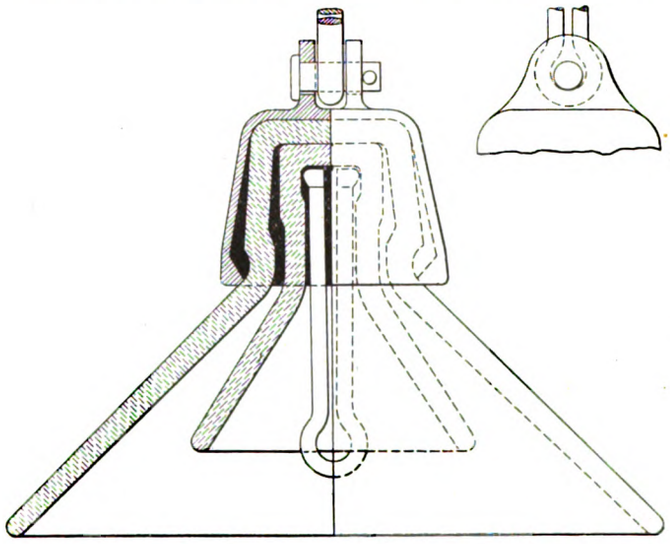
"Liconite" Cable.—In connection with the article on the new leadless cable published in our last issue, we are requested to state that Messrs William Geipel & Co., Vulcan Works, St. Thomas' Street, S.E., will be pleased to give information with regard to the cable in question to anybody desiring to have it. We are also informed that a two yard length, cut off the 40-yard length of cable with "reinforced" liconite insulation mentioned in our article, was tested after the visitors had left, and only broke down at 54,000 volts. This piece had been bent round an 18 in. drum three times in each direction, prior to being tested. The thickness of the insulation, which consisted of alternate layers of liconite elastic and impregnated paper, was 0·5 in., excluding the braiding. The insulation resistance was 86 megohms per mile. Liconite, and liconite cables are being exhibited by Messrs. Geipel & Co. at Stand No. 260 in the Machinery Hall at the Franco-British Exhibition.

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200,000-VOLT SUSPENSION INSULATORS

WE have received some particulars of the development of the suspension type insulator manufactured by the Locke Insulator Manufacturing Co., of Victor, New York, from Messrs. W. Geipel & Co., who are now sole agents for these insulators for the Continent of Europe and the Colonies.

The underhung insulator as first developed consisted essentially of several conventional type line insulators, and these, when tested, gave such excellent results that it was quickly recognised as the proper method of insulating extra high potential lines. Since lines erected in this manner are usually of considerable importance, the matter of mechanical weakness was first under consideration, and as the conventional type line insulators have no great amount of strength in tension, some new development was necessary. This feature was first taken care of by using a single shell of porcelain on the outside of which was cemented a metal cap and on the inside of which was cemented an eye-bolt. Mechanically, the device was very nearly ideal, since mechanical strength in excess of 20 tons could be readily obtained, but electrically the device is not a success when built in this manner, since the condenser effect causes a piling-up of potential around the end units, and if



UNIT OF 200,000-VOLT LOCKE SUSPENSION INSULATOR.

Leakage distance ... ... 24 inches.
Striking ,, ... 4½ ,,

Scale—One-quarter full size.

made of reasonable size, will be found not to have dielectric strength comparable with the flash-over potential. These insulators behave exactly like line condensers in series, and if the approaching wave be steep and coming with great rapidity, the first unit has to stand a very high potential. For this reason it was found necessary to introduce two pieces of porcelain which could be made thin and of good quality, and would permit of approximately 100,000 volts being applied upon the unit. Also, it added materially to the leakage distance of the whole device. It is the custom to test the shells of this underhung insulator to flashing-over potential for about five minutes before assembling, and after assembling, to test the unit to 100,000 volts for a period of five minutes. A mechanical test of 5,000 lb. is then applied to the device in order to ensure that the porcelain and cement have been properly put together and are of good quality.

The mechanical features of this insulator are not without interest. As shown in the accompanying sections of one unit, each of the shells is recessed on the inner side, and that inner connection is made by means of a "U" bolt which springs out in the recess, and then the annular space is filled with neat Portland cement, which is allowed to obtain its permanent set under water. Analysing for a moment the mechanical strains which fall upon this sort of a joint, it will be seen that from the upper end of the "U" bolt strains may be transmitted at 45° through the porcelain and cement to the expansion cap which supports the whole device through throwing the porcelain into compression, and permitting of the development of any desired mechanical strength. The device shown has a mechanical strength, ultimate, of something in excess of 14,000 lb., though for this excessive value the cement should be allowed to set for several weeks under water.

The insulator is normally used in a vertical position, about 25,000 volts per unit, four units being allowed for a 100,000-volt star connected line. For corners it will, of course, be necessary to use the insulators in a horizontal position to by-pass the line wire.

It may be noted that these insulators are even safer in a horizontal position than vertically, for if the arc does leap over the surface, it is immediately blown out by its own heat and away from the insulator, whereas, in the conventional type of insulators, if an arc plays over it, sufficient heat is usually liberated underneath the shells to destroy it.

HULL MUNICIPAL TELEPHONE ACCOUNTS

THE accounts of the municipal undertaking for the year ended March 31st, 1908, show a capital expenditure during the year of £1,882, making a total of £54,747. The revenue amounted to £9,567, and the expenditure to £5,596, and after deducting sinking fund and interest charges, there is a net profit of £1,055.

Details of the revenue are as follows:—Exchange rentals, £8,792; private line rentals, £222; public telephones, £309; tolls (toll services), £141; trunk fees and telegrams, £95; and sundry sales, £8. Total, £9,567.

In maintenance and repairs £1,429 was spent; establishment charges, including salaries and wages, amounted to £2,392; royalties, £966; rents, rates and taxes, £668; and wayleaves, £140. Total, £5,596.

In accordance with a resolution passed in April, 1907, the balance on net revenue account at March 31st, 1907, has been applied as to £214 for writing down preliminary expenses from capital account, and the balance of £1,578 has been transferred to reserve fund, which now stands at £1,633.

In a report by Mr. T. Holme, Engineer and Manager, it is stated that the total underground conduits now laid amount to 34 miles 1,671 yards, and the underground mileage is equivalent to 7,157 miles of single wire. The overhead wires have an equivalent length of 1,037 miles of single wire. The cost per telephone station now stands at £22·36, against £24·04 last year, and this amount will further decrease as the spare cable and plant become occupied.

At the meeting of the Telephone Committee on Wednesday last week, at which the report and accounts were adopted, the Chairman, Mr. Alderman J. Brown, said that it was a matter for great congratulation to Mr. A. R. Bennett, the consulting engineer, that what he foretold was being carried out, and he also complimented Mr. Holme and the staff. Mr. Alderman F. Larard, J.P., in seconding the resolution, complained that they had not had more assistance from the Post Office, who had received £966 during the past year in royalties.

CATALOGUES AND PAMPHLETS RECEIVED

INSULATED WIRES.—A new price list of guttapercha, indiarubber, silk, and cotton-covered wires has been issued by the Indiarubber, Guttapercha, and Telegraph Works Co., Ltd. The list includes single and twin bell wires, telephone cords and flexibles, silk and cotton-covered copper and German-silver wires for instruments, dynamos, &c., guttapercha insulated wires, special shot firing cables, and a very complete list of jointing materials and jointers' tools.

SWITCHGEAR.—A leaflet from Messrs. A. Reyrolle & Co., of Hebburn-on-Tyne, describes a simple form of isolating link, operated by a hooked pole, which the company have introduced to comply with the Home Office stipulation that it shall be possible to isolate all parts of a switchboard for cleaning purposes, inspection, &c. Another leaflet describes a special experimental switchboard at the Central Technical College, South Kensington.

CONDUIT FITTINGS.—A new catalogue from the Armorduct Manufacturing Company gives particulars of various fittings for interior conduit wiring on the "Witton Grip" system for ensuring electrical continuity, which was described in ELECTRICAL ENGINEERING, February 13th, page 244. It will be remembered that a conduit fitting of the ordinary non-screwed type, and of the size ordinarily used, is slotted to part of its diameter, and a claw grip metal band, which is fitted with sharp projections or teeth, so as to engage the tube firmly, when the binding screw is tightened home. In the closing and scraping movement which naturally results, the enamel, which would otherwise prevent electrical continuity, is automatically removed. A mechanical contact of great strength is secured, and electrical continuity is ensured.

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SUMMARY

The contractors for the gas generating plant in Johannesburg are credited with the intention of putting this in working order again, as they claim to have arrived at the causes of its non-success in the past. (Page 876.)

The automatic signalling system which is being installed on the Metropolitan Railway between Praed Street and Aldgate is similar to that in use on the District Railway, except that the actual points and signals are electrically driven through an oil transmission instead of by compressed air. (Page 877.)

An article on the accounts of the Hull Telephone Department for the year ended on March 31st last shows that the total cost of working, including capital charges and Post Office royalties, but with no allowance for depreciation of plant, averaged about £3 14s. per telephone station. These results are about the same as last year, the only notable exception being that the exchange repairs have risen from 1s. to 2s. per telephone station. The capital expenditure per telephone station stands at £22 7s. Although the Corporation's licence, which was obtained in 1902, expires in 1911, and the loans for the construction of the system were borrowed for periods of 25 years, no depreciation fund has been set aside, and the reserve fund stands only at £1,633, out of a total capital expenditure of £54,747. (Page 878.)

Some notes are given on the equipment of the two overhead trolley lines of the London County Council at Woolwich and from Hammersmith to Harlesden respectively. Span wire construction is used, with a grooved trolley wire, and special arrangements are made at the crossings of the Hammersmith line with the lines of the London United Tramways Co. (Page 879.)

The following books are reviewed in this issue:—"Modern Views of Electricity and Matter," by Sir Oliver Lodge (Third Edition); the Deinhardt-Schlomann Series of Technical Dictionaries in Six Languages, Vol. II., "Electrical Engineering"; and Whittaker's "Arithmetic of Electrical Engineering for Technical Students and Engineers." (Page 880.)

When Lord Cromer's Committee of the House of Lords adjourned on Thursday for the Whitsun recess, the case for and against the London and District Electric Power Bill had been concluded, the Hon. J. D. Fitzgerald, leading counsel for the Bill, having deferred his reply, by arrangement, until he comes to oppose the Bill of the eight electric lighting companies. Evidence was given on behalf of the companies against the Bill by Mr. J. Conacher, of the Metropolitan Electric Supply Co.; Mr. H. B. Renwick, Secretary of the County of London Electric

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Supply Co.; Mr. E. W. SEALE, Secretary of the Charing Cross, West End & City Electricity Supply Co.; Mr. A. F. HARRISON, Secretary of the City of London Electric Lighting Co.; and Mr. C. P. SPARKS, Engineer to the County of London Electric Supply Co. In this evidence, stress was laid upon the fact that the companies have carried out a canvass of the whole of the County of London in order to ascertain the amount of power, electrically driven or otherwise, in existence. It will be remembered that during the proceedings upon the Administrative Bill of 1905 it was stated that there was over 500,000 h.p. in the area, of which only about 7 per cent. was driven electrically. The canvass of the electric lighting companies showed that the total in London is only about 208,000 h.p., and that the existing supply authorities, both companies and municipalities, are supplying 35·38 per cent. of this. Whilst Mr. Sparks was being cross-examined at some length upon the basis of his tables, showing that the existing companies could generate as cheaply as the proposed new company, and that there would be no benefit to them in taking a supply in bulk, the Chairman intervened with the remark that the Committee had heard sufficient examination and cross-examination upon this point, and he asked Mr. Balfour Browne to commence his speech in reply. In his speech Mr. Balfour Browne argued that to set up a new competition such as was proposed under this Bill would be a breach of Parliamentary bargain, and would introduce competition under conditions not contemplated at the time of the passing of the Electric Lighting Acts nor by Major Marindin's report. He severely criticised the finance of the Bill, but it was apparent by the Chairman's interruptions that the Committee did not share his views. Mr. Balfour Browne's argument was that none of the promoters were committed to finding a single penny of the capital, whereas the Chairman said he thought that £500,000 was tolerably assured. The Committee adjourned until Tuesday, 16th inst., when Mr. Balfour Browne will open the case for the Companies' Bill. (Pages 881-884.)

THE Heysham-Morcambe-Lancaster lines of the Midland Railway form the first example of single-phase traction in England. The length of single road now electrically equipped is about 21 miles. The overhead line works at 6,600 volts, 25 cycles, and is supported from cross gantries mounted partly on wooden poles and partly on lattice steel bridges by means of specially designed catenary suspension, presenting some novel features. Three-car trains are employed, at present equipped some on an all-electric and some on an electro-pneumatic multiple unit system, but arranged to be interchangeable. Power is taken from an existing gas-driven station at Heysham, where an extra generating set and some motor generators have been put down. (Page 885.)

THE Felten Guilleaume Lahmeyer Co. have recently introduced an interesting new design of starter for large rolling mill motors. (Page 891.)

A LONG letter from Mr. A. A. VOYSEY, elicited by our editorial note on street lighting last week, points out the futility of cut-throat competition, and puts forward a plea for greater harmony of working between conflicting commercial interests. (Page 892.)

WE give the full programme of the Nottingham Convention of the Incorporated Municipal Electrical Association, which will be held from June 30th until July 3rd, inclusive. The Presidential Address will be delivered on June 30th, and will be followed by a Paper by BAILIE WIGHTMAN. The second day will be devoted to an excursion. On Thursday, July 2nd, the Annual General Meeting will be held in the morning, and two Papers on generating stations, by Mr. H. Richardson and Mr. C. M. SHAW, will be read and discussed in the afternoon, the annual dinner being held in the evening. The final meeting will be held on Friday morning, July 3rd, when Papers by Mr. A. M. TAYLOR and Mr. H. A. RATCLIFF, dealing with A.C. accumulator sub-stations, and testing departments respectively, will be discussed. (Page 893.)

A SINGLE-PHASE goods locomotive, equipped with three 350 h.p. compensated repulsion motors of the Winter-Eichberg type, has been constructed for the Prussian State railways, and is now being used on the experimental line at Oranienburg. The locomotive is constructed in two halves, and weighs 59·5 tons complete. The maximum speed of the locomotive is about 37 miles per hour. (Page 893.)

IT is officially announced that the International Congress on Electrical Units and Standards in London will be opened on October 12th. A memorandum has been prepared of the proposals to be laid before the Congress, the chief object of which is to consider and advise as to the steps to be taken to bring about agreements in the definition of electrical units forming the basis of legislation in different countries, and in the methods necessary to give effect to these definitions. (Page 894.)

IN a Paper read before the Cape Town Local Section of the Institution of Electrical Engineers, Prof. H. BOHLE investigated the problem of giving, with a suitably designed reflector, a uniform illumination over a wide area from a single source of light. (Page 894.)

AT the Edinburgh exhibition, some electrically driven laundry machinery and coal-cutting machinery, both presenting points of interest, are exhibited. (Page 897).

A NEW graphical method of determining the mean spherical intensity of a lamp has been devised by Mr. A. E. KENNELLY. (Page 898.)

UNDER "Electrochemistry and Electrometallurgy" is described a process for the electrical refining of silica. An abstract is also given of a Paper by Dr. A. Frank, read before the Faraday Society, on the commercial production of cyanamide. (Page 899.)

UNDER "Electrical Science" is included a note on the radioactive deposits from actinium. In the Papers abstracted in the Continental section, HEMSALECH describes the results of two methods of investigating harmonics in spark discharges, and SCHAMES shows how to determine permeabilities with alternating currents. (Page 900.)

AMONG the Patent Specifications published on Thursday last is one by S. Z. DE FERRANTI, in which some forms of polyphase electric furnaces are described. Heating by chemical combustion is combined with electrical heating, circulating, and mixing arrangements. A process for rendering soft petroleum pitch sufficiently dense and ductile to be of use for filling cable trenches is the subject of a Patent by T. MARRIOTT. A specification of SIEMENS BROS.' DYNAMO WORKS, LTD., relates to that system of alternator compounding in which a small rotary converter mechanically coupled to the alternator, and supplied with current from a series transformer, governs the excitation of the alternator. By the use of additional brushes on the rotary converter, the alternator is compounded for both watt- and wattless components of the load current at all power factors. This system can also be applied to the excitation of boosters in connection with buffer batteries on alternating-current systems. A load-equalising system for use on alternating-current circuits is described in a specification by P. M. LINCOLN, and another specification by B. KAUFMANN relates to the manufacture of metallic paper or tinfoil substitutes, as are used for electrical condensers. (Page 901.)

ONLY one tender has been received by the Buenos Aires Corporation for the construction of tube railways

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in that city, namely, from the French Thomson-Houston Co.—The Croydon Corporation electricity accounts for 1907-8 show a net surplus of £12,242, against £8,927 for the previous year.—In consequence of the East Molesey Council refusing to consent to the erection of overhead telephone wires, the Postmaster-General has decided to defer the telephone extension in the district until the Council changes its attitude.—A proposal was made last week to the Edinburgh Corporation that it should instal a competitive telephone system with the National Telephone Co., but as a licence would only be granted until 1931, the proposal is not to be entertained.—The Glasgow tramways receipts for the past year amounted to £907,494, an increase of £20,113 over those of the previous year.—A statement has been prepared by Mr. S. E. Fedden, engineer and manager of the Sheffield Corporation electricity undertaking, by which it is shown that, whereas in 1899, when the company's undertaking was acquired in Sheffield, there was not a motor connected to the mains, at present there is the equivalent of 9,674 h.p. connected, the average price for the supply to which is 0·943d. per unit. (Pages 903–906.)

THE Manchester Corporation require direct-current motors, direct-current motor starters, ampere-hour and watt-hour meters, and fuse boxes.—The London County Council require tramway feeder pillars.—The Sheffield Corporation contemplate an expenditure of £20,000 upon the electrical undertaking. (Page 906.)

THE report and accounts of the Birmingham and Midland Tramways Co. for 1907 show a net profit of £44,236; a 4 per cent. dividend is recommended upon the preferred ordinary shares. At the annual meeting of the Anglo-Portuguese Telephone Co., last week, it was stated that during the year extensions of the switchboards at Lisbon and Oporto have been carried out, giving an increased capacity for 900 subscribers in the former, and 240 subscribers in the latter.—The accounts of the Brush Electrical Engineering Co. for 1907 show a net profit of £10,229, after paying debenture and other interest. No dividend is declared. The output of the works during 1907 has been the greatest in the history of the company, but the company has been suffering from inadequacy of working capital, necessitating temporary loans from bankers and others at a high rate of interest. (Pages 907–8.)

A DISCUSSION took place in the House of Commons on Wednesday last week with regard to the increasing number of fatal and non-fatal accidents in factories. There was considerable criticism on the present methods of appointing factory inspectors, objection being taken to the examination system, which, it was alleged, did not provide for any practical knowledge on the part of the candidate. Mr. Herbert Gladstone, Home Secretary, replied that he was perfectly ready to change the system as soon as he was convinced that it did not produce the right men for inspectors. Although the present system had been ridiculed, no case of failure or shortcoming had been brought to his notice, but nevertheless he would welcome an impartial inquiry, either by departmental or select committee. (Page 909.)

A SHORT article gives some of the principal figures from the accounts of the National Physical Laboratory. (Page 909.)

A CONSULAR Report contains some figures relating to the consumption of electrical energy and the application of electric driving in Berlin, and some statistics showing the foreign trade of Germany in electrical machinery and apparatus for the year 1907. The imports, as would be expected, are very small in comparison with the exports. (Page 910.)

Mr. C. W. MALLINS has been appointed general manager of the Liverpool Corporation Tramways. (Page 910.)

THE group of Lancashire lines of the Midland Railway, which have recently been converted to electric traction, will be watched with great interest by electrical and railway engineers, as being the first example of single-phase traction to be actually put to work in the country. The running of these lines electrically must of course be regarded to some extent as experimental, for upon their working will depend the more extended adoption of the system upon which they are equipped on the main line railways of Great Britain. From a technical point of view, however, the work can hardly be classed as experimental, founded, as it is, upon the results of experience with varieties of the system in use on the Continent and in America. Although based to a considerable extent on such experience, the equipment is not a case of merely following after the work of others, but shows points of originality—notably in the 6,600-volt catenary suspension designed by Mr. J. Sayers—which would appear to mark advance rather than imitation. Although the line is only a comparatively short section, with a frequent service of small trains, there is much in the equipment, especially as regards the overhead work, which is practically the same as would be adopted for heavy main lines, and it is in the bearing of the experiment on the conditions of main line traffic that much of the interest lies. The question of power supply was, of course, different, and the methods adopted must be viewed rather as expedients to utilise an existing generating station, than as an example of what would be done on a large scale, when the problems of cheap generation by large units, overload capacity, feeding and transformation, would require different solutions. A glance at the description of the generating plant and overhead equipment in another column will show the thoroughness with which the engineers to the Midland Railway have considered the conditions, and the running of a well-equipped line such as this should do more to define the conditions for which the single-phase and continuous currents are suitable than the wordy warfare which has been waged on paper by the partisans of the two rival systems of electric traction.

THE programme of the annual summer meeting of the Incorporated Municipal Electrical Association, which we publish to-day, shows that, as usual, pleasure and business will be combined, and this excellent arrangement conduces to the maximum individual benefit to members attending the Convention; for many men derive as much useful information from informal talks and comparison of experiences with their fellow engineers as from the discussions on the actual Papers. In Nottingham it is particularly wise to have arranged a whole day and an afternoon for excursions and visits to works, for, owing to the smallness of the hotels, the members will be more or less scattered all over the town, so that each member will meet fewer of his friends in the hotel smoking-room. It will be noticed that there is no Paper on electric traction this year. Papers on this subject are getting fewer at the Municipal Electrical Association meetings, owing to the rival claims of the various tramway associations, and this year it is not surprising that tramway matters should be left to the meeting of the Municipal Tramways Association, that will be held in Nottingham in the autumn, under the presidency of Mr. JOHN

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ALDWORTH, General Manager of the Nottingham Tramways. On the first day (Tuesday, June 30th) BAILIE WIGHTMAN'S "experiences" will doubtless give rise to an instructive and entertaining debate, which will be allowed a wide range; on the Thursday afternoon the design of generating stations will be discussed, in connection with Papers by Mr. H. RICHARDSON, of Dundee, and Mr. C. M. SHAW, of Worcester; and on Friday Mr. A. M. TAYLOR will justify his title, "Alternating-Current Accumulator Sub-Station," probably with one of his usual energetic displays of curves and tables, while Mr. RATCLIFF will describe the system of testing and standardising employed at Manchester. Upon metallic filament lamps and street lighting there is no Paper, but this will not prevent a useful interchange of ideas upon these two subjects during the week.

A PAPER, read by Prof. H. BOHLE before the Cape Town Local Section of the Institution of Electrical Engineers, published in an abbreviated form in this issue, should be regarded rather as an exercise in the theory of illumination than as a designer's guide for those practically engaged in electric lighting, whether for room or street illumination. Theoretically, uniform illumination, seldom obtainable in daylight, at any rate in cities, will still less be attained by any means of artificial lighting. For interior illumination, any calculations on a definite basis might be entirely upset by a change of wall-paper, or by an alteration of the positions of the furniture in a room, while for street lighting the idea of absolutely uniform illumination is Utopian. We do not wish in any way to depreciate the excellent work that Prof. Bohle has put into his Paper, and we are glad to see such painstaking contributions as this coming from one of our two "oversea" Local Sections, but we think it necessary to sound a note of warning lest the rules he gives should, without any saving clause, find their way at once into pocket-books of engineering formulæ and become ineradicably crystallised and copied from pocket-book to pocket-book, as is wont to happen in such cases. Caution must also be used in adopting the "A.E.G." figures of candle-power per sq. ft. for various purposes. Like Sir WILLIAM PREECE'S convenient 1 watt per sq. ft. for illumination with carbon-filament lamps, there are cases in which half the rating may be excessive, and others where double the figures given may still give insufficient light.

THE graphic method devised by Mr. A. E. KENNELLY for finding the mean spherical candle-power of a source of light from a polar curve is an interesting application of the involute and evolute, and may be found to be practically useful in certain cases. There is something attractive about the production of a mere straight line of definite length when a single quantity is sought, but in his natural satisfaction in discovering this novel construction Mr. Kennelly perhaps does some injustice to the Rousseau diagram, to which he favourably compares it. Engineers need not be told that the area of a diagram must be measured "either by a planimeter or by counting little squares on suitably squared paper"; there are more expeditious ways for such purposes as this, where great precision would be a waste of time. Mr. Kennelly claims a somewhat higher accuracy for his construction than for that of Rousseau, but it seems that in the time required for his rather intricate work a Rousseau diagram with a larger number of radii could be constructed and evaluated, and that nothing would be gained in accuracy. Besides this, Mr. Kennelly's method seems to demand considerable care, for any errors are cumulative.

ARRANGEMENTS FOR THE WEEK

FRIDAY, JUNE 12TH.

Physical Society.

8 p.m. Meeting in the Physics Laboratory of the Royal College of Science, South Kensington. Included in the agenda are the following Papers:—(1) "Experiments on a Directive System of Wireless Telegraphy," by Messrs. Bellini and Tosi; (2) "On the Resistance of a Conductor of uniform thickness whose breadth suddenly changes, and on the Shapes of the Stream Lines," by Prof. Lees; (3) "On the Self-Inductance of two Parallel Wires," by Dr. Nicholson.

WEDNESDAY, JUNE 17TH.

Dynamicables.

7.15 for 7.30 p.m. Dinner at the "Old Welcome Club," Hungarian Exhibition, Earl's Court.

THURSDAY, JUNE 18TH.

Faraday House Old Students' Association.

7.0 for 7.30 p.m. Annual Dinner at the Queen's Hotel, Leicester Square, London, W., Mr. Gerald Partridge in the chair.

THE GAS GENERATING PLANT AT JOHANNESBURG

THE *British and South African Export Gazette* states that the electrical power supply problem continues to attract much attention in engineering circles in Johannesburg, the chief new feature during the past month being the prominence accorded to Mr. W. A. Harper, who, as consulting engineer to Messrs. W. Beardmore & Co., Ltd., the guarantors for the gas-engine contract, has been discussing the whole matter with the municipality. According to a statement made by him, it is Messrs. Beardmore's intention to put the gas plant in working order immediately, their principal reason being that they have supplied exact replicas of those installed at Johannesburg, and in all cases they have worked satisfactorily. He is of opinion also that the gas-producing portion of the plant is everything that can be desired, with slight modifications in details to suit the use of Transvaal coal. He adds that the engines have been considerably damaged by "this dirty, tarry gas," but that they can be made as good as new at a very small expenditure, and, if a modern and suitable cleaning plant is added, he sees no reason why they should not be as successful in other parts of the world. The Council's attitude in the matter, however, is not known at the time of going to press, but we understand that further negotiations are now proceeding through the post.

London Tube Railways.—The announcement is made of the introduction of through booking between the Central London Railway and the Great Northern, Piccadilly and Brompton Railway.—As a counter-proposition to the proposal to push forward with the construction of the Cricklewood-Victoria tube railway, some of the frontagers along Edgware Road seem to prefer tramways in the thoroughfare. It is pointed out that the Royal Commission on London Traffic recommended the continuance of the existing tramways from Cricklewood down Edgware Road to Victoria, where they would join the present tramways from Victoria and Vauxhall Bridge to South London.

Telegraph Traffic.—The Eastern cable between Accra and Lagos was restored on June 3rd, while the cable between Cadiz and Tangier became interrupted on the same day. The via Hanekin route suffered a breakdown between Diarbekir and Bagdad and Alep and Bagdad, but it was put into working order again on the following day. Telegrams may now again be sent to all inland offices in Hayti, West Indies. It will be remembered that owing to a revolutionary outbreak, telegraphic correspondence was confined to the coastal towns only. Some delay exists on the Saigon-Bangkok line. On the 8th inst. the lines between Tauris and Teheran were interrupted. The cable between Cayenne and Salinas is still down, and the cable between Guam and Manila, belonging to the Commercial Pacific Cable Co., was down on May 25th last. The cable steamer owned by the company is not now at Honolulu, but the cable has since been repaired. The cable between Dardanelles and Constantinople broke again on June 9th, and the cable between Djedda and Suakim followed suit.

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AUTOMATIC SIGNALLING ON THE METROPOLITAN RAILWAY

THE Metropolitan Railway Company have been for some time considering the adoption of a complete system of automatic signalling on the parts of their lines where the traffic is more dense, and the announcement that a contract had been placed with the McKenzie, Holland, and Westinghouse Power Signal Co. for the provision of an automatic signalling system on that part of the Inner Circle between Praed Street and Aldgate and also up to Bishop's Road, did not come as a surprise. With the system in use, excellent though it is, 28 trains per hour is about the maximum that can be conveniently handled. The new system which is being installed is, however, designed for a headway of 1½ minutes or a maximum of 40 trains per hour, so that the increase in the carrying capacity of the line available will be very considerable. We are not at present able to publish full details of the apparatus which is to be installed, but a few notes on the general working and scope of the system and the important points wherein it differs from the signalling system in use on the District Railway may be of interest.

As already stated, the system is to be installed on that portion of the Inner Circle from Praed Street to Aldgate, and on the short length from Bishop's Road to the Praed Street junction, where the Great Western line branches off from the circle. This stretch amounts to about 5½ miles, mostly in tunnel, with 10 intermediate stations. The important junctions are at Praed Street and Aldgate, but sidings used for special purposes are provided at Edgeware Road and Farringdon Street. The company are already using a simpler form of automatic signalling to some extent between Praed Street and South Kensington, where, as we shall see below, the conditions are somewhat different, so that when the installation we are considering is completed, the ordinary working of the whole of the Inner Circle will be automatic.

The system is similar in many respects to the Westinghouse signalling equipment of the District and new tube railways, but has the important difference that, instead of compressed air being employed under electrical control, the working is "all-electric"; that is to say, electricity is used as the motive power for the points and for working the signals, as well as for detecting the positions of the trains. The general principle of working, whereby the completion of the rail circuit of the train itself sets the signals behind the train at danger is the same, and the arrangement of the track circuit and its relays is practically identical; but, as we shall see, the method of actuating the points and signals is entirely different.

The general principles of track circuit working were dealt with at some length in a Paper read before the Institution of Electrical Engineers in December, 1906, by Mr. H. G. Brown, who is now engineer to the McKenzie, Holland, and Westinghouse Power Signal Co., and under whose direction the contract is being carried out (see ELECTRICAL ENGINEERING, Vol. I., page 27); it is therefore unnecessary to deal with this part of the subject at any great length. The only alterations to be made to the track rails are their subdivision into sections corresponding to the length of the "blocks" by means of insulating joints, bonding the rails and making the necessary connections, all of which is being done in practically the same way as on the District Railway. The relays will be of the same polarised type arranged one near each end of every section with their contacts in series, so that any accidental movement of one due to extraneous currents will not affect the signals. The actual track circuit is supplied from a 60-volt continuous-current signal main running the whole length of the line. This main will be supplied at three points from motor-generators, taking current from the three-phase supply, which are being installed in the Baker Street, Charlton Street, and Moorgate substations, and will also be used for the power supply for actuating the signals, although, as will be seen hereafter, a separate supply at a higher voltage will be provided at the junction for working the points, &c.

The whole 60 volts is, of course, not placed across the track, but there is a resistance between the main and the rail in the usual way, across which most of the potential is dropped, leaving only some three or four volts actually between the rails. The most suitable proportioning of these resistances and the sensitiveness of the relays is a subject of considerable interest, and reference may be made to the Paper already mentioned for a discussion of the matter. These relays and resistances are contained in cast-iron boxes alongside the track.

The signals in the tunnels are of very simple character. Each consists of a case containing two electric lamps controlled by a relay and placed, one behind a green and one behind a red Fresnel lens. The tongue of the lamp relay normally rests by gravity on the contact closing the circuit of the "danger" lamp, but is drawn up by its magnet when the track relay allows a current to flow. Thus any failure of current always causes the danger signal to be given. In the parts of the line outside the tunnels electrically-worked semaphores will be used, and the method of working these is similar in principle to the moving of the points, and is one of the most interesting features of the system. For this purpose an intermediate gearing between the electric motor and the signal arm, known as the Johnson oil motor, is employed. In the form used in connection with the semaphore signals this consists primarily of a cylinder containing a piston which actuates the signal arm. When it is required to lower the arm, oil is pumped into the cylinder by a rotary pump worked by a small electromotor through a non-return valve, and when it is desired to put the signal to danger, another valve is opened, and the oil released, when the counterweight causes the arm to rise. This release-valve is normally held open, but is closed by a solenoid when a "line clear" signal is required at the same moment that the pump motor starts. Thus a failure of signal current opens the release-valve and causes the signal to fly back to danger, even if the pump continues to work, and avoids overloading and damage to the motor.

The point motor is somewhat different as, of course, a power movement is required in both directions. In this case a pivotted vane inside a fan-shaped chamber is used in place of the piston or cylinder, and the oil is pumped in on one side or the other, according to the direction of motion of the motor-driven rotary pump. The pump is provided with a by-pass kept normally closed by a valve, so that in event of a point fouling or a vehicle standing on the locking-bar, the pressure, as soon as it rises above a certain value, is released, and the motor simply circulates the oil through the by-pass. This is a very important feature of the apparatus, and gives it a sensitiveness very difficult to obtain by mechanical gearing. The appliance was the invention of Mr. A. H. Johnson, the Signal Engineer to the London and South-Western Railway.

It must, of course, be understood that the working of the Praed Street and Aldgate junctions is what is known as semi-automatic—that is to say, the points are set and the signals to proceed are given by the signalmen in the cabins at these points. The track-circuit arrangements, however, automatically place the

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signals at danger as soon as the train passes, and the electrical interlocking prevents any signal or point relating to an occupied section being moved in error.

At these junctions a special supply of 120 volts is provided for working the point motors and other appliances. This supply is entirely distinct from the 60-volt signalling main, and taken from batteries and motor-generator in the Baker Street and Moorgate sub-stations respectively. We are not able, at the present time, to give a detailed description of the arrangement of the locking frames, but we understand that some recent improvements are adopted whereby, when a complicated movement is to be made it is not necessary to pause between the pulling over of the various levers until the completion of the movement of the point or signal actuates the check-lock, although an equally efficient locking is secured. This will result in a considerable saving of time. The Aldgate frame will have 30 levers, but that at Praed Street will be of smaller size. All the stop signals will be provided with automatic train stops, similar to those used already by the Metropolitan Railway.

The existing hand-worked frames at such places as Edgeware Road and Farringdon Street, where there are junctions and sidings used for special purposes and not for the ordinary traffic, will be retained, and fully-qualified signalmen will be in attendance, although their duties will probably be combined with inspectors' work. Thus when special shunting, &c., is to be done, a signalman will enter the box, and will, by an appropriate arrangement, so to speak, isolate the section from the automatic system, and proceed to handle the movement in the ordinary way, restoring the automatic working when he has finished. Except on these occasions, the whole ordinary working between the Praed Street and Aldgate cabins will be fully automatic. The block sections will vary in length from about 750 to 1,000 feet. The work is being pushed forward with all speed, and the equipment of the Praed Street junction is already in an advanced state.

The system we have just outlined must not be confused with the automatic system which the company have been using now for some time between Praed Street and South Kensington. This latter is not a track-circuit system, but simply works by means of treadles and contacts controlling electrically-actuated signals. The arrangement is a good deal simpler and cheaper than track-circuit signalling, and has been found to answer admirably for this part of the line where there are nothing but electric passenger trains. It was not, however, considered to fulfil all the requirements of a line where there is also goods traffic, as in the possible event of a goods train parting into two the same security as given by the track-circuit is not afforded.

In conclusion, we wish to acknowledge the help given to us in the preparation of these notes by Mr. W. Willox, Engineer to the Metropolitan Railway, and Mr. H. G. Brown, of the McKenzie, Holland, and Westinghouse Power Signal Co., both of whom gave us information as to the system to be used.

HULL CORPORATION TELEPHONE ACCOUNTS

THE accounts of the Hull Corporation Telephone Department were briefly alluded to in our last issue, and we are now able to give some fuller information with regard to them. In his general report for year ending March 31st, 1908, Mr. T. Holme says:—

The gross receipts amount to £9.567, compared with £8,989 for 1907, being an increase of £578. The working and maintenance charges amount to £5,596, compared with £4,842 for 1907, being an increase of £754. The increase is chiefly accountable by two new items of Income Tax and advertising, and also a rise in the maintenance charges on the exchange, instrument and line plant. With regard to the exchange and instrument plant, the cost per station has now reached a normal figure, and no increase is expected in the future apart from the general increase due to additional subscribers. The maintenance of the line plant is regulated largely by the building alterations and other works in the City, and this year is estimated to be above the average. The total amount carried to loan repayment account is now £3,185, to reserve fund £1,652, and to temporary sinking fund, &c., £651, being a total (including this year's surplus of £1,055) of £6,525 after three years' working.

The capital account totals £54,747, compared with £52,864, being an increase of £1,883, which has been expended on extending the plant under the main headings of underground, overhead, exchange, and instrument construction.

Underground Construction.—The amount expended during the year has been incurred in laying 494 yards of conduits and extending the cable system by cables containing 151 miles 1,024 yards of metallic circuit. The total conduits laid now measure 34 miles 1,671 yards, and the underground mileage equals 3.578 miles 1,064 yards metallic circuits, or 7,157 miles of single wire.

Overhead Construction.—The amount expended during the year has been incurred in joining up additional subscribers and extending the overhead routes in the area by the erection of 91 poles, 54 being required in extending to Coniston and Skidby, where public telephone offices have been opened on extra mileage rental charges. The total overhead mileage is now 518 miles 1,223 yards of metallic circuit, or 1,037 miles of single wire.

Exchange Construction.—The amount expended during the year has been incurred in slight additions to the Central Exchange

Instrument Construction.—The expenditure during the year has been incurred in joining up additional telephones, also private branch exchanges, extension bells, and sundry apparatus.

Cost per Station.—The cost per station now stands at £22·56, compared with £24·04 last year, and this amount will further decrease as more of the spare cable and plant becomes occupied.

Revenue.—The amount carried forward for unexpired rentals equals £4,250, compared with £4,391 last year. At first sight it would appear that the revenue would decrease, but this difference is due to proportioning the whole of the Corporation telephone rentals to March 31st, and the revenue due for this year has already exceeded £10,000.

The capital expenditure on the system now stands at £54,747, made up as follows:—

	During the Year.	Total.
	£	£
Exchange buildings	—	1830
Exchange switchboards, fittings, &c.	83	4554
Underground construction	709	25718
Overhead construction	640	12155
Instruments	402	9094
Consulting engineer, commission ...	49	2255
Furniture	—	177
Preliminary expenses	—	964
Total	1883	54747

The expenditure out of revenue was as follows:—

	£	£
Maintenance and Repairs:		
Exchange repairs	236	
Line maintenance	653	
Instrument maintenance	512	
Roof repairs	28	
	——	1429
Establishment:		
Salaries	350	
Wages		
Office staff and canvassers	255	
Operators	1384	
Charges	284	
Printing and stationery	100	
Petty expenses	20	
...	——	2393
Royalties, Rents, and Rates:		
Royalty	966	
Rents, rates, and taxes	668	
Wayleaves	140	
	——	1774
		5596

The income statement is as follows:—

Exchange rentals	8792
Private line rentals	222
Public telephones	509
Tolls (toll services)	141
Trunk fees and telegrams	95
Terminal fees	1
Sundry sales	7
	9567

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Of the balance of £3,971, £2,916 has to be allotted to capital charges, leaving a nett profit of £1,055. None of this has yet been allotted to a reserve fund or a depreciation fund, but a balance of £1,792 brought forward from previous years has been divided into £1,578, as the nucleus of a reserve fund, and £214 towards writing off the preliminary expenses. The reserve fund now stands at £1,633, £55 interest having accrued during the year. This is still but a small proportion of the total capital expenditure of £54,747, when it is remembered that the system is in competition with one of the National Telephone Co., and that its licence expires on December 31st, 1911. The mistake has been made in the case of more than one municipal telephone department that a substantial reserve or depreciation fund is not built up to meet the contingency of the licence not being renewed, necessitating a compulsory sale of the undertaking below its book value.

The total number of telephone stations is 2,445, the number of junctions 158, and the number of exchanges 8. The average number of calls received per day per subscriber is 9·79.

The increase in the number of telephone stations is 288, and, in calculating the following averages, we have taken the average between 2,445 and 2,157 as the average number of telephone stations during the year.

The exchange repairs have cost about 2s. per telephone station, as compared with 1s. last year; the line and instrument maintenance (including roof repairs) about 10s. 4d. per station as compared with 8s. 8d. last year; the total working expenditure, excluding Post Office royalties and capital charges, £2 per telephone station, compared with £1 19s. last year; and the total working expenses, including royalties, but not capital charges, £2 9s. per station, as against £2 8s. last year. Including capital charges, but not depreciation or the contribution to the sinking fund, the total costs have been £3 6s. per station, without royalties, or £3 14s. with royalties, as compared with £3 6s. and £3 15s. last year. As stated in Mr. Holme's report, the capital cost per station now stands at £22 7s., as compared with £24 last year.

THE OVERHEAD TROLLEY TRAMWAYS OF THE LONDON COUNTY COUNCIL

ALTHOUGH the extensive system of tramways of the London County Council is almost entirely on the underground conduit system, full details of the equipment of which have already appeared in ELECTRICAL ENGINEERING from time to time, there are two lines now working which have been equipped by the Council on the ordinary overhead trolley system, and a few notes on the principal features of their arrangement may be of interest. The first overhead L.C.C. tramway line to be opened was that between Beresford Square, Woolwich, and Wickham Lane, and the second was the new line from Hammersmith to Harlesden, which started running on May 30th, and passes the Franco-British Exhibition.

The overhead equipment of both of these lines is similar. A grooved trolley wire is employed of No. 4/0 size, with a simple form of mechanical ear, and this is arranged with a minimum clearance above the track of 21ft. at all points, except where the lines pass under bridges, where it is sometimes necessary to reduce the clearance to 17 ft. The wire is specified to have a breaking stress of 23·5 tons per square inch, and an elongation of 3 per cent. The construction is on the span wire principle throughout, with side poles. The medium-weight British standard pole is employed at all parts of the line, except at curves, where poles of the heavy type are used. The span wires themselves are of 7/12 stranded wire, and are carried on bobbin insulators at each end. Every pole is earthed to the rails by a 7/14 galvanised steel wire, or, in cases where a guard wire is attached to a pole, by a copper wire in accordance with the requirements of the Board of Trade. The overhead equipment of both lines was carried out by Messrs. Dick, Kerr & Co.

There are practically no special features in the Woolwich line. As already stated, it runs at present from Beresford Square, Woolwich, through Plumstead, to Wickham Lane, but the route will shortly be extended to Abbey Wood, a further distance of about one mile. The power supply to this line is taken from the Woolwich Borough Council, as it was not considered worth while to erect a special substation for the supply of so small a service from the London County Council's own generating station at Greenwich. The line is at present quite isolated from the main part of the L.C.C. tramway system.

The new Hammersmith-Harlesden line, which runs from Hammersmith Broadway to Harrow Road, Harlesden, is supplied from a small substation at Hammersmith, which is connected to the nearest substation at Wandsworth by two small feeder cables. The machinery in the substation consists of one 150 kw. motor-generator, and two 500 kw. motor-generators, all manufactured by the Electric Construction Co. The high and low tension main switchboards were supplied by Messrs. Johnson & Phillips, and the low-tension track board by Messrs. Spagnoletti & Co. The high-tension cables were made by Messrs. Siemens Brothers & Co., and the low-tension cables by the Western Electric Co. The general arrangement of the substation equipment closely resembles that of the Council's other tramway substations, except that the switchgear is somewhat simpler. One point of difference is that the brick partitions separating the high-tension cells actually form part of the outside wall of the building.

The trolley wires, span wires, poles, &c., are similar to those on the Woolwich line, but there are one or two special features necessitated by local conditions, as, for example, where bridges are encountered, under which the trolley wire is taken in the usual inverted trough construction. Special poles are also used in the Shepherd's Bush Road, with provision for carrying the arc lamps of the Hammersmith Borough Council.

An interesting feature of the line is the way in which the level crossings over the lines of the London United Tramways Co. are arranged at Goldhawk Road and Uxbridge Road. In both lines section insulators are placed in the trolley wire close to the nearest poles at each crossing, so that in each case a section of about 40 yards is isolated, these sections being connected to each other at the four points where they actually cross. The isolated double cross thus formed can be fed either from the Council's or the tramway company's system, and for this purpose two-way change-over switches are provided in special boxes in the bases of the poles. The wires from these switches feeding the section are run inside the poles. On each system jumper cables are used to run past the isolated section, and these are also carried down inside the poles. It is probable that the line will be continued from Hammersmith Broadway to Putney Bridge on the overhead system as soon as the necessary powers are obtained, instead of on the conduit system, for the construction of which the Council already hold powers. The cars in use are of the latest form of double-deck top canopy type, similar to those familiar on the conduit lines, except that they are fitted with the usual form of trolley instead of the plough collector. In conclusion, we should acknowledge our indebtedness to Mr. A. L. C. Fell, Chief Officer of Tramways to the London County Council, for information upon which these notes are based.

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REVIEWS OF BOOKS

Modern Views of Electricity and Matter. By Sir Oliver Lodge, F.R.S. Third edition. 518 pp., 4¾ in. by 7¼ in.; 67 figures. (London: Macmillan & Co.) Price 6s.

THE title of this book, "Modern Views of Electricity," was an attractive one when the first edition was published in 1889, and three years later, when the second edition was called for, on account of the merits of the work, the title still held good, but for how long can this continue? It is true that this third edition has been revised, and more than one quarter of the book consists of additional lectures. The scientific reader will welcome these and all other writings by Sir Oliver Lodge on physical science. But the general reader of electrical literature, who, during the last five or six years, has been bewildered by modern views of electricity, is inclined to leave the subject alone until the half-baked hypotheses are offered to him in a digestible form. He may wonder whether this author was a prophet, that he has little or nothing to correct, and whether he deals with other people's modern views as plausible speculations or as serious theories. An hypothesis begins to lay claim to rank as a theory when inductions from dissimilar observations converge, and when results predicted on theoretical grounds are verified by experiment. It was a happy title, modern "views"—a non-committal expression. The electron theory (grudgingly as some people may concede the status) claims many converging "proofs," and its enthusiastic students hail a result as confirming a prediction if it comes within 3 or 4 in the powers of 10.

It is interesting to see how the author has stitched the admittedly new material into the old garment. It was not the worse for wear if there were a hole or two—call it a lacuna—a little editorial darning, or perhaps a patch "added 1906," or a chapter, "most recent views concerning the ether (1907)," brings it up to the fashion of the day—to be accurate, the preface is dated "April, 1907." To say that the old garment was not the worse for wear is perhaps an understatement, for there are many people who even to-day appreciate the mechanical models which illustrate so vividly the magnetic field, current conduction, and current induction. If the day should come when the electrical theories pictured by these models are as dead as the corpuscular theory of light, the student of "ancient views of electricity" will nowhere obtain a better idea of those old theories than by reading the first nine chapters of one of the first three editions of "Modern Views." These models are only analogies. They contain no new information, they do not contain complete information, but the value of such analogies is the presentation to the mind of an easily imaginable arrangement by which it is guided to conceive one which is less easily imaginable.

The exponents of the latest "views" of electrons are necessarily mathematicians, and some of them do not stop to imagine anything, though they will occasionally try to let outsiders know what they are doing. It is safe to say that eighteen out of twenty men having a general acquaintance with elementary science after reading these first nine chapters will succeed in grasping a large part of that which the author offers, but of twenty such men who heard the memorable lecture on "The Modern Theory of Electrical Conductivity of Metals," delivered before the Institution of Electrical Engineers in February, 1907, it is safe to say that eighteen came away bewildered and unconvinced, and perhaps those younger students suffered less disappointment than any other section of the audience, who gave the thing up as hopeless after the first quarter of an hour, and simply enjoyed the delivery and personality of the lecturer. That this was no fault of the exponent is clear to those who try to study the modern electron theory. The explanation seems to be that it is at present unfit for presentation to general readers, for even Sir Oliver Lodge, who has written elsewhere on electrons, does not attempt in the present volume to affect any reconciliation between two theories so deadly hostile. No intelligent man can set aside the electron theory as nothing but speculation, and most scientific men will agree with the author when he writes: "We in England have not been lacking in veneration for Clerk Maxwell, nor in admiration for Lord Rayleigh, but I think that we may say that we feel that the mantle of those extraordinarily brilliant predecessors has descended worthily on their successor, and that his researches . . . have brought lustre not only upon the Cavendish Laboratory but upon the general pursuit of physical science in these islands."

The preface to the first edition began with the words, "The doctrine expounded in this book is the etherial theory of electricity," but this is not reprinted in the present volume. The general reader of to-day wants to know if the ether theory of Maxwell is dead and shelved, and the electron theory is to be recognised as a substitute, or does the latter supplement the former? The preface to the third edition clearly states the author's present view that it is noteworthy that few actual corrections have had to be made showing that new discoveries are of a supplementary rather than of a revolutionary character. Supplementary, in fact, it is, so far as new pages are concerned, but the plain man wants to know if there is room in the universe for that which these admirable mechanical models illustrate, and for the "electrons, isolated charges . . . flying along without any body to them, disembodied electricity, the pure spirit of electric charge." When we have mastered the idea of "line of slip," the purely skin-deep current in a perfect conductor, the "spin" of magnetism, and thus are prepared for the Heaviside and Poynting distinction between the paths of flow of electricity and of electric energy, what "is the good of" electrons? The answer probably is that certain phenomena are more readily explained by the electron theory. Be it so; but how much is there so excellently explained in the first edition of "Modern Views" that nobody has yet attempted to explain by electrons? The electron is the creature of the mathematician. More hard thinking is needed before it is ready for the general reader. It is a step, but it seems to be a step sideways, not one in advance. "I am convinced," writes the author in the last page and a half of Chapter III., identical with that of the first edition, and worthy to be quoted in full if space permitted, "I am convinced that it is unwise to drift along among a host of complicated phenomena without guide other than that afforded by hard and rigid mathematical equations."

The word "electron" is not to be found in the index of the first edition, but a statement of the action between a magnet and an electric charge in relative motion, reprinted almost verbatim, and not containing the word, is indexed now under "electron." The nimble electron having flitted in, the infection of radium naturally follows, and, of course, α-, β-, and γ-rays. Helium and transmutation cannot be kept out, and the unhappy general reader who wants modern views of electricity, and would not mind ancient and modern views, is presented with perspective views of branches of physics and of chemistry not yet fit for the treatment which made the first edition so remarkable. New chapters on the ether, and on Hertz's experiments and their consequences, are more in keeping with the professed subject of the work, but the verbatim reports of lectures should have been re-written; the author's style is so vivid and attractive that it gains nothing from the use of the present tense and of

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the first person singular. "By the kindness of Prof. Silvanus Thompson I have a few slides to show the principle of the invention." No doubt the audience at the Royal Institution enjoyed them, but since they are not reproduced they need not have been mentioned.

The Deinhardt-Schlomann Series of Technical Dictionaries in Six Languages. Vol. II. Electrical Engineering, including Telegraphy and Telephony. Edited by Charles Kinzbrunner. Pp. 2,100, 7 in. by 4 in.; about 4,000 illustrations. (London: Archibald Constable & Co.) Price 25s. net.

THE second of the series of Deinhardt-Schlomann of six-language technical dictionaries deals with words connected with electrical engineering, including telegraphy and telephony. This volume is edited by Mr. C. Kinzbrunner, and in general respects, except as regards its greater size and price, follows the lines of the first volume devoted to mechanical engineering published some little time ago. A subject matter arrangement of the contents is adopted, and each page is divided into a number of sections. In the left-hand column of each section are the German, English and French equivalents of the idea in question, while the corresponding Russian, Italian, and Spanish words or phrases are to be found in the right-hand column. The space between the two columns of text is devoted to suitable explanatory drawings or diagrams. The latter part of the volume contains alphabetical indices of the words. The first index gives the English, French, German, and Italian words all together in alphabetical order, but owing to the differences of alphabets the Russian words are contained in a separate index. Naturally, the index portion is of some length, occupying about one-third of the whole volume. An idea of the range dealt with is best obtained from the following list of the sections into which the classification divides the ideas dealt with:—Cells and batteries, boilers and prime-movers, electric machinery, switch apparatus, electric supply stations, mains, house installations, lighting, various applications of electricity, telegraphy, telephony, electrochemistry, electromedical apparatus, units of measure, electrophysics, and a miscellaneous appendix, each of these sections being divided into several subsections. Electric traction is not dealt with, as this part of the subject is to be included in a forthcoming volume on railway engineering. The choice of the illustrations is a little amusing at times, as, for example, the representation of a book to explain what is meant by a telegraph code and the miniature reproduction of a German telegraph form to illustrate the word telegram. On the other hand, the diagrams of the connections of the different wireless telegraph systems accompanying their names are distinctly suggestive, and the equations and chemical formulæ in the electrochemical section are certainly of use. Some of the pictures of apparatus are helpful, but it is hardly necessary to illustrate such homely articles as a jug for filling up accumulators with electrolyte. With regard to completeness, prolonged use can only suggest omissions, although we notice on p. 18 that the Osmium lamp is mentioned, but not the Osram. On the whole, however, the tendency is to over-completeness, as vast numbers of unnecessary expressions are included, the meaning of which is quite obvious from the separate words therein which one would naturally refer to first. Inaccuracies also can only be traced by a very detailed examination, but it hardly speaks well for the accuracy of the proof-reading to notice that in the very first name in the list of contributors and revisers the intials of a gentleman with whom we are acquainted are given incorrectly.

Whittaker's Arithmetic of Electrical Engineering for Technical Students and Engineers, containing 72 worked Examples and 300 Exercises. 159 pp. 7½ in. by 5 in. (London: Whittaker & Co.) 1s.

THIS little book deals exclusively with the simpler problems met with in continuous-current work, and will be found of use to beginners, as it contains, besides 72 worked examples, some 300 exercises with answers. Many sentences in the text are, however, very liable to mislead a beginner, and in some cases the statements are incorrect. For example, in the section on Electro-chemistry, the author states that "each atom of H requires 8 atoms of O for combination to form water." Again, in the same section, he speaks of "The amount of an ion liberated." In the chapter on Electromagnetism it is stated that "Currents of electricity radiate magnetic force," and when dealing with electromagnets the following statement is made:—The *energy* corresponding to a given magnetisation is proportional to the square of the flux-density, and, like the lifting power or tractive force of electromagnets, is given by

$$P = \frac{B^2 A}{8\pi} dynes.$$

The author's attempt to explain the laws of electromagnetic induction by considering the linkage between a conductor and the magnetic flux instead of the more usual coil and flux method appears rather confused. In the last pages of the book the very serious mistake is made of denoting the output of a dynamo as so many *units*, meaning so many kilowatts. These and other similar cases of looseness of expression considerably take away from the value of the book.

LONDON ELECTRIC POWER BILLS

OUR report last week ended with the proceedings of Tuesday, June 2nd, when the case for the eight electric lighting companies against the Bill was being heard.

WEDNESDAY, JUNE 3RD.—(NINETEENTH DAY.)

Mr. CONACHER'S evidence in chief was continued. He referred to the efforts of the London companies to do away, as far as possible, with small local generating stations, and as an instance referred specifically to the action of the Metropolitan Electric Supply Co. in erecting their Willesden station, in consequence of which five local stations were discontinued, and only that in Paddington was retained as a stand-by. As showing the possible dangers arising from the concentration of large supplies in one central generating station, and the need for duplicate mains, he mentioned that on one occasion a bargee had driven his spike accidentally into one of the duplicate mains which the Metropolitan Company had laid along the banks of the Regent's Canal from the Willesden power station, and but for the existence of the duplicate mains the supply to the district served by the company would have been seriously interfered with. Mr. Conacher next dealt at some length with the comparative failure of the bulk supply companies in Great Britain, and especially those without distributing powers, special reference being made to the South Wales Electrical Power Distribution Co. Coming to the effect of the passing of a bulk supply Bill in London upon the financial position of the existing companies, witness expressed the opinion that the existence of such a company, with its possible competition hanging over the heads of the existing authorities, would seriously prejudice the raising of further capital. Even now, the £5 shares of the Metropolitan Company, which had stood at 10, were at 4¾.

Lord WELBY reminded the witness that recently there had been such a serious decline in the price of all stocks, that great caution must be taken before coming to any conclusion as to the cause of this.

Mr. CONACHER agreed, but still thought the uncertainty created by the promotion of these power Bills for London was a contributory cause.

In cross-examination, Mr. Conacher agreed that the Paddington power station was bound to be kept working under an agreement with the Borough Council.

Mr. FITZGERALD: And but for that, you would not keep it there as a stand-by?

Mr. CONACHER: I cannot say that, but the station is there now.

Questioned as to the possible effect of competition, Mr. Conacher agreed that in spite of competition the dividends of the company had increased, but he wished to draw attention to the fact that the force of the competition depended upon the equality of conditions. The competition of the proposed bulk company would not be upon the same terms as those now imposed upon the existing companies, and furthermore, when Parliament had sanctioned competition between distributing companies in London, the terms had always been less favourable to the new comer.

Mr. FITZGERALD then questioned Mr. Conacher as to one or two matters connected with the working of the Willesden station in order to test Mr. Conacher's general statement that the Metropolitan Company could supply as cheaply as the promoters. Witness said the capital cost per kilowatt was about £40, but this included much land, buildings, &c., capable of dealing with a much greater capacity. Asked as to the lbs. of coal per unit and the total costs, Mr. Conacher said he had not these figures, and he was not sure that the engineer to the company, who had the figures, would give evidence.

Mr. FITZGERALD protested against this, and urged that he was entitled to this information.

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Mr. C. A. CRIPPS, K.C., said that Mr. Sparks, an engineer, was to be called.

Mr. FITZGERALD again complained on the ground that Mr. Sparks was not the engineer to the Metropolitan Company.

The CHAIRMAN said that the Committee could not take it from Mr. Conacher that the Metropolitan Company could supply as cheaply as the power company, unless he could substantiate the statement.

Lord SAUNDERSON said that in the Board of Trade returns, the charge for power by the Metropolitan Company was 1·96d. Witness would not suggest that the company overcharged, and therefore the costs must be in the neighbourhood of 1d. per unit, as suggested by Mr. Fitzgerald.

Mr. CONACHER replied that this was an average charge, and many of the consumers were supplied at less than the average price in the Board of Trade returns.

The CHAIRMAN thought that the discussion upon the details need not be continued. If Mr. Conacher could not give details such as were reasonable to substantiate his statement, the Committee must wait for further evidence before accepting his statement.

Mr. FITZGERALD then read a long list of the places in the western area of the Metropolitan Company, in which a bulk supply may be given, but he said only Acton was being supplied. Mr. Conacher said he believed the price to Acton averaged 1·5d. per unit.

With regard to the Marylebone undertaking, Mr. Conacher could not remember what terms were offered for a bulk supply.

Mr. FITZGERALD pressed the question on the ground that Mr. Conacher must know this. Receiving no satisfactory answer, Mr. Fitzgerald said that he had extracted the figure from Mr. Conacher with some difficulty on another occasion, and the price offered averaged 1·7d. per unit. With such prices as these for a bulk supply, he was not surprised that the Metropolitan Company had not secured many bulk supply customers.

The cross-examination of Mr. Conacher was next directed to the other London companies, some particulars of which had been given in tables handed in to the Committee; but witness replied in almost every case that he had no knowledge of the particular circumstances of these, answers which called forth another complaint from Mr. Fitzgerald.

Mr. FITZGERALD then came to the purchase clause, which was included in the unfair conditions under which Mr. Conacher said there would be competition. Mr. C. A. Cripps, K.C., for the London companies, objected to the questions on the ground that this would all come up again on their Bill. Mr. Fitzgerald persisted, however, and the Chairman allowed the questions to be put.

Mr. CONACHER admitted that the purchase clause in the companies' Bill was substantially the same in principle as that in the present Bill, viz., that the new capital was to be redeemed by the purchasing authority, but there was an automatic provision for wiping out the capital at the end of 42 years.

Mr. FITZGERALD pointed out that this sinking fund would only be created after the payment of interest, when the sinking fund came in as surplus profits.

The CHAIRMAN having intimated that he thought Mr. Fitzgerald was going rather far, and in view of the later opportunity which he will have on the companies' Bill, this point was then left.

Mr. FITZGERALD concluded his cross-examination by a reference to the speech of Mr. Fladgate, the Chairman of the Charing Cross Company, who, he said, had obtained the sanction of his shareholders to the promotion of the companies' Bill, by telling them that there was no intention of spending the one million of money authorised by the Bill. Mr. Conacher said he had no opinion to offer on this.

In re-examination, Mr. Conacher said his main point on the question of bulk supply was that where this had been separated from the distribution business, the result has been a failure.

Answering Lord Welby, witness said that the sinking fund in the companies' proposed purchase clause came after the interest on the new capital, but not after the payment of dividends on the ordinary capital of the individual companies.

Mr. H. B. RENWICK, Secretary and General Manager of the County of London Electric Supply Co., gave evidence as to the amount of power in London. He said the figures put forward by Mr. Merz had always been regarded as over-estimated by the London companies, the figures being 456,415 h.p. in the "industrial" area and over 500,000 h.p. in the whole area of the Bill, whilst it was said that only about 7 per cent. was driven electrically. The committee of the chief officials of the London Electric Supply Companies had appointed a sub-committee to go into this matter, and it was decided that a systematic and careful canvass should be made in the whole of the areas of the 13 London companies. The result of this canvass, which lasted from July, 1906, until the spring of 1907, was that in the area of the companies there were 47,299 h.p. of electric motors, and 55,591 h.p. of other forms of power, making a total of 120,890 h.p. In making these calculations, it was thought that the local authorities should be approached, and a further canvass of the local authorities' areas showed that there were 26,591 h.p. of electric motors, and 79,325 h.p. of other forms of power, a total of 105,916 h.p. The total in London, therefore, was only about 208,000 h.p., and the existing supply authorities were supplying 35·38 per cent. These figures related to 1906, and as an indication of the progress made since, he mentioned that during the past year the County of London Co. had increased its motor load by between 4,000 and 5,000 h.p.

A question by the Chairman elicited the information that the figures given related only to the County of London, and not to the whole area covered by the Bill, whereas the evidence of the promoters that there were between 300,000 and 400,000 h.p. related to the whole area of the Bill.

In the course of his further evidence, Mr. Renwick dealt with the difficulty of getting power users, and mentioned a case in which the County of London Co. quoted 0·45d. per unit for power to a paper mill in Wandsworth, and then did not get the business. He thought there had been a good deal of misapprehension as to the amount of canvassing and "pushing" that had been carried on by the existing authorities, for no less than £69,656 had been spent in this way by the County Company practically since 1900. In one case they had purchased a private installation for £4,000 in order to get the consumer on to their mains; they put in electric motors free on trial, without charging for current, and they hired out motors when consumers decided to retain electric driving after a trial. In fact, in one case they gave a consumer a motor absolutely free. The general effect of the promotion of these Powers Bills was that possible consumers were inclined not to go in for electric driving, in the hope that they would be able to obtain their power at ¾d. or ½d. per unit later on.

Mr. TALBOT cross-examined to the effect that, having heard the companies had carried out a canvas of power users, they had tested it by communicating with a large number of power users, and had received many replies that no canvass had been made of their particular firms. Mr. Renwick said that, in a large number of cases, the electric supply authorities had records of many power users, and these were not personally canvassed.

Mr. E. W. SEALE, secretary of the Charing Cross, West End and City Electricity Supply Co., said he adopted much of Mr. Renwick's evidence as to the efforts of the London companies to secure business. The total amount of power installed in his company's area was 11,488 h.p., and of this the Charing Cross Co. supplied 38 per cent. With regard to efforts made to induce the local authorities along the line of route of the mains from their Bow station to take a bulk supply, he mentioned that West Ham had been offered a supply at £4 per kw. per annum and 0·5d. per unit; Poplar, £4 and 0·33d.; Stepney, £3 and 0·4d.; and Bethnal Green, £4 and 0·5d., and subsequently a flat rate of one penny per unit. But none of the offers were accepted. As to the effect upon the present companies and the continual promotion of bulk supply Bills, he said he had got out figures which showed that since Mr. Merz introduced his first Bill in 1905, the depreciation in the value of the companies' securities amounted to no less than £186,000. This, he thought, indicated entirely that the Stock Exchange did not regard these Bills as in any way supplementary to the existing supplies, but as confiscatory measures. The Power Bills forced the companies to keep reducing their prices, which lessened the dividends, and thereby the market value was reduced.

THURSDAY, JUNE 4TH.—(TWENTIETH DAY.)

Mr. WILLIAM FORBES, General Manager of the London, Brighton and South Coast Railway Company, gave evidence as to the contract which has been entered into with the London Electric Supply Corporation for the supply of energy in connection with the electrification of the London Bridge—Victoria line, a distance of 8 miles 51 chains. The Electric Supply Company had been put under very severe penalties, and he was satisfied on the score of continuity of supply. Personally, he thought that an extension of the application of electricity to their lines would be necessary very shortly, at any rate to the extent of 40 miles.

Cross-examination by Mr. Fitzgerald gained the information that the agreement with the London Electric Supply Corporation was for seven years, and there were heavy penalties for failure of supply, running up to £150 per day. The agreement also provided for duplicate mains. At the end of seven years, the London Electric Co. were to have first option of a renewal. At first witness said he preferred not to mention the price, but subsequently said that for the first supply, which would be on a low load factor, the price varied from 1d. per unit to ¾d. per unit, but there was a guarantee that when the load factor reached 35 per cent., the price would be ½d. per unit. Mr. Fitzgerald drew attention to the fact that under the Bill the supply of transformed alternating current, which was the supply to be taken by the London, Brighton, and South Coast Railway, at a 35 per cent. load factor, would be ·474d. per unit, but Mr. Forbes replied that he had not observed this.

MR. E. W. SEALE, Secretary to the Charing Cross Company, continuing his evidence, referred to Clause 73, which gives the power company authority to acquire undertakings, and sug-

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gested that if by the operations of the power company the market value of the existing companies was depreciated, these could be very easily acquired, and thus a dangerous monopoly would be set up. In a general reference to the effect of metallic filament lamps upon the electric supply industry, Mr. Seale said that since the introduction of these lamps the income of the Charing Cross Company had decreased by £2,000 per annum in consequence.

In cross-examination, Mr. Fitzgerald suggested that the fact that the company's dividend had fallen from 8 per cent. in 1906 to 5 per cent. in 1907, was the cause of the depreciation of the market value of the shares. Further, the evidence put before Parliament on behalf of power bills had shown that the prices being charged were too high, and consequently reduced prices had entailed reduced dividends. Mr. Seale replied that it was the possible competition from a bulk company under unfair conditions that had been mainly responsible for the fall in market value. Mr. Fitzgerald next pointed out that the Charing Cross Company's business had been built up on competition, and in fact the company had invaded the City of London, where there was already another company, on the ground that they could suppiy cheaper, and Mr. Seale's answer was that this competition was an altogether different thing to that proposed under this Bill.

In answer to other questions, Mr. Seale admitted that the terms quoted by the Charing Cross Company in 1905 for bulk supply to the West Ham Corporation was 2d. per unit, on an agreement for 42 years. With regard to the suggestion that the power company could acquire all the electrical undertakings in London, Mr. Fitzgerald pointed out that when the Administrative Bill was under consideration, Mr. Seale made the same suggestion, but Lord Camperdown had stopped cross-examination on the ground that the Committee would take the suggestion for what it was worth. Mr. Seale's reply to this was that when the Bill was before the House of Commons provision of the kind asked by him was made.

Mr. Fitzgerald's comment on this part of Mr. Seale's evidence was that he was glad to have such an estimate of the financial standing of the promoters that they could not only raise the £6,000,000 for the power company's business, but a further £10,000,000 for buying up existing companies.

Lord LYTTON suggested that if the offer to West Ham was for 42 years with a specified price, the local authority would not have the advantage of subsequent reduction in cost of generation.

Mr. Seale agreed that it would not have been a good bargain for West Ham in the light of subsequent events, but there was a clause in the agreement providing for a revision of prices at certain periods.

Mr. A. F. HARRISON, Secretary to the City of London Electric Lighting Company, who gave evidence in the absence of Mr. J. Cecil Bull, one of the managing directors, said that the output for power supply was 27 per cent. of the total. There were four power users whose maximum demand was over 250 kw., and the revenue from those consumers was £11,879. During 1907 the revenue from street lighting and public buildings was £14,990, and for railway purposes, mainly lighting, £2,427. All of this revenue the power company could compete for; it was equal to 4 per cent. on the ordinary capital, and as the dividend last year was 6 per cent., assuming the power company secured this business, the dividend would be reduced to 2 per cent. A recent investigation showed that the City Co. was supplying 84 per cent. of the total amount of power in the company's area, their total number of power consumers being 1,048.

Mr. HARRISON produced a map showing the very complete way in which the power field in the City of London is being catered for, and Mr. Fitzgerald, for the promoters, commented that this was rather inconsistent with the argument of Sir Ralph Littler, who stated that there was no power demand in the City at all.

Mr. FITZGERALD then put some questions on the general working of the City Co.'s undertaking, all of which witness said were engineering questions, and that he could not answer them. At the same time, he was not aware that the engineer to the City Co. was to be called to give evidence.

Mr. C. P. SPARKS, Engineer and Manager of the County of London Electric Supply Co., criticised the promoters' tables of the advantage to the existing authorities by taking a bulk supply, and handed in tables which showed there would be a substantial loss instead of a profit, a result brought about by the fact that the promoters had insufficient knowledge of what the companies had been doing during the past few years. The promoters had estimated that the cost of generating additional units over the present output in the future would be 0·5d. per unit, whereas in the case of his own company he estimated it at 0·36d. per unit. In fact, since 1905, the London companies had generated an additional 22,000,000 units at an extra works cost of 0·18d. per unit; and this took no account of any possible saving which would be effected under the linking up scheme under the companies' Bill. As to the diversity factor assumed by the promoters, viz., 1·5d., he regarded this as quite wrong, having in view the proportion of the load which was to go to the authorised distributor, and the experience of the companies, after having examined the records of the authorised distributors, was that the diversity factor which ought to be taken was, if anything, below 1·1; he would prefer to put it at 1·05. The effect of this would be that the capital of the new company would have to be increased before any supply to railways and power users could be given, for, upon the revised diversity factor, the plant proposed would only be sufficient for the supply to the authorised distributors.

The CHAIRMAN asked Mr. Sparks if he agreed there was no common standard for calculating diversity factor.

Mr. SPARKS said "Yes"; but he had had much more experience of electric supply in London than either Mr. Hammond or Mr. Parshall, and therefore his opinion, which was based upon that experience, must be more valuable.

The CHAIRMAN said that as there was no common standard for calculating diversity factor it was not surprising that different results were obtained, and he thought they might leave the question open.

Mr. Sparks' cross-examination was largely taken up with a discussion of the basis upon which his tables had been calculated, a particular item in dispute being the generation expenses of the Charing Cross Co. It appeared that although a certain sum for these had been certified in the accounts, and had been taken by the promoters as applying solely to generation, they represented the cost of the energy delivered at the sub-stations; Mr. Sparks had consequently deducted a proportion, and so considerably altered the result arrived at by the promoters. All through, the Committee has expressed itself more or less uninterested in the effect upon the authorised distributors of taking a supply in bulk, for the reason that they are not bound to take it, and therefore, after allowing the cross-examination to continue for some time, the Chairman intimated that they had heard sufficient examination and cross-examination, and said the Committee would be glad if Mr. Balfour Browne would commence his speech.

Mr. BALFOUR BROWNE, K.C., addressing the Committee on behalf of the eight companies, said that no evidence had been produced that electricity in London was so expensive as to limit its use. The existing companies had invested no less than £13,482,000 in the enterprise which, although originally confined to lighting only, was now distributed over lighting and power, and, in fact, power was becoming a very important part of their business, and they had succeeded as well as anybody could have expected in London. Where the field was left for the new company he did not know, in view of the evidence which had been given of the large proportion, in various districts, of the power which was supplied electrically. There had been a popular superstition since Mr. Merz introduced his Bill in 1905 that London was badly catered for in the matter of electric power supply. Mr. Merz's statement that only 5 per cent. of the total power installed in the area of the Bill was supplied electrically, and only about 4 per cent. in the industrial area, had been accepted all round, and it had even penetrated to the House of Lords, for Lord Onslow, in moving in the House this session that the London Power Bills should be referred to a Joint Committee of Parliament, had stated that it was a scandal that power users in London had not the advantage of a cheap power supply, and in the House of Commons Mr. Lloyd George, when opposing the motion of the House of Lords that the Bill should go to a Joint Committee, also stated that it was a scandal that cheap supply was not available, and that something should be done immediately to remedy the defect. But in spite of this, not one witness had been called by the promoters to say that they required a supply of electricity upon reasonable terms and could not get it. On the contrary, the evidence had shown that no less than 35·38 per cent. of the total power in the area was supplied electrically by the companies and local authorities combined, whilst in various areas the proportion was considerably greater; for instance, it was 84 per cent. in the City. He contended: (1) that to introduce a new power company into London would be a breach of a Parliamentary bargain; (2) the proposed scheme was one which would largely go far to take away the best consumers of the existing distributors; (3) it was competitive in a further sense that it covered practically all the ground that was proposed to be covered by the companies under their Bill. In view of the evidence that had been given, especially that of Mr. Falconar, he doubted whether the company could ever be a success, and if this was so, no interest would be paid except that out of capital, and this would have to be repaid by the purchasing authority at the end of the term. The problem of the supply of electricity in London, instead of being solved by the Bill, would be shelved for years, and the opportunity of doing what the companies proposed in their bill, namely, to link up the larger generating stations, and to use the smaller ones as peak stations, would be frustrated. In this matter he disagreed with the promoters that the Bills were not competitive. If both Bills were passed and both sets of promoters went into the money market for money, it would be exceedingly difficult for either of them to succeed. At the same time, he did not say it would be impossible for the companies to raise the £1,000,000 proposed by their Bill, because it was to be 4 per cent. guaranteed stock; it might cost a little more to raise it, and this would reflect upon the consumer; at the same time, he did not believe the new company would get their money at all. The position the existing companies took up was that they were creatures of Parliament under serious restrictions, which had to a certain extent crippled their in-

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dustry very seriously, and, being creatures of Parliament, they claimed the protection of Parliament, unless there was some overwhelming advantage to the public that the concessions granted should be revoked. They were quite prepared for competition with the existing companies, because the conditions were the same. At present they could not even supply one another in case of emergency, but the promoters of this Bill gave themselves the utmost freedom: freedom which the companies sought to have conferred upon them by their own Bill. The general feeling of Parliament on the question of competition between companies dealing with a commodity such as electricity, gas, or water, was that there should be no competition on account of the unnecessary duplication of capital, and, generally, the opinion was held that where combination was possible, competition was impossible. As an instance, he mentioned the division of London into districts in respect of water and gas. He urged that if there was to be competition it should be upon fair terms. It was quite clear from Major Marindin's report that the Board of Trade did not contemplate competition, except between holders of Provisional Orders.

The CHAIRMAN: Do you ask us to go to Major Marindin's report or elsewhere for an interpretation of the legislature?

Mr. BALFOUR BROWNE: No; I ask you to make up your minds solely from the wording of the Act.

Continuing, he said the Act of 1888 quite clearly contemplated that competition should only be between the holders of Provisional Orders, and the practice had been that when an Order was passed in London it had to expire in 1951, *i.e.*, at the same time when the original Orders expired, and thus it had a shorter life. It would be a serious thing for finance generally if it came to be understood that Parliament, having granted concessions, altered the terms indirectly by sanctioning competition under an Act of Parliament such as this. The average dividends of all the electric lighting companies in London since the commencement was only £3 18s. 2d. per cent., and they had, in addition, to provide sinking fund to pay off the capital by the end of their term of 42 years. Dealing with the prospects of the London and District Power Co., he pointed out that Mr. Hammond, on behalf of the Bill, had stated that they must have the authorised distributors, but it would be the height of folly for the authorised distributors, knowing that the London and District Co. would never get on its feet unless they took power from it, to enter into agreements with it, for by so doing they would be placing the power company in a position to compete with them for the other class of business, namely, large power users, &c. In fact, the whole evidence showed the determination of the authorised distributors not to take a supply from the power company. Another point against the passing of the Bill was in respect to competition between power companies; if the promoters' principle were carried out, their Bill should not have been introduced. The promoters' witnesses had stated that there should not be competition between power companies, but he claimed that the existing companies were power companies, in addition to which the North Metropolitan had extensive bulk powers, whilst the Metropolitan and Charing Cross Companies also had bulk powers, and the County of London Co. had power to supply railways for traction purposes. A good deal of evidence had also been brought to show that bulk supply to local authorities without powers for distribution had in no case been successful. The North Metropolitan had distributing powers, the Newcastle Co. also had distributing powers, whilst the Yorkshire Power Co., the Chairman and Engineer of which the promoters had called, were acquiring a large number of Provisional Orders. With regard to the clause in the Bill which authorised the acquisition of undertakings, Mr. Balfour Browne said this was a very dangerous power, and mentioned that if by any means the power company could buy up, say, the London Electric Supply Corporation, they would then be in a position to compete with nine companies and three local authorities. Coming to the finance of the Bill, he regarded this as of the shadiest character, and was nothing more than mere suggestions. The evidence of Sir Hugh Bell did not bind him to find a penny and constituted no guarantee whatever. Mr. Owen Hugh Smith likewise did no more than say that he would be prepared to endeavour to find a certain amount of capital, whilst the letter of Lord Fitzwilliam to the Chairman, which, if he might say so, was a little irregular, was of the same character.

The CHAIRMAN pointed out that the attitude of the London County Council on the question of finance was that the promises of the promoters with regard to the first £600,000 were sufficient for them if a provision was put into the Bill that this sum was provided in twelve months.

Mr. BALFOUR BROWNE replied that the London County Council was in a most awkward position in this matter of electric supply in London, for having violently opposed the Bill of Mr. Merz, they themselves promoted one, somewhat audaciously, on the same lines, so that anything the County Council said on the matter was of the utmost indifference.

Mr. CLEASE, on behalf of the London County Council, stated that the position of the Council was that it was extremely anxious that the Committee should be fully satisfied, not only as to the amount which the promoters would guarantee, but that the whole capital would be raised.

The CHAIRMAN said that quite naturally the County Council wished to throw upon the Committee the responsibility of seeing that the money was found.

Mr. BALFOUR BROWNE then continued his criticisms of the finance of the Bill.

The CHAIRMAN interrupted with the remark that he thought at any rate £500,000 was tolerably assured.

Mr. BALFOUR BROWNE, with respect, differed, and said that Sir Hugh Bell was not pledged to one penny.

The CHAIRMAN: I do not think we need labour this matter.

Mr. BALFOUR BROWNE, in some further criticisms of the Bill, said that seven-tenths of the power business was already supplied by the existing authorities, and the remaining three-tenths was of such a class that it might never come on to the mains at all. With regard to the purchase clause, he would rather leave his comments on this until the clause stage was reached, if it was reached. As to the modified Kitson clause, he agreed that this was a better clause for the power company than the original Kitson clause, and would enable them to compete more effectively with the existing authorities. He did not think the promoters of the companies' Bill wanted the Kitson clause or the modified clause proposed in the present Bill, because it would not fit in with the scheme of their Bill.

The Committee then adjourned until June 16th, when Mr. Balfour Browne will open the London Electric Supply Bill. Mr. Fitzgerald's reply to the case against the London and District Electric Supply Bill will be embodied in his speech in opposition to the existing companies' Bill.

At the conclusion of the sitting the Chairman threw out a hint that it would be a desirable thing if the promoters and the London County Council could renew their negotiations with regard to the purchase clause. He said he supposed it was too much to hope for that the rival promoters could come to some agreement.

Power Supply in the South of France.—The following notes relating to the "Sud Electrique" power distribution system are taken from a description which was recently published in the *Bulletin de la Société Internationale des Electriciens*. The system includes the towns of Nimes, Avignon, Sommières, Bollène, Montpellier, Marsillargues, and other smaller towns. The main stations are situated at Sommières, Saint Victor, and Bollène. The first-named station receives three-phase current at 30,000 volts from the 28-mile distant Madières waterpower station of the Soc. de forces motrices de la Vis, which is situated in the Cevennes. The second station receives three-phase current at 50,000 volts from the 62 mile distant water-power station Brillanne-Villeneuve in the Alps, but has a steam reserve of four 1,000 kw. Curtis turbo-generator sets. Besides this reserve there are smaller steam stations on the system with a total capacity of 6,000 h.p. The main distribution pressure is 13,500 volts, and the power is distributed locally at 120 volts for lighting, and 500 volts for power. On the high-tension lines iron poles, between 30 and 40 feet long, are used.

Rome Electric Power Supply.—According to the *Times Engineering Supplement* a comprehensive scheme for the supply of power to the city of Rome, which has been worked out by Mr. Giorgi, Engineer to the city, has been approved of by the authorities, and is already being partly carried into effect. The scheme consists in building a 30,000 kw. steam generating station in Rome, and water-power stations at Aniene and Nera of 5,000 kw. and 7,000 kw. capacity respectively. For the present a steam station of 10,000 kw. in Rome, and the water power station at Aniene of 5,000 kw., are to be taken in hand. The Nera station and the extension to the steam station will be considered when the extension of the city renders it necessary. The steam plant is to consist of eight boilers and four three-phase turbo-generators with a capacity of 2,500 kw. each. The works at Aniene will include a canal some eight miles long, carrying 460 to 530 cubic feet of water per second, and giving a fall of about 200 feet. The power station will contain four 2,600 h.p. turbines, coupled to 1,800 kw. three-phase alternators generating at 6,500 volts, 50 cycles. The pressure will be raised to 30,000 volts for transmission by four 2,200 k.v.a. oil insulated, water-cooled transformers. The length of the transmission line from the power station to the sub-station in Rome will be 23·5 miles. This will consist of two three-phase circuits, each capable of transmitting the whole of the power if necessary. Rigid iron poles will be used in the mountainous sections, and elastic poles on the "Semenza" system on the plains. At the sub-station, four 2,100 k.v.a. oil-insulated, water-cooled transformers will reduce the pressure from 30,000 volts to the distributing pressure of 6,000 volts. The main distributing system will consist of eight cables, the total length of which will be 56·5 miles. The secondary distributing system will extend over practically the whole area of the town. The total cost of the plant and distributing system has been estimated at £742,400, of which £150,400 is allocated for the hydraulic works and central water-power station on the Aniene, £28,800 for the transmitting line, £140,400 for the central steam generating power station, and £258,800 for the main and secondary distributing system in town. For the further extension, which is contemplated, of the steam central station (to give an additional 20,000 kw.) there are to be installed four turbo-generating sets, each of 5,000 kw. capacity.

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ELECTRIC TRACTION ON THE MIDLAND RAILWAY

Single-phase Equipment of the Heysham, Morecambe, and Lancaster Lines

THE electrical equipment of the Heysham, Morecambe, and Lancaster lines of the Midland Railway, parts of which were opened for traffic under electric traction on April 13th last, is of particular interest as presenting the first example of the single-phase system of main-line electric traction to be put to work in this country. We are now enabled, through the courtesy of the officials of the Midland Railway, and of the manufacturers of the electrical equipment, to give full details of the equipment, which will be seen to embody distinctive features of its own, as well as a combination of some of the leading points of Continental and American designs.

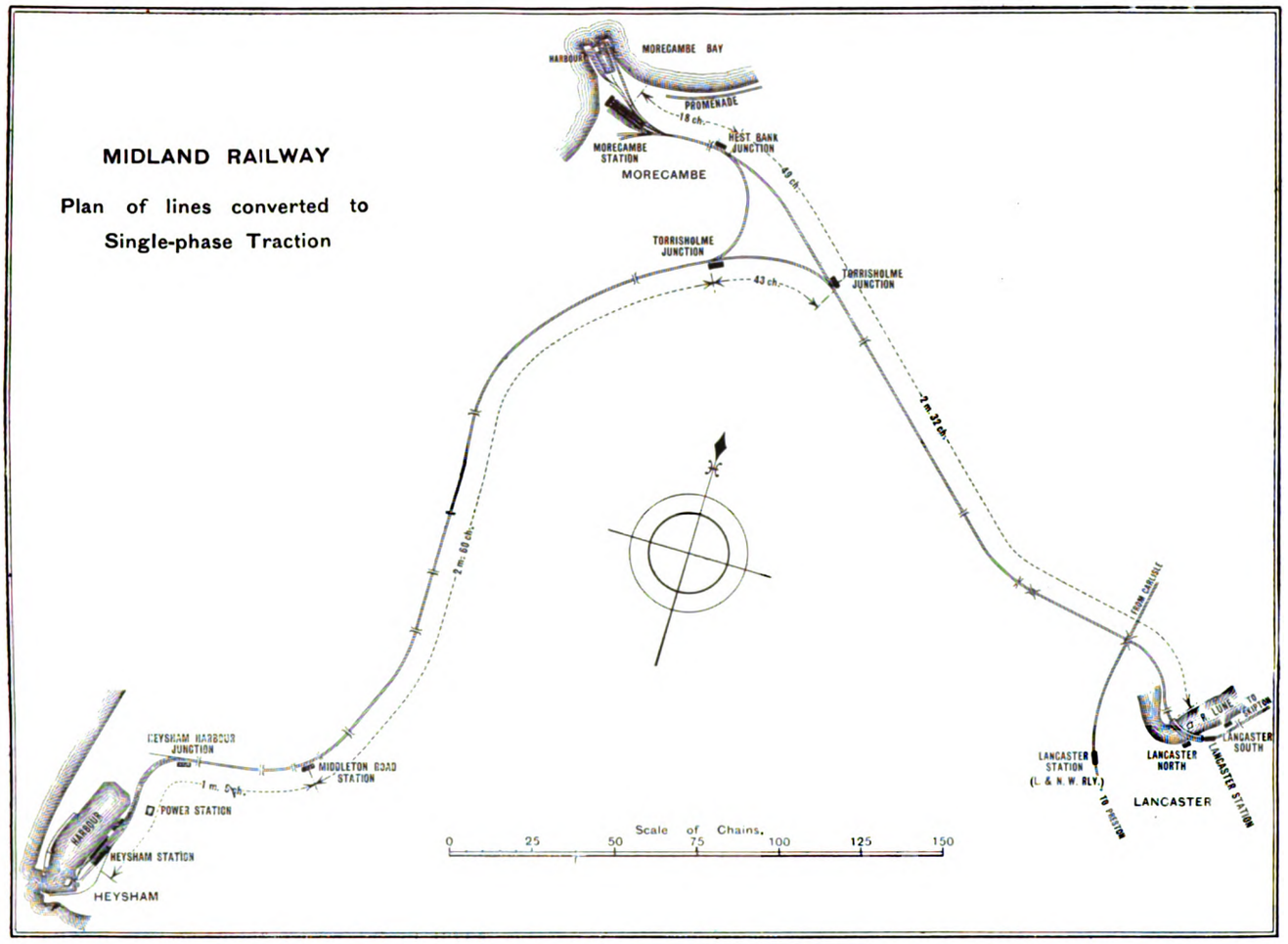


FIG. 1.—SKETCH PLAN OF HEYSHAM-MORECAMBE-LANCASTER LINES.

A map of the route is shown in Fig. 1. The distance from Heysham to Morecambe is five miles, and from Morecambe to Lancaster four miles. There will be practically no direct running from Heysham to Lancaster. There is also a short extension of about three-quarters of a mile from Lancaster Green Ayre to Lancaster Castle. The distances, except the last-mentioned one, have all been increased by about a quarter of a mile since the scheme was decided upon, by the alteration in position of the new station at Morecambe as compared with the old. The services for which the trains are contemplated to be capable is a 20 minutes' continuous service between Heysham and Morecambe and a 15 minutes' service between Morecambe and Lancaster, using a single train in each case. The trains will, however, not be worked up to anything like this service throughout the day.

There are no gradients of any importance on any section of the line, except between the two Lancaster stations. There are, however, a number of speed restrictions near each of the three terminals of the line.

The rolling stock consists of three trains, there being three motor-cars, two with equipments by Siemens Brothers, and one equipped by the Westinghouse Co. One of the Siemens trains is shown in Fig. 2. It may be mentioned here that the determining cause of the order being thus divided was purely that Messrs. Siemens were supplying all-electric control, which was preferred by the Railway Co., whereas the Westinghouse Co. preferred to adhere to their electro-pneumatic control apparatus, otherwise the proposals were equally acceptable. In addition to the motor-cars, four trailer cars have been specially built, while one or more old bogie coaches will be utilised for carrying workmen, luggage, &c., particularly between Morecambe and Heysham. Each end of the trailers and of the motor-cars is equipped with driving apparatus, this being necessary, as the trains will vary considerably in length owing to the traffic being very variable from season to season, and also as the coaches are liable to reversal in the way they head, owing to the triangular junction, near one apex of which Morecambe station lies.

Before proceeding to a detailed description of the

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overhead equipment and rolling stock, we propose to give a few particulars of the power supply to the line.

The line is supplied from the existing power station, situated at the Heysham end of the line, which has had added to it the necessary additional machinery to increase its capacity, and to enable it to supply single-phase current, as its original equipment was all for direct current. The transmission system is simplicity



FIG. 2.—THREE-CAR TRAIN WITH SIEMENS EQUIPMENT.

itself, as there are no feeders other than the two contact wires. The existing power station was originally provided for working the cranes, capstans, lifts, and other machinery, together with lighting, of the harbour at Heysham.

This station is gas-driven and works from "Mond" producers, supplied by the Power Gas Corporation. There are two producers of about 750 to 1,000 h.p. capacity each, with the accessory blowing, steam producing, cooling, and cleaning apparatus. The engine-room (a general view of which is given in Fig. 3) contained three 250 h.p. three-cylinder British Westinghouse Co.'s engines, each driving a 150 kw. direct-current, 460-volt generator. There was also installed a battery having a capacity of 100 kw. for five hours, with the usual corresponding rates for shorter and

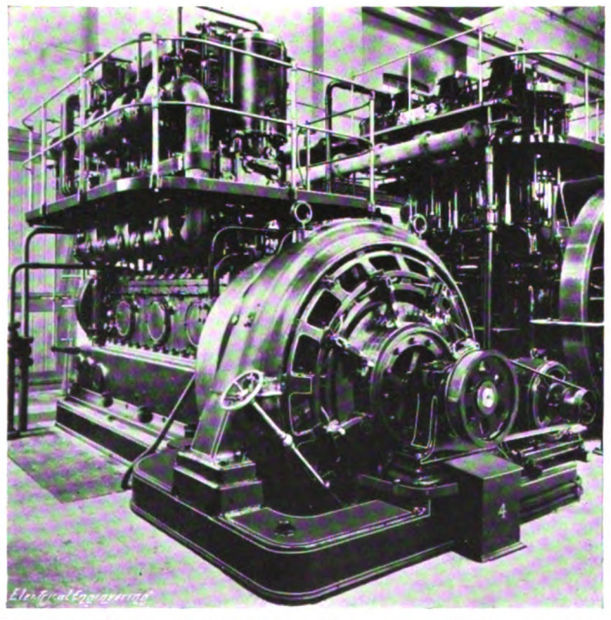


FIG. 3.—NEW GENERATING SET IN HEYSHAM POWER STATION, DRIVEN BY WESTINGHOUSE SIX-CYLINDER TANDEM GAS ENGINE.

longer periods. The existing load on the station, consisting chiefly of fast-speed powerful electric cranes, is very variable, and the battery has been used, in conjunction with a British Westinghouse Co.'s automatic reversible booster, for taking up the "peak" loads.

In connection with the traction scheme, an additional 350 h.p. 235 kw. Westinghouse Co.'s engine and generator, also generating 460 volts direct current, has been added. The single-phase current is obtained through two direct-current alternating-current motor-generators, by the Electric Construction Co. (shown in Fig. 4).

From the nature of the traffic the demand on the station will be one of a very "peaky" character and with very heavy "peaks." During these "peaks" the whole possible output of the machinery at work in the station must be utilised, and the intention is for the engines, whatever the actual load they be working on previous to heavy loads coming on, to work up to their full overload capacity, which is about 20-25 per cent. in the case of the old, and 10-15 per cent. in the case of the new sets, before the battery is called upon to discharge heavily. The latter will, however, be called on to work up to its full one-hour rate of 750-1,000 amperes. The old battery booster not being large enough for these discharges, a new one has been installed, built by the Lancashire Dynamo & Motor Co., whose machine is particularly suited for this method of working. A difficulty was, however, found in that the generators were working on a very falling portion of their characteristics, and their pressure dropped badly as their loads increased, this having been com-

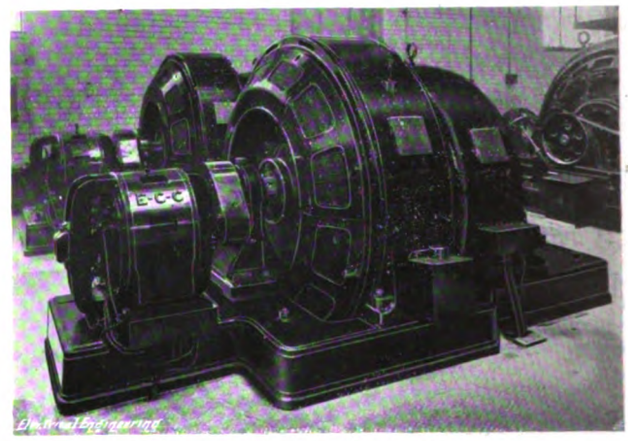


FIG. 4.—TRACTION MOTOR-GENERATORS IN HEYSHAM GENERATING STATION.

pensated for by hand regulation of their excitation, or else during "peaks" they continued to work at their previous loads, and the battery supplied the excess, both courses being inadmissible under the new conditions.

Compound winding in the usual way was an extremely expensive remedy, since, as the copper necessary for full excitation was already on the fields, new series coils would be excessively large and heavy, added to which was the trouble of entirely dismantling the machines. A very simple solution was found in fitting exciters, each mounted on the engine bed-plate, and belt-driven from a pulley fitted on the generator shaft, the compound windings being fitted on these exciters and varying their voltage, and consequently that on the main generator fields, so that the existing copper on the latter was fully utilised. This not only proved a very much cheaper arrangement, the exciters being only of 3 kw. capacity, and of fairly high speed, but enabled the whole change to be made in the course of a week, obviating any dismantling or any serious stoppage of the generating sets.

As regards the new machines, the Lancashire Dynamo & Motor Co.'s booster is of their standard three-wire type. With a comparatively low continuous rating it satisfactorily commutates the "peak" discharges up to 750-1,000 amperes; and it can be set

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to make the engines work up to their overloads as above, or to work under practically any other conditions without any serious drop on the bus-bar voltage.

The new Westinghouse Co.'s generating set is driven by one of the latest type of Westinghouse gas engine. This has three cranks, with three sets of cylinders, two in tandem in each case. It runs at 300 r.p.m., and is fitted with "forced" lubrication. The Engineers to the Midland Railway consider its design and construction sound and thoroughly mechanical, and have informed us that its performance has so far proved it to be an excellent engine, and as reliable as any steam engine.

The motor-generators deserve special mention, not only because they form that part of the generating station most directly connected with the traction installation, but because there are many noteworthy points about them. They are in many ways exceptional machines and working under exceptional conditions, bearing the heavy "peaky" nature of the load, which varies from nothing to upwards of 1,000 kw. in very short periods, in mind.

The specification called for the machines to be each capable of a continuous output of 150-200 kw., with a temperature rise of 80° Fah., but they were also called upon to be capable of safely carrying output overloads of 900 kw. instantaneous, 600 kw. for half a minute, 500 kw. for three-quarters of a minute, and 300 kw. for 2½ minutes, and were required to be also tested under a regular cycle of these overloads, with underloads in between, for eight hours. The internal driving losses were also required to be kept down, while on the alternating-current side they were required to regulate within 6 per cent. on throwing off a non-inductive load equal to the full continuous load, and within 20 per cent. on throwing off a similar but inductive load of 0·8 power factor. Further, they were required, with the assistance of external means if necessary, to restore the pressure to normal within seven seconds of the coming on or throwing off of loads up to 600 kw. at 0·8 power factor, or 300 kw. at power factors down to 0·3. Widely varying proposals were received in connection with these machines, but the Electric Construction Co.'s machines were finally selected, partly on account of their being very compact and requiring a small amount of driving current, as well as having a high efficiency.

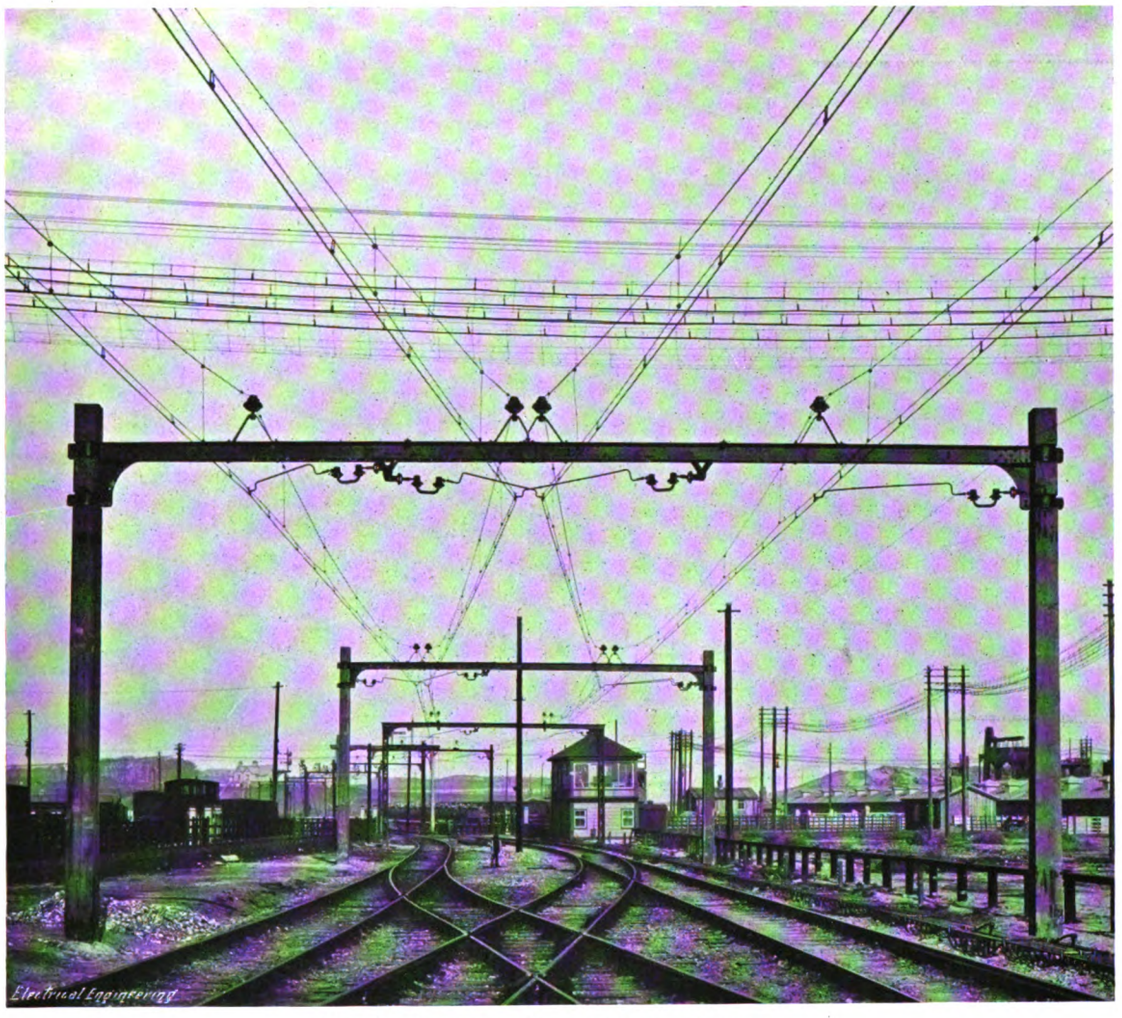


FIG. 5.—OVERHEAD CONSTRUCTION AT JUNCTION.

The makers' specification was 175 kw. on continuous rating, the machines on test being well within the specified temperature rise, but not excessively so. We understand that the running of the trains at Heysham experimentally, each of the sets have several times been subjected to loads up to 900 kw. input without the slightest commutator trouble, and smaller overloads of 600 kw., 500 kw., &c., have been very frequent, and have been carried with equally satisfactory results. The alternating current regulation is also fully up to the specified requirements, and on an average after the switching on or throwing off of a heavy load the voltage is restored to its normal of 6,600 volts within three seconds, while the voltage even then only varies about 300 volts each way; nothing could, in-

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deed, be more satisfactory than the performance of these machines.

The direct-current motor is compound wound with commutating poles, the series winding being a very slight one, and put in principally to assist the two sets to run in parallel satisfactorily, which they do. The alternator has a three-phase star winding, so that if one winding breaks down, the other two may be used for the single-phase supply, otherwise no use is made of the three-phase connections. The machine is of the standard internal revolving field type, and is excited from an exciter, which is carried on the end of the bedplate and spur-geared up to about 1,100 revolutions. This exciter has laminated fields, and is compound wound, its series winding carrying a portion of the main motor current, so that (so far, at least, as varying loads of equal power factor are concerned) the tendency of the alternator to drop in volts is thus compensated for.

Compensation for varying power factors is effected by means of a regulator, designed and constructed by the Electric Construction Co., and the first of its kind, which inserts or extracts resistance from the circuit of the shunt field of the exciters by the action of solenoids, which are respectively excited as the voltage exceeds, or is less than, the normal. As shown in Fig. 4, the direct-current motor armature and the revolving field alternator are carried on the same shaft without any intermediate bearing. There are only two main bearings on the machines, and these are ball bearings. These bearings have so far given every satisfaction, and have proved very advantageous in reducing the starting current, which at 460 volts is only about 75 amperes, and the no-load loss, which is about 23 kw., with the exciter and alternator fully excited.

The switchboard has been designed and constructed by the Railway Company, the instruments being of the Westinghouse Co.'s make. Each of the motor-generators is supplied from the low-tension bus-bars through a no-voltage and overload circuit-breaker. The shunt circuit is excited through a separate double-pole knife switch, with kicking contacts and resistances. Starting resistance is cut out by means of a set of knife switches. By means of a throw-over switch, these can be used to start either set of the machines, a heavy triple-bladed knife switch being thrown in finally when the machines are fully started up, connecting them direct to the bus-bars.

On the alternating-current side each alternator is connected up to the bus-bars by a hand-operated oil switch, and the current passes from the bus-bar through duplicate automatic circuit-breakers to duplicate feeders passing out to the overhead lines. All the circuit-breakers, both high and low tension, have time-limit devices. The exciter shunt fields of the alternators are also connected through double-pole switches with non-inductive contacts and resistances. The instruments used consist of an ammeter, on each of the direct-current motor circuits, and a voltmeter, ammeter, and watt-hour meter on each of the alternator circuits, all, of course, operated through transformers. The incoming wire from the rails is, of course, at " earth " potential. There is also an indicating watt-meter between the bus-bars and the out-going feeders, and the regulator is connected to the same transformer.

The high-tension apparatus is contained in a lock-fast

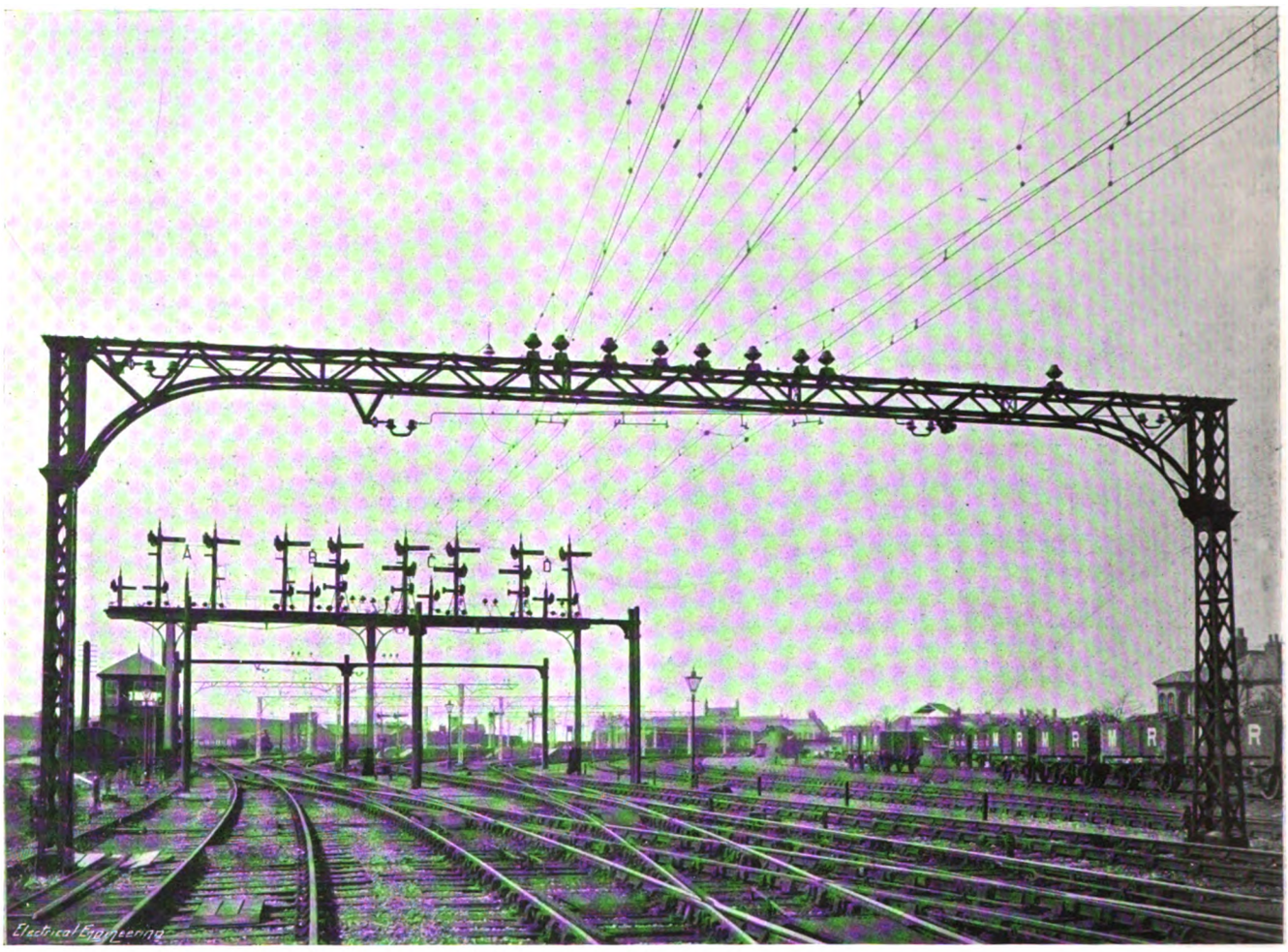


FIG. 6.—OVERHEAD CONSTRUCTION AT MORECAMBE.

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expanded metal chamber placed over and at the back of the actual switchboard, the switches being operated from the handles of the latter through rodding. The door of this high-tension chamber is interlocked with the holding-up coil of the motor circuit-breakers, so that, unless the door is closed, neither motor-generator set can be started, while if it is opened during running, everything stops.

The overhead construction has been designed and carried out under the direction of Mr. W. B. Worthington, the Chief Engineer of the Midland Railway Co., by Mr. J. Sayers, the Telegraph Engineer of the company, and Mr. Argyle, the Northern Divisional Engineer. It is similar as regards the type of suspension to that adopted for the electrification of the Hamburg-Altona Railway, the patents for which in England are held by Siemens Bros.' Dynamo Works, Ltd. The chief difference lies in the new type of suspension of the catenary wire, which is the design of Mr. Sayers.

The length of line electrified comprises the double roads between Heysham and Morecambe, Morecambe and Lancaster Green Ayre, and the single line from Lancaster Green Ayre to Lancaster Castle Station, the total length of single road being about 21 miles. A diagram plan is attached. From Fig. 1 it will be seen that the line passes under a large number of overbridges, mostly of the arched shape, and the clearance of these bridges has been a matter of considerable interest. The use of a single bow for travelling in both directions necessitates the bow being symmetrical about the centre line of the coach, and this brings the bow necessarily very close to the structure of the bridge. In order to get through at all, it is necessary to take the contact wire well out towards the centre of the arch, so that it may come down low, but yet will be clear of the loading gauge, so that the other side of the bow may clear the structure properly. In addition to the bridges, the Lune viaduct presented a special problem, as it is on a nine-chain curve, and terminates at the end of Lancaster Station, which is also on a curve.

The contact wire is of the figure 8 section, and is run in lengths of from 800 to 1,000 yards. One end of each length of the contact wire is fixed through insulators to a terminal gantry, and the other end is attached through suitable pulleys, &c., to a weight equal to about 1,200 lb. The fixed end is always that at which the train enters, and the weighted end that at which the train leaves; the tendency of the bow is, therefore, always to straighten the contact wire. It is worthy of note with regard to the contact wire, which is 70 sq. mm. section, that the strain at first put on was equal to 800 lb., and the horizontal stagger was made equal to four feet—that is, two feet from the centre line of the coach—but the experimental trials which went on for some months before passenger trains were run showed that the total friction of pull-offs, &c., was such as to make it necessary to increase the tension to about 1,200 lb. for a 1,000 yards length, and with this tension the strain goes fairly evenly throughout the whole length. It was also found that a four-feet stagger for a bow which measured from tip to tip 7 ft. 1 in. was too much for practical purposes for running at high speeds. The line is situated in a country swept by very violent gales, experiencing the worst of weathers, and it is now considered that a stagger of two feet is a more practicable figure, though part of the line is actually run with three-feet stagger at present.



FIG. 7.—ARRANGEMENT OF OVERHEAD CONSTRUCTION UNDER BRIDGE.

The height of the contact wire from rail level varies from 18 ft. 3 in. in the open to 13 ft. 3 in. under bridges. It is suspended by short loops about 4 in. long from a steel cable called the auxiliary wire. The loops are fixed to the contact wire, but are movable on the auxiliary wire. The auxiliary wire again is held by the main catenary cables, of which there are two, the main catenary span being thus broken up into six short spans on the auxiliary. The two catenary cables are clipped together throughout their length, except for about three feet on either side of the insulator, where they divide to pass through the grooves of a ring, the said grooves being on opposite sides of the insulators. The catenary is, therefore, free to move for this distance, and this equalises the strains in the spans due to unequal loading; at the same time, it is secure in the case of the breaking of the wire, as has actually been proved by experience.

Section switches are provided so as to isolate the up and down lines, or to isolate the different branches. These switches are of the double-break air pattern, and

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are fixed on the top of the poles supporting the gantries. Each section switch is, in addition, duplicated, and the connection from one contact wire to the section ahead of it is accomplished by means of a short section of switch wire, which requires to be connected to the two contact wires before the line is switched through at this point. This arrangement was adopted in order to get a duplicate break, and, what is more important, a short length of line into which a car can run without bridging two sections by means of its bow, if it is required to be isolated. The switches are provided with padlocks. A similar type of switch is in use at the various stations to enable the station staff to earth the overhead wiring in case of emergency.

The gantries are connected together by a separate overhead steel cable, which is earthed every half mile, the same earth-plates being used for lightning arresters of the horn type, the object being to diminish the number of earth-plates requiring attention, and thus to give better security from danger due to the poles being charged by a leaky insulator. This earthed steel cable has been erected in every case between the contact wire and the telegraph wires, which are open on one side of the line, and it is believed that its presence has had a great effect in reducing the electrostatic induction from the contact wire to the telegraph wires.

It was the object of the company to avoid, if possible, cabling their telegraph and telephone wires, and, so far, the results are favourable to the idea that it will not be necessary to put all such open wires underground when high-pressure traction systems are erected overhead. At the same time, it will certainly be necessary to provide some sort of high-resistance leak on any wire parallel to such a system, as circumstances may arise, as, for example, in the case of a wire thrown out of work by disconnection at the test-board when there might be high electrostatic potential produced between.

Figs. 5, 6, and 7 show the various forms of construction employed. The poles used have been mostly straight creosoted wooden poles, as shown in Fig. 5, but at Morecambe Station and at one or two other points it has been necessary to erect lattice steel poles and lattice girder gantries, owing to the big spans, as shown in Fig. 6. Where wooden poles are used, the gantries are made of two angles, brought together at the ends, but kept apart for the greater part of their length by distance pieces one inch thick, enabling the bolts from the insulator saddles to drop in the gap, so giving a great range of adjustment of the insulator position without any necessity for drilling.

The design of the insulators is shown in Fig. 8. Before getting out the dimensions, the company's staff took advantage, by the kindness of Messrs. Siemens Bros.' Dynamo Works, Ltd., of experiments this firm undertook to ascertain what was the minimum distance at which a 6,600-volt, 25-cycle circuit would maintain an arc in the heaviest weather from an insulator shed. It will be noticed that the steel bolts supporting the insulators are encased with ebonite—a

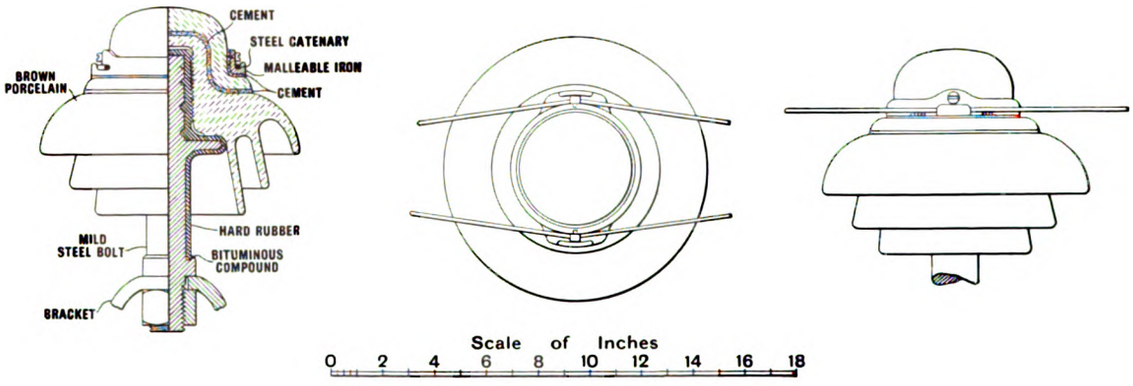


FIG. 8.—SPECIAL INSULATOR FOR OVERHEAD LINE.

similar arrangement to that adopted by Messrs. Siemens on the Hamburg line, with a view to getting practically double insulation with one insulator. In addition to this, however, the Midland company preferred to make the insulator itself in two portions, and to make it very massive. The line is very likely to suffer from damage from stone-throwing at the large number of level crossings, and, in addition, will suffer from very bad weather conditions. It will be seen that the design of the insulator in combination with the twin catenary cable brings the side strain of the overhead gear below the level of the inside bolt, and there is no point at which the catenary cable itself is being deformed by the pressure of any clamp of any sort, and no point at which the mechanical waves tend to break the wire at a point of reflection.

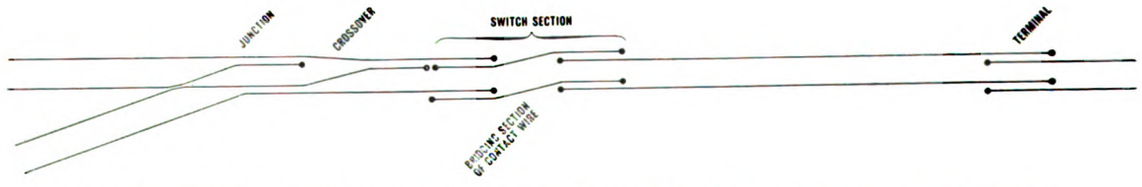


FIG. 9.—DIAGRAM OF WIRING AT JUNCTIONS, CROSSOVERS, SWITCH SECTIONS, AND TERMINALS.

The outer rail on each line is bonded throughout its length with bonds of the Forest City type, in duplicate, placed under the fish-plates. At crossings and junctions all rails are bonded together, and these bonds and those used for cross bonding are ordinary copper cable bonds. Very great care was exercised in bonding the line to prevent any moisture getting into the drilled holes or on to the bond plugs during the process, and in very wet weather the work was abandoned. By means of protective devices, however, it was found possible to go on with bonding in moderately wet or damp weather, but the tests carried out, when the whole of the work was finished, of the resistance of each bond showed in an interesting manner that.

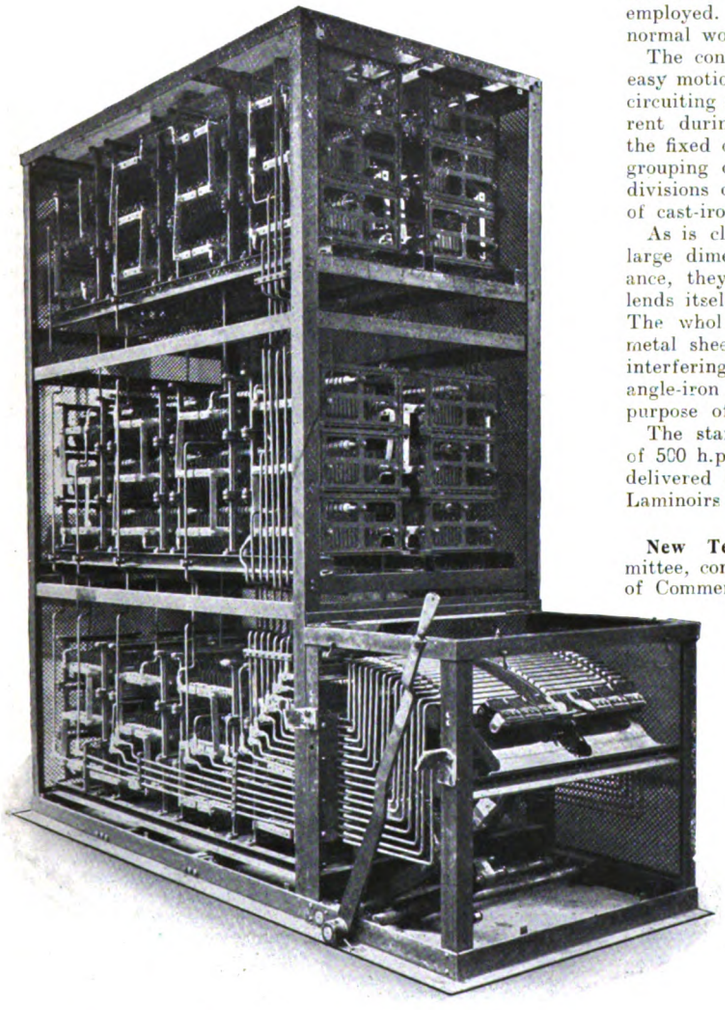
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although the bonds were quite satisfactory, those which were carried out in perfectly dry and fine weather were quite distinguishable, by resistance test, from those which were carried out in damp or misty weather. It will be interesting to note, as time goes on, whether this difference in resistance is intensified.

The rails are earthed at Heysham Harbour in the sea by duplicate copper earth-plates. At Morecambe they are earthed at the end of the Midland Railway Pier, these plates being of copper again, but for protection they are dropped into a large cast-iron caisson recovered from an old Midland bridge. At Lancaster the rails are earthed to the cast-iron columns of the bridge, where they rest in the bed of the river, where water is always flowing. Recording ammeters have been put in these various earths, with a view of indicating the proportion of current which returns by these routes. The arrangement of wiring of junctions, cross-over switch section and terminals is shown in Fig. 9. A full description of the rolling stock will be given in our next issue.

STARTER FOR LARGE ROLLING MILL MOTORS

DIFFICULTIES are presented in the design of starters for large direct-current rolling mill motors on account of the heavy currents which have, as a rule, to be dealt with. The contact surfaces must be large, and the resistances of considerable carrying capacity, while means should be provided of preventing the operator cutting out the resistance too rapidly. The accompanying illustration shows a starter embodying the above-mentioned points, designed and constructed by the Felten & Guilleaume-Lahmeyerwerke A.-G., of Frankfort-on-Main. The fixed contacts are arranged to form the segment of a cylinder, and are divided into two parallel rows, thus increasing the certainty of good connection between the fixed and moving contacts. The latter comprise a number of units for each half of the contact way, and are of the roller type. As a result of the duplication of the fixed contacts, the resistance is also divided into two portions, the arrangement of which may be seen in the figure.



STARTING SWITCH AND RESISTANCE FOR 500 H.P. CONTINUOUS-CURRENT ROLLING MILL MOTOR.

The operating lever is connected to the contact arm through a ratchet gear, and the lever must be moved through a complete cycle to and fro to advance the contact arm one step. The necessary slow-starting is thus ensured. In switching out, however, the operating lever returns the contact arm to its off position in one rapid motion. To prevent arcing, the last contact on opening the circuit, a powerful magnetic blow-out is fitted to each half of the contact way. The contact bars are supported on an angle iron framework, but only at their ends; they are thus entirely free and open to the circulation of air, and the possibility of dirt or metallic dust lodging between them and forming an electrical connection from one to another is avoided. The first bar is broader in the case of one half of the contact way than in the other, and consequently the first to-and-fro movement of the operating lever closes the circuit through one half of the resistance only, and the rush of current from the network amounts only to one-quarter of the full-load current of the motor The next movement of the contact arm connects the second half of the resistance in parallel with the first, and the current rises to one-half of the normal working current. The effect of broadening the first step of one half of the contact way is therefore to add an extra step, doubling the resistance in circuit without increasing the amount of material employed. The remaining steps are so calculated that the normal working current of the motor is at no time exceeded.

The contact arm is fitted with a balance weight to ensure an easy motion, and on reaching its final position it closes a short-circuiting switch, so that the roller contacts are only under current during the actual time of starting. The arrangement of the fixed contacts renders possible a very orderly and accessible grouping of the conductors between them, and the successive divisions of the resistance, which is built up in the usual way of cast-iron elements.

As is clear from the illustration, in spite of the necessarily large dimensions of the actual starting switch and the resistance, they are combined to form a compact apparatus, which lends itself to inexpensive erection with a minimum of labour. The whole apparatus is protected on all sides by perforated metal sheets, which prevent disturbance of any part without interfering with the ventilation, and are so fastened to the angle-iron framework that they may be easily removed for the purpose of inspecting the contacts or resistances.

The starter controls a rolling mill motor having an output of 500 h.p., at 240 volts and 200 to 250 revolutions per minute, delivered by the Felten & Guilleaume-Lahmeyerwerke to the Laminoirs de Thy le Château Charleroi.

New Telephone Charges.—The permanent telephone committee, consisting of representatives of municipalities, Chambers of Commerce, and Chambers of Trade throughout the country, which was formed in connection with the new scale of charges introduced by the Postmaster-General and the National Telephone Co., has now got to work, and a meeting was held in London on Thursday. The proceedings were private, but it is announced that Mr. J. S. R. Phillips, editor of the *Yorkshire Post*, has been elected a member of the committee, as representing the Newspaper Society.

Tramway Rating.—The dispute between the Blackpool and Fleetwood Tramroad Co. and the local authorities through whose areas the lines run, with regard to rating, still continues. The company argues that, being a tramroad and not a tramway running on the highways, their undertaking comes within the category of a railway, and as such is entitled to a reduction of three-quarters of the net assessment. The Council of Bispham-with-Norbrech have differed from the Lancashire justices on the point, who have held in favour of the company, and last week they sought a mandamus in the High Courts, ordering the justices in question to issue a distress warrant against the company for the full assessment. Sitting as a Divisional Court, the Lord Chief Justice and Justices Darling and Sutton decided against the Council.

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CORRESPONDENCE

STREET LIGHTING IN THE CITY OF LONDON.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—The publication of the results of some of our work on the City lighting makes me wonder whether it will be the occasion of more antagonism between those who are interested in gas and those who are interested in electricity. Personally I am a greater advocate of going to bed when it is dark than of either gas or electric light, and as I desire above all to promote unity among men rather than discord, I will ask you to allow me to say a word to both parties in this discussion.

When one observes the terrible waste of human life and material that is taking place, a waste that does not arise so much from the want of technical knowledge as from its neglect, when one looks upon this terrible farce which is proceeding once more before a Committee of Parliament, and when one carefully "examines" the cause of these dreadful things, one is led irresistibly to the conclusion that they arise from want of unity among men. Instead of adding one to one and making two, we are everlastingly subtracting one from one and making worse than nothing. This madness has proceeded so far that recovery is probably a very difficult matter; we are like people bound by some magic spell. Yet delivery from this spell must come sooner or later, and when trade is bad is the best time to stop and think, for when trade is good, few of us will "ever think of what we are really doing."

Now both gas and electric light people are public servants fulfilling the same task in different ways. It is quite easily ascertainable, as a matter of fact, and not as an opinion, that electricity can be under most circumstances cheaper for lighting, and gas cheaper for heating, but even supposing this were not so, and that the facts were quite different, why should not both unite to do that which is best, and find some reasonable basis of agreement by which both should get a fair return for the services they render. Of course, the suggestion of a combination between the gas and electric light people is enough to make the hair of the average trader stand on end, and justly so if a superficial view of the case is taken.

As buyers, we all know the apparent advantages of price-cutting, but try and trace out the whole system of trade competition, and we shall find that we gain one penny in one pocket and lose twopence out of the other, and that the whole thing is madness, which is bringing us to destruction.

If we are going to admit that one man will not properly serve another man unless a third man is waiting to eat him up if he does not, then disaster is already complete. But I will not believe it, and I say the time is now ripe for men to take a more serious and simple view of what is proceeding, and endeavour to stop the madness that is now destroying us.

I venture to send you a short piece from a Report about the Electric Supply Bills for London. The unity that I ask for among all parties interested in the electric supply of London I would like to see extended to those interested in gas, and as a practical man having the good of all the people of London at heart, I do not believe that there would be a great deal of difficulty in preparing a scheme which would be satisfactory to Parliament, if we all tried to be reasonable.

Your obedient servant,

Dorking, June 6th, 1908. A. A. VOYSEY.

P.S.—It may be thought that there is an argument against what I have urged in the fact that the gas mantle, the metal filament lamp, and the flame arc lamp have possibly been developed as the result of competition between gas and electricity, but it is no argument against me. Do we not all know that the great discoveries which have advanced the consciousness of man have been made for the love of truth, and not for the love of self? Is not my own experience like that of all men, that the less I think of the size of my salary the better my work becomes? If we were not madly trying to eat each other up, we might now be considering a scheme for the partial conversion of gasworks to join with the electric light works in endeavouring to give London the cheapest possible light with a reasonable profit, instead of wasting our money over propositions for further waste and chaos. A. A. V.

The following is the extract from Mr. Voysey's Report on the London Power Bills referred to in his letter:—

"London wants the cheapest possible electricity. Engineering properly *is* economics, and on economics fundamentally depends the solution of this problem. Unfortunately, the slate is not clean—it is covered with incoherent writing which cannot all be rubbed out, and the question is how much can be rubbed out, how can what remains be best used, and can it be usefully altered and added to? Those are the questions that have to be answered. It is obvious that these questions cannot be answered properly till they have been put and carefully considered. It is also obvious that if men wish to attain any given object they should unite with that one object in view. But in this matter of London's electric supply the real object has been left out of sight altogether, the true fundamental questions have never been asked. The Parliamentary Committee sit without any independent technical adviser, but if they had one it would not make matters much better, for the real object is not presented to them at all, only the conflicting interests of various parties. Parliament cannot pass propositions which are not before it. Those that have written on the slate strive to perpetuate or increase their writing, while those who may inherit the slate or part of it strive for their little bit of prospective interests, and fresh parties come forward wanting to write all over the slate and make it much bigger, and in the midst of this strife the slate is seized upon by political parties who try to bang each other's heads with it. It is one of the most dreadful fallacies by which men are deceived, and by which we are now being destroyed, that the strife of men with men is good for men. The progress of animal life is through strife, the progress of human life through unity. I am not moralising, but writing plain common sense, which ought to be practically applied and might quite possibly have been applied if serious attention had been given to this matter. I hope my words may be accepted in the earnest sense in which they are offered, for I am speaking of that which involves vast questions of waste in life and material.

"I will now proceed to consider the Bills more in detail. Mr. Lloyd George has pointed out the necessity for agreement among the interested parties, which is precisely what I have from the beginning been urging an endeavour to bring about. Mr. Lloyd George at the same time thought the Bills ought to be considered by committees, but both the Bills are just of that kind which has caused all the strife of the past. I do not know by what peculiar process of reasoning it can be supposed that what is opposed to unity can promote unity, unless Mr. Lloyd George is thinking of the confectioner and his assistants, but even so, the case is not parallel, for the confectioner himself pays for the sickening process, whilst in this case the public ultimately bears most of the cost.

"The main truth about the public and the electric supply business may be shortly re-expressed as follows:—There was a certain rich and wasteful man, and many sought to serve him. He hired servants according to their clamouring and without thinking of his real needs; he had no idea of the relation of the work of one to the work of another, and he made no proper arrangements for controlling, directing, or dismissing them. Some of the servants were bad and tried to rob the master. But the master, not able to dismiss the bad ones, got still more servants to look after them and help to do their work. The old servants tried to drive out the new ones, but finding they could not they agreed with each other against the master. The waste and extravagance was terrible, and the pinch began to be felt. Then came others to the master, wishing to serve themselves, and they said their services would be good for the master and would put everything right, but some of the old servants said that if they could work together things would be better. Neither master nor servants saw that first of all the master had not understood his own needs, and then that the servants had not worked for the master but for themselves, and that all the trouble lay in this. The cure lies in the recognition of the truth in the study by the master of his needs with the aid of the servants, in the resolve of the servants to care more for the needs of the master and of the master to care well for his servants, and in the resolve of all to work together for the good of all. The time is rapidly approaching when men will look with horror on the waste that is wrought of strife and when reasonable agreement will more and more be regarded as a better way of life. Let us take time by the forelock."

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION

Full Programme of the Nottingham Convention

WE have now received the full programme of the thirteenth Annual Convention of the Incorporated Municipal Electrical Association, which will be held in Nottingham from June 30th to July 3rd.

On Tuesday, June 30th, the Association will meet at the University College at 10.30 a.m., when the Mayor (Mr. Councillor Spalding) and the Sheriff (Mr. Councillor Carey) will be present to welcome the Members. Mr. H. Talbot, the Chief Electrical Engineer to the Nottingham Corporation, will deliver his Presidential Address, after which the following Paper will be read and discussed: "The Experiences of a Convener in the Establishment of an Electricity Undertaking," by Bailie Wightman, Convener of the Govan Electricity Committee.

Luncheon will be served at the Mechanics' Large Hall by invitation of the Chairman (Sir J. Turney), and members of the Electricity Committee, and at 2.30 p.m. special tramcars will leave for the Trent Bridge car shed and repair shops, and later for the St. Ann's power station, where tea will be provided.

The works of the Brush Electrical Engineering Co., at Loughborough, will be open for inspection during the Convention, as will also the generating station of the Derby Corporation.

Wednesday, July 1st, will be devoted to a whole-day excursion to Dovedale, a special train leaving Nottingham at 8.40 a.m. for Matlock, Bath.

The Annual General Meeting will be held at 10 a.m. in the University College, Nottingham, on Thursday, July 2nd, and at 2.30 p.m. a meeting will be held at University College, when the following Papers will be read and discussed: "Some Considerations on the Design of a Generating Station," by Mr. H. Richardson (Chief Electrical Engineer, Dundee), and "The Reconstruction of an Electric Lighting Scheme," with observations on the working of a combined steam and water power plant, by Mr. C. M. Shaw (Chief Electrical Engineer, Worcester).

The Association Annual Dinner will be held at the Exchange Hall, Nottingham, at 7.30 for 7.45.

The final meeting of the Convention will be held at 10 a.m. in the University College on Friday, July 3rd, when the following Papers will be read and discussed: "Alternating-current Accumulator Sub-stations," by Mr. A. M. Taylor (Assistant Electrical Engineer, Birmingham), and "The Work and Equipment of a Testing and Standardising Department," by Mr. H. A. Ratcliff (Superintendent of the Testing Department, Manchester Corporation Electricity Works).

Obituary.—We regret to have to record the death at Cherbourg, at the age of fifty-six, of Mr. L. G. Mouchel, of the firm of L. G. Mouchel and Partners, who have done so much in introducing ferro-concrete construction into this country. It was in 1898 that Mr. Mouchel acquired from Mons. F. Hennebique the sole agency for his system of ferro-concrete construction, and since that time he has devoted himself entirely to this branch of engineering, having carried out some 600 buildings and engineering works of this nature in Great Britain. About a year ago he took Messrs. J. S. E. de Vesian and T. J. Gueritte into partnership.

Protection of High-pressure Circuits.—An interesting form of water-jet protective device has been recently patented in Germany by the A. E. G. of Berlin. A fine stream of water falls parallel to a plate connected to the line. On a rise of pressure, the stream is attracted to the plate and the system is momentarily earthed. The top of the plate and the pipe from which the stream of water falls are horn shaped so as to extinguish the arc formed. No continual discharge to earth takes place as in former water-jet lightning protectors.

1,000 H.P. SINGLE-PHASE LOCOMOTIVE FOR THE PRUSSIAN STATE RAILWAYS

IN the latter part of last year a large goods locomotive was built by the Allgemeine Elektricitäts-Gesellshaft for use on the experimental single-phase line of the Prussian State Railways at Oranienburg. This locomotive is now in use, and the following description is abstracted from a recent article in the *Elektrotechnische Zeitschrift*.

The locomotive consists of two two-axle units coupled together. Three of the axles are driven by single-phase motors of the Winter-Eichberg compensated repulsion type, but there is room for a fourth motor on the remaining axle if this is considered necessary. Each motor is rated at 350 h.p. on the one hour 75° C. basis, and with this load runs at a speed of 450 r.p.m. On account of the forced draught cooling, the continuous capacity is as high as 250 h.p. or 70 per cent. of the one-hour rating. The speed at this load is 500 r.p.m. It is stated that these motors differ only in a few constructional details from the 350 h.p. motor experimented with in the year 1906. This was a six-pole, 25-cycle motor, and weighed 5·5 tons without gear, or 35 lb. per horse-power. (With this figure should be compared the weight of the Metropolitan District continuous-current motor of 240 h.p. on the one-hour rating, which weighs 2·51 tons without gear, or 23 lb. per horse-power, and runs at a speed of 530 r.p.m.) The electrical and constructional design of these large 350 h.p. motors is similar to the other well-known Winter-Eichberg motors, a smaller size (115 h.p.) of which is being used for the motor-cars of the London, Brighton and South Coast suburban line. Returning to the locomotive in question, the motors are geared to the axles with a gear-ratio of 1 : 4·21, and the driving wheels have a diameter of 4·6 feet. Thus at the rated output (one hour, 75° C.) of the motors a speed of 17·5 miles per hour is attained with a total drawbar pull of 22,000 lb., and at the continuous capacity of the motors a speed of 19·5 miles per hour is attained with a drawbar pull of 14,300 lb. The maximum speed of the motors is about 955 r.p.m., corresponding to a maximum locomotive speed of 37 miles per hour. The total weight of the two units is 59·5 tons, or about 15 tons per axle. The locomotive is supplied with current at 6,000 volts 25 cycles by means of two bow-collectors fitted on one of the units. The bow presses upwards on to the contact wire with a pressure of about 9 lb., and reverses automatically on a reversal of the direction of motion. The framework carrying the bow can be raised or lowered by compressed air or by hand, but can only be raised if the door of the high-tension compartment is closed. In the same half of the locomotive are situated the high-tension oil switch, lightning protection apparatus, and the main transformer which transforms down from 6,000 to 1,000 volts. This transformer is cooled by a forced draught from the same fan which blows air through the motors. The control-gear, contactors and fuses, as well as the regulating and instrument transformers, are also situated in this half of the locomotive.

In the other unit are the fans for the forced draught, the compressor for the brakes, collector, sand distributors, and whistles, and the compressed air chamber. The fan is driven by a 30 h.p. Winter-Eichberg motor, which is started by means of a series choking coil. The coil is automatically short-circuited when a speed of 700 r.p.m. is reached. In order that the air blown through the motors and transformer may be free from dust it is drawn through coke filters at the two sides of locomotive, just under the windows. The air-compressor is driven by a 7 h.p. Winter-Eichberg motor, and is automatically started when the air pressure in the air chamber is less than 6 atmospheres, and stopped as soon as the pressure reaches the value of 8 atmospheres.

At each end of the locomotive is a driver's compartment, shut off from the rest of the interior. The main controller, which has four starting positions and four running positions, is situated on the left side of the compartment. A simplified controller operating the motors on the lowest voltage only is placed on the right side of the compartment for use in shunting operations, when the driver may require to be on that side of the cab. The three motors are operated in two independent groups, and the various operating steps are obtained by running off different taps on the secondary of the main transformer. The lead to the motor is connected to the centre of a choking coil, and the ends of the choking coil are connected to two adjacent tappings on the transformer, so that in changing from one tapping to another the motor circuit is never broken. The contactors are operated with current taken from the main transformer at a pressure of 300 volts. The compressed air brake acts simultaneously on all eight wheels, and can be operated by hand, if necessary, from the driver's compartment.

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INTERNATIONAL CONGRESS ON ELECTRICAL UNITS AND STANDARDS

AS announced on page 686 of our issue for May 7th, it has been decided to hold an International Congress on Electrical Units and Standards in London in October next, and invitations to send representatives have been issued to the foreign Governments interested in the subject and also to the self-governing Colonies. The Board of Trade have appointed a Committee consisting of Mr. G. R. Askwith, K.C., Sir John Gavey, C.B., Dr. R. T. Glazebrook, F.R.S., Major P. A. MacMahon, F.R.S., Major W. A. J. O'Meara, R.E., C.M.G., and Mr. A. P. Trotter, with Mr. M. J. Collins, of the Board of Trade, as Secretary, to prepare a programme for the consideration of the delegates at the Congress, and to make the necessary arrangements for the reception and assembly of the delegates.

The Committee have fixed Monday, October 12th next, as the date for the assembly of the Congress, and they have also prepared the following memorandum which sets forth the proposals to be laid before the Congress as a basis for their deliberations :—

Memorandum as to the proposals to be laid before the Congress on Electrical Units and Standards to be held in London in October next.

The general object of the International Congress on Electrical Units and Standards, which is to meet on the invitation of His Majesty's Government in London in October, 1908, is to consider and advise as to the steps which should be taken to bring about agreement in the definition of electrical units which form the basis of legislation in different countries, and in the methods of constructing and employing the electrical standards necessary to give effect to these definitions.

It is hoped that the delegates to the Congress may find themselves able to embody their conclusions in draft Articles which might be commended to the several Governments represented as a basis for uniform legislation and administration in relation to electrical units and standards.

The fundamental units of electrical measurement are the ohm, the ampere, and the volt. Of these two are primary units, being independent, and the other secondary or derived. It is generally agreed that the ohm should be accepted as one of the primary units. There is some difference of opinion as to whether the ampere or volt should be the second. This point will be one for the Conference to consider.

Again, the ohm is realised by means of the resistance of a column of mercury of definite dimensions, the ampere by means of the electrolytic deposition of silver, and the volt by aid of a standard cell.

If this method of realising the units be accepted by the Congress, specifications for the ohm and ampere will call for consideration, while the standard cell must be selected and the method of setting it up prescribed.

In view of the scientific questions raised in connection with each of these matters, including also the choice of the two primary units, it will be suggested at an early meeting of the Congress, should such a course appear to be desirable, that the Congress should appoint a small Technical Commission of experts to discuss the question, and report thereon to the Congress.

The Congress will also be asked to consider the best methods of securing uniformity of administration in the future, and for arriving at a decision on any questions left undecided at the close of the Congress.

It is desirable to have some definite questions before the Congress, and with this object the following propositions embodying conclusions arrived at by the representatives of the various National Standardising Laboratories which met at the Reichsanstalt in 1906, and which are also generally in accordance with the decisions of the Chicago Congress held in 1893, will be brought forward as a basis for discussion.

1. That the ohm shall be the first primary unit.
2. That the ampere shall be the second primary unit.
3. That in consequence the volt shall be treated as a secondary or derived unit.
4. That the international ohm be defined as the resistance at the temperature of melting ice of a column of mercury of uniform cross section terminated by planes at right angles to its length 106·3 centimetres in length and 14·4521 grammes in mass.
5. That the international ampere be defined as the unvarying electrical current which when passed through a solution of nitrate of silver in water deposits silver at the rate of 0·001118 gramme per second.
6. That the International volt be defined as that electromotive force which when applied steadily between the ends of a conductor of resistance 1 international ohm produces a current of 1 international ampere.
7. That the Weston cadmium cell be adopted as a convenient standard of electromotive force, having at a temperature of 17° C. an e.m.f. of . . . international volts, but that it is undesirable that the number representing the e.m.f. of this cell should be the subject of legislation in any country.
8. That specifications dealing with the methods of setting up mercury standards of resistance, of realising the ampere by the deposition of silver and of preparing standard cells, be issued with the authority of the Congress, and that for this purpose a Technical Commission be appointed to prepare these specifications.
9. That the Congress consider and advise as to the best method of securing uniformity with regard to the fundamental electrical standards for the future.

SOME NOTES ON ILLUMINATION

AT a meeting of the Local Section of the Institution of Electrical Engineers at Cape Town, on February 10th, a Paper on the above subject was read by Prof. H. Bohle. The author divided his Paper into four sections. The first section dealt with the fundamental laws of the distribution of light, the second with the illumination of buildings, the third with outdoor illumination, and the fourth with illumination photometers. The following is an abstract of the Paper :—

Fundamental Considerations.—The illumination of a surface by rays falling obliquely from a source of light is expressed by the equation :—

$$E = \frac{I \cos \theta}{R^2}.$$

E will be the illumination in candle-feet* if I is the intensity of the source of light in British standard candles, θ the angle of the incident rays with the normal to the illuminated surface, and R the distance in feet of the source of light from the surface. If the source L be at a vertical distance h from the surface, the illumination at a point P on the surface is expressed by the equation :—

$$E = \frac{I \cos \theta}{a^2 + h^2} = \frac{Ih}{(a^2 + h^2)^{\frac{3}{2}}}$$

* In the original the author expressed the illumination in Lux. The Lux is generally defined as one candle-metre, but the German Lux is a Hefner-candle-metre, and the French Lux a Bougie-candle-metre. The author used a Lux of the value of one British-candle-metre. As the candle-foot is the accepted unit of illumination in England, the author's formulæ and figures have been converted to suit this unit. Thus one candle-foot is equal to 10·74 Lux (British-candle-metres). —ED. E.E.

where a is the distance, on the surface, of the point P' from the trace of the normal from L on to the surface. E will again be expressed in candle-feet if I is in candles and a and h in feet. This holds for any plane, whether the same be vertical, horizontal, or inclined.

Consider a symmetrical source of light, *i.e.*, a source from which uniform illumination along the same latitudes on an imaginary hollow sphere surrounding the source is obtained. By measuring its distance h from the illuminated surface and the distance a of any point P from the projection of the source upon this plane, we are able to plot, with the aid of the above equation and the polar curve, giving the distribution of intensity along a meridian, the well-known illumination curve. This has been done for an ordinary arc lamp, and is shown in Fig. 1, which represents the illumination in candle-feet along a horizontal plane at right angles to the axis of the lamp. The points of similar illumination caused by a single symmetrical source lie on a circle, as is illustrated in Fig. 2.

Suppose a lamp has to illuminate a given circular area, say a table, so that the illumination is a maximum at the circumference of the table. At what height should the lamp be suspended above the table? For the above condition, the illumination curve must rise to a maximum at a distance a from the centre of the area, where a is the radius of the circular area: and, from the above illumination equation, we find that for this to be so h must be equal to $0{\cdot}7a$. The illumination from the centre towards the circumference of the table varies considerably, but it can be made more uniform by fixing a shade above

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the source of light. The shape of the shade or reflector is of great importance in determining the uniformity of illumination. By the application of properly designed reflectors, the polar curves of most lamps may be varied more or less at will. Given the values of h and a, and the natural polar curve of a lamp, a reflector can be made which will alter the polar curve to the necessary shape for uniform horizontal illumination over the given area.

From the fundamental equation for the illumination from a source of uniform intensity we get :—

$$I = \frac{E(a^2+h^2)^{\frac{3}{2}}}{h}.$$

If the illumination along a horizontal plane is to be uniform and equal to E^1, the equation of the polar curve of the source of light necessary to give this is given by :—

$$I = \frac{E^1(a^2+h^2)^{\frac{3}{2}}}{h}.$$

Consider the particular case of a circular area of radius $a=60$ ft., which has to be uniformly illuminated to the extent of one-tenth of a candle-foot by a single lamp suspended at a height of 30 ft. above the centre of the area. Making use of the above equation, it will be found that the polar curve must have the shape given in Fig. 3. The curve resembles that of an arc lamp with vertical carbons, and may readily be obtained with the use of a suitable reflector.

In most cases the illumination by a single lamp is insufficient and a number of lamps are required. The area which can be effectively illuminated by a single lamp depends upon the size of the lamp, its height above the surface to be illuminated, and the illumination required. For incandescent lamps the ratio a/h for effective illumination is, on the average, limited to 1·5, for arc lamps to 3·0. In other words, the radius of the area which can be effectively illuminated by an incandescent lamp is about one and a half times the height of the lamp above the ground, and the equivalent radius for an arc lamp is about three times the height of the arc above the ground. To obtain the illumination given by two lamps suspended a certain distance apart, the illumination curve for each lamp is plotted, and the resultant illumination along the surface between the lamps is obtained by adding the ordinates of the two curves. If a space has to be uniformly illuminated by a number of lamps, the best results are obtained by arranging the lamps at the corners of equilateral triangles, or parallel to the boundaries of the space, in such a way that they are equidistant from each other in all horizontal directions. It must be remembered that flame arcs and carbon incandescent lamps are not quite symmetrical, and also that the uniformity and degree of illumination is considerably affected by the reflection from the surrounding walls.

Illumination of Buildings.—The methods described above enable us to determine the illumination of any given room or space. With an illumination of 5 candle-feet we can read as easily as in daylight, but in no case should the illumination be less than one candle-foot for reading purposes. For a general illumination 0·7 to 1 candle-foot is sufficient. The illumination is generally required in a horizontal plane about 3 ft. above the floor. In picture galleries, however, most of the light is required on the surrounding walls, and the fixing of the lights and the calculation of the illumination should be made accordingly. For a uniform distribution it is advisable to employ a large number of small lamps spaced equidistant over the whole ceiling, but a very uniform illumination is obtained by the use of inverted arcs. With this indirect method, however, 20 to 30 per cent. of the light is lost through absorption of the reflecting surfaces. When the illumination takes place with lamps arranged in clusters, we may treat these as single lamps with a mean spherical candle-power equal to the sum of the individual candle-powers, less a certain percentage on account of the fact that one lamp screens off part of the light from the other lamp. For clusters of two lamps about 12 per cent. should be deducted, for three lamps 16 per cent., and for four lamps 18 to 20 per cent. For purposes of calculation the polar-curve of the whole cluster should be plotted. The horizontal illumination from clusters consisting of more than two lamps is practically uniform. It is, of course, impossible to pre-calculate correctly the illumination of any room, since a great deal depends upon the nature and colour of the walls, ceilings, and furniture.

Some idea of what the illumination should be may be gathered from the following figures, recommended by the A.E.G., which give the necessary candle-power of the lamps to be used expressed in candle-power per square foot of floor space :—(1) For private houses : drawing-room, 0·4 to 0·5; dining-room, 0·3 to 0·35; bedroom, 0·15 to 0·2; kitchen, 0·1 to 0·2. (2) For shops : counter, 0·4 to 0·7; stores, 0·3 to 0·35; offices, 0·5 to 0·6. (3) For hotels : concert rooms, 0·9 to 1·3; meeting rooms, 0·5 to 0·7; private rooms, 0·2 to 0·4. The height of lamps in rooms less than 15 ft. high is usually 6 to 8 ft. For rooms more than 20 ft. high the convenient height is 0·4 times that of the room. For factory yards a good figure is 0·03 to 0·05 candle-power per square foot of floor space, for railway stations 0·05 to 0·1, for market halls 0·15 to 0·25, and for factories 0·2 to 0·3. In shops, factories and workshops, two kinds of illumination are wanted : a general illumination best supplied by arc lamps, and a concen-

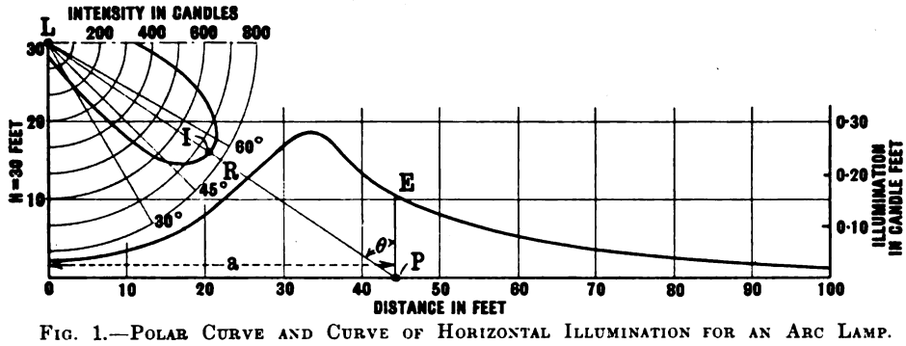


FIG. 1.—POLAR CURVE AND CURVE OF HORIZONTAL ILLUMINATION FOR AN ARC LAMP.

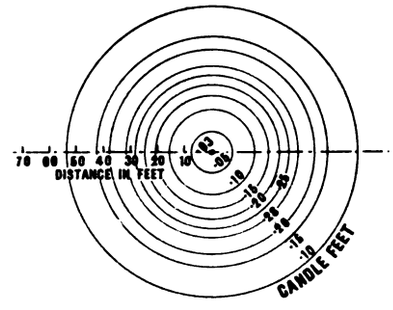


FIG. 2.—HORIZONTAL ILLUMINATION FROM AN ARC LAMP.

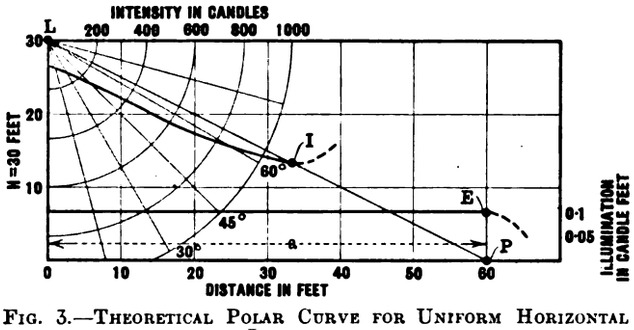


FIG. 3.—THEORETICAL POLAR CURVE FOR UNIFORM HORIZONTAL ILLUMINATION.

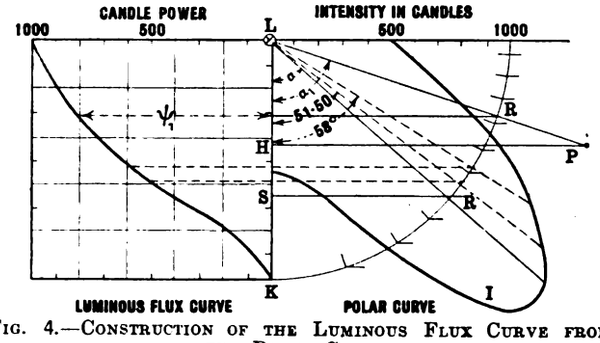


FIG. 4.—CONSTRUCTION OF THE LUMINOUS FLUX CURVE FROM THE POLAR CURVE.

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trated illumination at the bench or machine which can be supplied by glow lamps.

Outdoor Illumination.—Outdoor lighting can best be judged by measuring, as above, the illumination in a horizontal plane, and, as it is inconvenient to test the illumination on the ground, the author proposes that the illumination should be determined in a plane one metre or about 3 ft. from the ground. The illumination should be judged by the average value, and the cost of the illumination should be stated per candle-foot per 1,000 sq. ft. of road surface. The uniformity of the lighting is expressed by the ratio of the maximum illumination to the mean illumination, and the ratio of the minimum illumination to the mean illumination. The more nearly these two factors approach unity, the greater is the uniformity of the illumination. Large squares and wide streets are best illuminated by arc lamps fixed 40 to 50 ft. above the ground. The best height would be 0·7 times the distance between adjacent lamps, but in this case we should require standards about 100 ft. high. In squares the lamps are best arranged at the corners of equilateral triangles; for streets, above the middle of the road. The average illumination for main thoroughfares should not be less than one-tenth of a candle; for side streets it is often less than one-tenth of this.

The determination of the average illumination may be accomplished by plotting illumination curves in various directions and taking the mean value. The method proposed by Dr. Bloch (*Elektrotechnische Zeitschrift*, 1906, page 493) is, however, much simpler. The street, according to this method, is divided up into a number of equal squares, so that each square receives one lamp bracket placed in its centre. The equivalent circular area of each square is taken, and it is assumed that no other lamp takes part in the illumination. If the average illumination over this circular area is then calculated, the value obtained must be multiplied by a factor κ, which is given by Dr. Bloch as $\kappa = 1{\cdot}2 - 0{\cdot}1\lambda$ where λ is the ratio of the distance between the lamps to the width of the street. The distance between the lamps is measured in the direction of the street, even if the lamps are staggered.

The problem is thus resolved into finding the average horizontal illumination over a circular area, due to a single source of light suspended over the centre of the area, and we can express this as follows:—If S_+ represents the circular area illuminated, and α_1 the angle subtended by the *radius* of the area (see Fig. 4), then the average mean horizontal illumination of the circular area is expressed by—

$$E_a = \frac{1}{S_+}\int_0^{\alpha} \frac{I\cos\alpha}{R^2} dS = \frac{2\pi\Sigma_0^{-1} I\Delta(\cos_\infty)}{S_+} = \frac{2\pi}{S_+} \times \psi_1.$$

The value of the integral alone is the mean spherical candle-power, that is, the mean candle-power taken over the solid angle of 4π, if we place π instead of α as the integration limit. To obtain the value of the integral from the polar-curve, we proceed as follows:—With the source L as centre, describe a quadrant with the radius $LK = 1$ (see Fig. 4). For each angle α we obtain then, on the vertical, the corresponding $\cos\alpha$, if we project upon LK the point of intersection R of each ray LP with the quadrant. Thus LS will equal $\cos\alpha$ since $LR = 1$. Now divide LK into, say, ten equal parts, so that each part represents $\Delta(\cos\alpha)$ or 0·1. For each angle α corresponding to the middle point of each zone, we can take the corresponding value of the luminous intensity I from the polar curve. By multiplying $\Delta(\cos\alpha)$ by I we get $I\Delta(\cos\alpha)$ for each of the ten zones, and by adding the separate values from below upwards we obtain $\Sigma\ I\Delta(\cos\alpha) = \psi$. These values of ψ have been plotted as a curve with LK as abscissa on the left of Fig. 4. This curve may be called a luminous flux curve, since any ordinate of the curve is proportional to the luminous flux within the corresponding angular region. In Fig. 4 the angle of 90° was divided into ten parts, and the mean value of the intensity I was taken for each part. The sum of these values for any number of parts is proportional to the total luminous flux in the corresponding solid angle. The values of ψ from the curve are equal to these summations of the intensities divided by the number of parts taken, in this case ten. The maximum value of the curve is the sum of the intensities of all the parts divided by the number of parts, or, as the polar curve is symmetrical about the vertical axis, the mean hemispherical candle-power, which in this case is 1,000 candles. Having determined this curve, we plot along LK a line LH proportional to h the height of the lamp above the testing plane, and perpendicular to this, HP_1 proportional to a_1 the radius of the illuminated area S_1. The angular region is then defined by $\alpha_1 = HLP_1$. The line or outermost effective ray LP_1 cuts the quadrant at R_1. Projecting this point R_1 towards the luminous flux curve, we obtain on the latter the value—

$$\psi_1 = \int_0^{\alpha_1} Id\cos\alpha$$

and, since $S_1 = \pi a_1^2$, the mean horizontal illumination is expressed by $E_a = \frac{2\pi\psi_1}{S_1}$.

The method possesses the advantage that the luminous flux curve has to be derived once only from the luminous intensity, or polar curve, and that we can obtain from it the value of ψ for any lamp height h and any radius a of any circular area to be illuminated. It may even be applied for lamps of different intensities as long as their distribution of light (or the shape of the polar curve) is similar. The values of ψ taken from the curve have then simply to be multiplied by a known ratio. It is advisable to plot for different types of lamps luminous intensity (polar) curves and luminous flux curves always ready for use. When the mean horizontal illumination and the area are specified, we find $\psi_+ = \frac{1}{2\pi} E_a S_+$ which is the necessary value of ψ_+ for an average illumination of E_a. For the radius a_+ corresponding to the given area and the given or assumed height, the angular region or the value of α_+ is obtained, and then the value of ψ on the mean candle-power curve of Fig 4, is found. The curve of Fig. 4 is for a lamp of 1,000 mean hemispheral candle-power, so, from the ratio of the calculated value of ψ_+ and value from Fig. 4, we can deduce the required intensity of the lamp. The following two examples show the use of this method:—

Example I.—A street 60 ft. wide is to be illuminated by arc lamps 150 ft. apart. The polar curve of the lamp used is as given in Fig. 4. The lamps are fixed 45 ft. above the road surface, or 42 ft. above the testing plane. We require to find the mean horizontal illumination.

The area to be illuminated by each lamp is 60×150, or 9,000 square feet. To this corresponds a circular area with a radius of 53·4 ft. Plot the height of 42 ft. in a suitable scale vertically, and the radius of 53·4 ft. horizontally, thereby determining the angle α_1 of 51° 50′. For this angle we obtain from the luminous flux curve of Fig. 4, the value $\psi_1 = 500$. The value of λ is $\frac{150}{60} = 2{\cdot}5$ and therefore $\kappa = 1{\cdot}2 - 0{\cdot}1 \times 2{\cdot}5 = 0{\cdot}95$, and so—

$$E_a = \kappa \times \frac{2\pi\psi_1}{S_1} = \frac{0{\cdot}95 \times 2\pi \times 500}{9000} = 0{\cdot}33 \text{ candle feet.}$$

Example II.—A street 54 ft. wide is to be given an average illumination of 0·4 candle-feet. The lamps are to be ordinary arcs with polar curves similar to the one in Fig. 4. They are to be fixed on standards 33 ft. high and 135 ft. apart. What must be the mean hemispherical candle-power of the lamp used?

From the formula $E_a = \kappa \times \frac{2\pi\psi_+}{S_1}$ we obtain

$$\psi_+ = \frac{S_+ E_a}{\kappa \times 2\pi} = \frac{54 \times 135 \times 0{\cdot}4}{0{\cdot}95 \times 2\pi} = 488.$$

The ratio λ was 2·5 as before, and the value of κ 0·95. The angle α_+ is determined as before by the ratio of the height of the lamp above the testing plane (30 ft.) to the radius of the equivalent circular area to be illuminated, which in this case is 48·15 ft., whence $\alpha_+ = 58°$. The value ψ_+ from Fig. 4 corresponding to this angle is 590, consequently, as the lamp of Fig. 4 has a M.H.S.C.P. of 1,000, the M.H.S.C.P. of the lamp which must be installed in this case is $1000 \times \frac{488}{590}$ or 830 candles.

In a similar manner we can find for given area, illumination and M.H.S.C.P., the height at which the lamps must be fixed; or, for a given street, height of standard and illumination, we can determine the distance between adjacent lamps. In the above determinations, reflection of light from the surrounding buildings has been entirely neglected. The average illumination will consequently be somewhat larger than that calculated, the amount depending upon the reflecting powers of the walls.

Illumination Photometers.—A photometer for measuring illumination must be portable, self-contained, easily set up, and suitable for comparing light of different colours. Illumination photometers may be divided into two classes: (1) Diffused reflection photometers, and (2) Diffused transmission photometers. In the former the light rays which are compared with those of the standard source are obtained by reflection from a white surface, and in the latter the light rays are directed straight from the source to the photometer screen. A photometer of the reflection type is that known as Prof. Weber's Photometer. This consists of a standard benzine lamp arranged

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in a box at the end of a horizontal tube. In this tube, and capable of sliding in it, is a translucent screen of opal or ground glass. The light from the standard lamp, coming through this screen, is reflected by means of a Lummer Brodhun prism into an eyepiece. A vertical tube capable of being placed at any angle transmits the light from the white screen through the prism into the eyepiece. The two screens are thus viewed together. Equality of illumination is obtained by altering the position of the sliding screen. The range of the Webb photometer may be increased by the application of Nicol prisms or opal glass discs of different degrees of transparency. It is extremely transportable, the complete weight being about 22 lb.

Brothun's Street Photometer is based upon the fact that when light is obstructed by a rapidly rotating disc with a sectorial aperture, whereby the light is allowed to pass at definite intervals, the intensity of the emerging ray is reduced in the ratio of the angle of the opening to the total angle of 360°. The observer views through an eyepiece the rays from the standard lamp and the rays (reduced in intensity) from the source to be compared. The comparison standard lamp and the motor are fed from a six-cell battery, which causes the whole apparatus to be somewhat bulky.

Trotter's Photometer (see ELECTRICAL ENGINEERING, Vol. I., p. 849) consists of a fixed electric lamp, a pivotted screen, an index connected with the screen by a cam, giving a uniform scale, and a slotted screen receiving the illumination. The pivotted screen is seen through the slot. The total weight of this apparatus is about 10 lb.

The author then described some methods for measuring the mean horizontal candle-power and the mean spherical or mean hemispherical candle-power of lamps, with a single measurement. One form of photometer, known as Ulbricht's Integrator or Spherical Photometer, and used for measuring the mean spherical candle-power, consists of a hollow sphere about six times the diameter of the globe of the lamp under test. The inside of the globe is painted with sulphate of barium, which gives a suitable white surface which does not crack with the heat. A light placed inside is diffused in such a manner that the resultant illumination is uniform over the whole surface. Consequently, by measuring the intensity of the reflected light in any part of the spherical surface, and screening from this the direct light emitted from the source, we obtain a value which is proportional to the mean spherical candle-power of the lamp. The sphere is provided with a frosted glass window, the illumination of which is measured with a suitable photometer. The sphere is celebrated in the first place with a large incandescent lamp, the M.S.C.P. of which has been determined by the point to point method.

SOME EXHIBITS AT THE EDINBURGH EXHIBITION

THERE is a great dearth of electrical exhibits at this exhibition; indeed, the whole machinery section is very small. Much of the available space is taken up with demonstrations of baking, &c., although, as one would expect of an exhibition in Edinburgh, printing machinery is very prominent, washing and drying machinery for laundries is also well represented. The drying machines, called hydro-extractors, consist of two concentric cylinders about a vertical axis; the walls of the inner one are pierced with holes, and this cylinder, which contains the articles to be dried, is made to revolve at a speed varying from 1,000 r.p.m. to 1,500 r.p.m. There are one or two difficulties connected with the driving of these machines. For instance, when full of wet clothes, it is pretty certain to be unequally balanced, and this causes the whole thing to oscillate when running at a high speed. Again, owing to their large moment of inertia, it takes some time to get up speed, and when it is belt driven from a shunt-wound motor, the motor is found to take a most unreasonably big starting current, and utterly to ruin any lighting taken off the same mains. In a particular case it took 2½ minutes before the starting switch of such a motor could be got to its "full on" position. If it was put on any quicker, it melted its fuse or pulled down the voltage to an abnormal extent.

One of these machines is shown with an electric drive by Messrs. Watson, Laidlaw & Co., Glasgow. The motor is fixed on a framework above the extractor, and its shaft is in the same vertical axis with the extractor spindle, which it drives through a centrifugal friction clutch. The motor, which is enclosed, is series-wound, and is started by simply shifting a lever on the machine to the "on" position. The motor is thus started up "light"; it rapidly gets up speed, the extractor following until both are running at the same speed. Unloaded, the extractor takes two minutes to attain its full speed, which is 1,000 r.p.m. loaded. The starting lever, which works a single-pole switch, also puts on a brake, and this rapidly stops the machine when moved over to the "off" position. On the machine shown the motor is 6 b.h.p.; it is supplied at 460 volts, and it is built by the Lancashire Dynamo Co. The whole thing is delightfully simple and foolproof. There is no chance of oil or dirt working down into the extractor from the motor.

Messrs. Watson, Laidlaw & Co. show other examples of these machines arranged for direct driving from a water-motor or for belt driving.

Mr. Alexander Orr also shows laundry machinery. Most of his machines and pulleys are built of wood (maple), which has proved quite satisfactory in laundry work, and is both light and cheap. A washing machine consists of two concentric wooden cylinders on a horizontal axis; the inner one is made to rotate at a speed of 160 revs. per min., but is automatically reversed every four revolutions. The articles to be washed are put in this cylinder, which is pierced with holes, and steam and hot and cold water can be admitted at will. A machine with a capacity of "60 shirts" is belt-driven by a one h.p. motor. The unit of capacity for all these machines appears to be one shirt!

Mr. Orr also shows various electrical fittings, including a small fan that can be put on an ordinary lamp-holder; the motor is contained in a case 6 in. by 2 in., and takes 230 volts and about 0·2 ampere.

A patent electrically-driven carpet-beating machine at this stall is an example of the diverse uses to which electric motors are applied.

One of the most interesting exhibits is an electrically driven coal-cutting machine shown by Messrs. King & Co., Leith. This machine is exhibited in position in a model coal-seam; it is of the disc type. The particular machine shown is intended for use in narrow seams, and occupies a head-room of only 23 inches. The holing is made at the floor level. A disc of cast steel is employed, carrying twelve cutters bolted to its circumference; it is carried by a bracket, also of cast steel, and is geared with a cast steel bevel wheel. The frame is provided with levelling screws, and travels on rails. The feeding gear is particularly ingenious (Wilson's patent), and is regulated by hand, by means of a friction brake, from its maximum to zero, quite independently of the motor speed. To protect the gearing from falling coal and dirt, it is all covered with sheet steel. The motor is for a 500-volt continuous-current supply, has four poles, and is of a capacity of from 25 to 30 h.p. The armature is of the slotted-drum type, with former-wound coils. Carbon brushes are used. The magnet coils are compound wound. The two poles on the horizontal axis of the field contain the shunt winding, and the two poles on the vertical axis contain the series winding. This arrangement is to keep the head-room as small as possible, the series windings taking up much less room than the shunt windings.

The starting resistance consists of carbon packed between iron plates. When starting up, the switch is put on to the first contact, and kept there whilst the carbon warms up and its resistance falls; after this it can be passed over the remaining contacts, which cut out the resistance altogether quite quickly.

The switch is of the rotating drum type and wholly enclosed; both poles can be instantaneously broken by a push button switch. This switch has been adopted after a trial of many types, including a tramway controller. The machine can be worked in either direction, it being necessary to interchange two connections to reverse. This is done by breaking two screw joints with removable rubber covers. The trailing cable consists of two rubber insulated leads bound together with double braiding. The depth of holing is about 3 ft. 5 ins., and the width of cut about 3½ inches.

This machine, as at present in use, cuts from 160 to 180 yards in seven hours, and may do more under favourable conditions. Machines such as this rarely get the chance of a continuous run for any length of time. They are principally used in the East of Scotland pits, which are not gassy.

Messrs. Babcock & Wilcox show a model of one of their water-tube boilers with superheating pipes, &c., and Messrs. D. Thomson, Ltd., have a working model of a Stirling boiler made of glass, and heated with a Bunsen flame. It shows the water circulation well, this being least in the tubes and drum furthest from the fire, where the gases are coolest, and in practice this is where the greatest amount of scale is formed.

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The Ingersoll-Rand Co. show several of their electric air drills. These are percussion drills, and combine in a very happy way the advantages of compressed air for the actual drill with the ease of transmission of electrical energy. The arrangement consists of two parts: the drill itself, which is mounted on a tripod, is very simple; it consists of a piston (to the rod of which the bit is attached) working in a cylinder; there are no valves, springs, &c. Two hose-pipes are attached to two openings into the cylinder, one at each end. These pipes are led to the second part of the apparatus, which consists of a compressor, driven by an electric motor, and the whole is mounted on a truck made for the gauge of the mine track. The compressor consists of two vertical cylinders, in which work two pistons, driven by cranks from a shaft, and the shaft is geared to the motor. The two cylinders are connected by hose to either end of the drill cylinder. The air is thus alternately compressed and expanded on either side of the drill piston. There is no exhaust. The motors shown are 220-volt 3-phase induction motors of 3 h.p. The controller switch can be worked by the man operating the drill by a cord. The length of drill is 42 inches, the length of stroke seven inches, approximate strokes per minute 460, diameter of hole drilled $4\frac{3}{4}$ inches. The makers arrange for two speeds with alternating current motors and four speeds with direct current motors.

The Simplex Co. have a stall in the industrial hall, and show their well-known conduits, as well as electric kettles, flat-irons, &c.

Practically all the working exhibits are electrically driven by continuous current motors, whilst among the amusements the figure 8 railway (easily the most popular side-show) and the "flying machine" are also electrically driven. The water chute lift is worked by a gas engine.

A GRAPHIC METHOD FOR DETERMINING THE MEAN SPHERICAL INTENSITY OF A LAMP

MR. A. E. KENNELLY, in a recent article in the *Electrical World* of New York, describes a new method of determining graphically the mean spherical intensity of a lamp. The following is an abstract of his article:—

There is a well-known graphic method, generally known as the "Rousseau diagram"* method for determining the mean spherical intensity of a luminous source, when the curve of mean luminous intensity in altitude, or, briefly, the polar curve, has been obtained. The Rousseau diagram has been much used by photometrists, and has been frequently referred to in photometrical literature, so that no detailed description of it is needed here.† The diagram requires to have a surface measured, either by planimeter or by counting little squares on suitably squared paper. The mean spherical intensity on the diagram is essentially a surface or two-dimensional quantity.

The new method described in this article has the advantage of yielding the mean spherical intensity as the length of a certain vertical straight line, or as a one-dimensional quantity. This dispenses with the use of a planimeter or equivalent surface measuring device. It consists essentially in determining graphically from the given polar curve an evolute, and the involute of the same, and then projecting this involute upon a vertical line. Half the length of the projection is equal to the mean spherical intensity, to the same scale as the original polar curve. The entire process requires only an angle protractor and a pair of compasses.

The new graphical method may best be explained by reference to Fig. 1, which shows its application to the particular case of a simple circular polar curve *OAHB*. This polar curve roughly corresponds to the distribution of intensity from an inverted incandescent lamp, having its base at *V* and tip at *V'*, except that the tip candle-power does not usually fall off so much as the curve between *B* and *O*. The mean horizontal intensity would be *OH*, the diameter of the circle, and corresponding, say, to 10 candle-power. In Fig. 1 the construction is adapted to zones of 30°. Find the radii of the midzones; *i.e.*, at +75°, +45°, +15°, −15°, −45°, −75°. Mark these by the dotted lines *Ot*, *Os*, *Or* *Or'*, *Os'*, *Ot'*, respectively.

With radius *Or* and centre *O*, describe the arc *hra*, through an angle of 30°. Draw the radius *Oa* at the end of the arc. Measure from *a*, along *aO*, a distance *ab*, equal to *Os* the second midzone radius. With centre *b*, and radius *Os*, describe the arc *ac* through an angle of 30°, so that *bc* makes an angle of 60° with the horizontal *OH*. Draw the line *bc* at the end of this arc. From *c* toward *b* mark off a distance *cd* equal to *Ot* the third midzone radius. With centre *d* and radius *Ot* describe the arc *ce* through an angle of 30°, so that *de* makes an angle of 90° with the horizontal *OH*. Draw the line *de*.

Extend the arc, *h a' c' e'* from the horizontal to the vertical beneath in the same manner as above, by steps of 30°, with centres *O*, *b'*, and *d'* and radii, *Or'*, *Os'*, and *Ot'* respectively. The curve *e c a r r' a' c' a'* will now be continuous and complete. Draw a vertical line *QQ'* through the convenient point *H*, and project horizontally the points *e*, *c*, *a*, *a'*, *c'* and *e'* upon the same. Then half the distance *QQ'* between the end projections will be equal to the mean spherical intensity of the lamp. The length *HQ* is the upper hemispherical intensity. The length *HQ'* is the lower hemispherical intensity. Their arithmetical mean is the mean spherical intensity. Since in this case the upper and lower hemispheres are symmetrical, $HQ = HQ' = \frac{QQ'}{2}$ = mean spherical intensity. By measurement, this half length is found to be 7·78 units. The lamp would thus have an apparent mean spherical intensity of 7·78 candles, and a spherical reduction factor of 0·778.

If, therefore, the geometrical construction were perfect, and could be read off with sufficient precision, the mean spherical intensity, with 30° zones, would be 7·7645 candles.

In Fig. 2, the new diagram is constructed for zones of 10° instead of 30°. We therefore arrive at a more nearly correct result by the same process, but with nine steps in each hemisphere

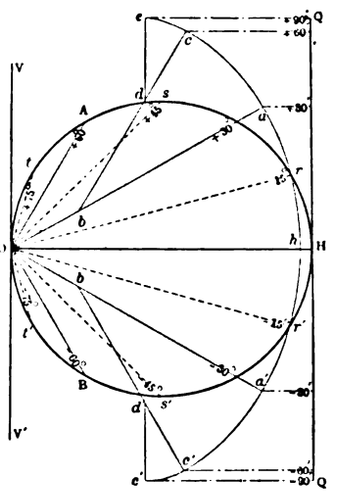


FIG. 1.—NEW DIAGRAM OF CIRCULAR MEAN INTENSITY DISTRIBUTION ON A VERTICAL MERIDIAN THROUGH A LUMINOUS SOURCE. MEAN HORIZONTAL INTENSITY $OH = 10$.

Rectification by 30° zones. Apparent mean spherical intensity $= QQ' \div 2 = 7{\cdot}78$
Theoretically correct value, 7·854.

instead of three steps. As before, with centre *O* and radius *O*+5°, we lay off an arc of +10°, and join *Oa*. Along *aO*, from *a*, we mark off the distance *ab*, equal to the second midzone radius *O*+15°, and carry the arc to *c*, such that *bc* is inclined 20° with *OH*. Proceeding in this way we draw the continuous curve *H a c e g i k m o q*, by successive steps of 10°. This curve may be called the involute. We also obtain the broken line *O b d f h j l n p*, which may be called the evolute. In fact the successive tangents *bd*, *df*, *fh*, &c., on the evolute, lie upon successive normals *ba*, *dc*, *fe*, &c., to the involute. If pins be inserted at the points *b*, *d*, *f*, &c., on the evolute, a string fastened at the point *O* and extended without slack to *q*, so as to carry a pencil at *q*, would, when unwound toward *H*, describe and draw the involute *q o m.....aH*.

A similar construction and condition apply to the involute and evolute of the lower hemisphere. When both involutes are completed, their horizontal projection on the vertical through *H* gives the distance $QQ' = 2 \times 7{\cdot}88$ by scaling.

* "Comptes Rendus des Essais Photométriques à l'Exposition d'Anvers, en 1885," par M. Rousseau.

† "A Treatise on Industrial Photometry," by A. Palaz, 1904, p. 20. "Handbuch der Elektrischen Beleuchtung," by Herzog and Feldmann, 1898, p. 10

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For many purposes the mean spherical intensity of such a polar curve can be satisfactorily secured by rectification in 30° zones, and a high degree of accuracy can, for practical

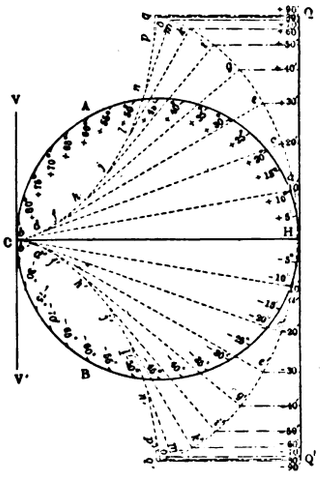


FIG. 2.—NEW DIAGRAM OF CIRCULAR MEAN INTENSITY DISTRITION ON A VERTICAL MERIDIAN THROUGH A LUMINOUS SOURCE.

Mean horizontal intensity $OH=10$. Rectification by 10° zones. Apparent mean spherical intensity $QQ'/2=7{\cdot}88$. Theoretically correct value $7{\cdot}854$.

purposes, be secured by rectification in 10° zones. For most purposes 20° zones are recommended as giving practically satisfactory results.

As another example of the new diagram, Fig. 3 shows the

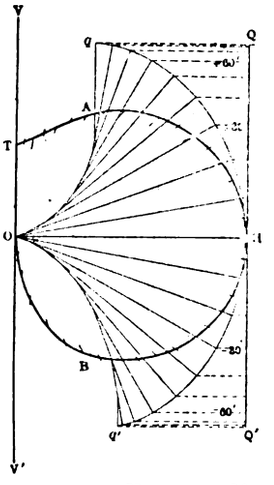


FIG. 3.—NEW DIAGRAM OF VERTICAL MERIDIAN INTENSITY DISTRIBUTION FOR A SAMPLE OF REGULAR OVAL ANCHORED FILAMENT INCANDESCENT LAMP, RECTIFIED BY 10° ZONES.

Mean horizontal intensity $OH=1$. Mean spherical intensity $=QQ'/2=0{\cdot}83$. See Bulletin of Bureau of Standards, December, 1907, vol, 4, No. 1, p. 106, Fig. 7.

rectification of the polar curve for a sample of regular oval anchored filament incandescent lamp as published in the *Bulletin of the Bureau of Standards*.* The rectification is effected for zones of 10°. The mean horizontal intensity OH, being taken as unity, the mean spherical intensity $\frac{QQ'}{2}$ appears as 0·83 from the diagram, and this is therefore the apparent spherical reduction factor for the lamp under consideration. The spherical reduction factor mentioned in the paper is 0·826.

A further example of the use of the new diagram is shown in Fig. 4. On the right-hand side of the vertical VV' is the polar curve for a certain 16-c.p. incandescent lamp.† The mean spherical candle-power of this lamp is indicated by rectification to be 13·2, representing a reduction factor of 0·825. Of the total light emitted by the lamp, $\frac{12{\cdot}95}{26{\cdot}4}$ or 49 per cent. is indicated as emitted in the hemisphere DCH to which the lamp base belongs, and 51 per cent. in the hemisphere ABH containing the lamp tip. On the left-hand side of the vertical VV' is

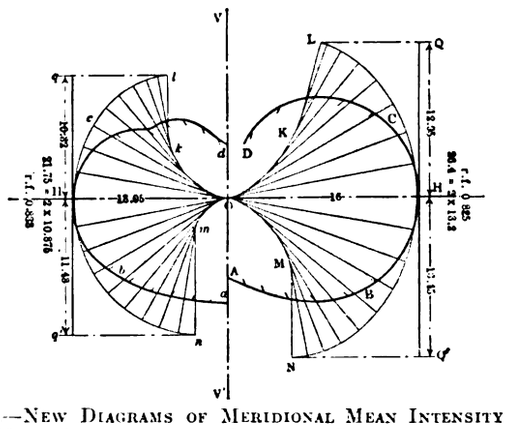


FIG. 4.—NEW DIAGRAMS OF MERIDIONAL MEAN INTENSITY OF A NEW 16 CANDLE-POWER LAMP, ON RIGHT SEPARATELY AND ON LEFT AFTER BEING ENCLOSED IN A 6-IN. FROSTED GLOBE.

Mean spherical candle-power 13·2 and 10·875, respectively. Rectification by 10° zones. See Transactions of the Illuminating Engineering Society, April, 1907, Vol. 2, No. 4, p. 216, Fig. 7.

the polar curve given for the same lamp after being enclosed in a 6-in. frosted globe. The mean spherical candle-power of the combination is found to scale $\frac{VV'}{2}=10{\cdot}875$, representing a spherical reduction factor of 0·833, and a diminution in mean spherical candle-power, and in total light flux, by 17·7 per cent., due to absorption of light by the frosted globe. This deduction assumes that the globe and enclosed lamp radiated light as a virtual point-source. If a globe or reflector attached to a lamp causes the light to radiate otherwise than from a virtual central point as viewed from the photometer screen, it is needless to say that neither the term candle-power nor zonal candle-power properly applies to the combination except as apparent values under the particular conditions of observation. Neither the Rousseau diagram nor the new diagram applies without modification to such a case.

The new graphic method for evaluating the mean spherical intensity of a lamp directly from its polar curve, above described, expresses the result as a straight line. It performs the same function as the Rousseau diagram; but dispenses with the planimeter, requiring only compasses and protractor. It possesses theoretically at least as great a degree of accuracy as the Rousseau diagram, for a given number of zones. It gives at a glance the upper and the lower hemispherical intensities, the mean of which is the mean spherical intensity. It further enables the luminous flux through any zone, per radiar of azimuth, to be read off directly from the line of projection. It has been found practically useful.

* Bulletin of the Bureau of Standards, December, 1907, Vol. 4, No. 1. "A Comparative Study of Plain and Frosted Lamps," by Edward P. Hyde and F. E. Cady, Fig. 7, p. 106.

† Transactions of the Illuminating Engineering Society, April, 1907. P. S. Miller, Fig. 7, p. 216.

ELECTROCHEMISTRY AND ELECTROMETALLURGY

MESSRS. LUDWIG, BOLLE & CO., whose British Patent, No. 5,764 (1907) was published last month, have invented a process and apparatus for electrically fusing, refining, and moulding refractory substances such as quartz. Silica is fused by heating it electrically in a horizontal or vertical carbon tube which forms one electrode in an electric furnace. The tube is surrounded by powdered carbon or other resistance material, and this is contained in a wide carbon tube which forms a second electrode, the whole apparatus being cased in refractory bricks. One end of the inner carbon tube is closed by means of a movable carbon plug, the other by a plunger which can be lowered into the melted material. The silica may be compressed into the form of a solid block, or it can be pressed against the walls of a carbon tube so as to form a hollow cylinder, depending upon the shape of the plunger. The plunger may also be made hollow, and then steam or compressed air can be forced through it into the carbon tube. At the end of the operation the plug at the bottom of the tube may be removed, then the plunger can be employed to eject the silica.

At a meeting of the Faraday Society held on the 9th, Dr. Albert Frank contributed a paper "On the Utilisation of the Atmospheric Nitrogen in the Production of Calcium Cyanamide and its Use in Agriculture and Chemistry." The Paper commenced with an historical introduction. The chief difference

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between the process of Birkeland and Eyde, and that of Caro and Frank, is that the former is endothermic, *i.e.*, heat is absorbed, whereas when nitrogen is fixed by means of carbide heat is given out, therefore the reaction is exothermic. Neither process is actually electric or electrolytic; they are both thermal, but, generally speaking, when high thermal effects are required, electrical energy is the most satisfactory method of producing the thermal effect—often the only method. When barium carbide is heated to 700 or 800° in the presence of nitrogen barium cyanide, $Ba(CN)_2$, is produced, but also at the same time barium cyanamide is produced. It is, however, found that by heating in presence of a flux, such as potassium carbonate, the whole of it can be converted into cyanide. With calcium carbide, on the other hand, the main product was calcium cyanamide, and by paying attention to the conditions, calcium cyanamide alone could be produced,

$$CaC_2+2N=CaCN_2+C.$$

When this was discovered, Messrs. Siemens and Halske, and the Deutsche Bank of Berlin, founded the Cyanid Gesellschaft in order to develop the process. One of the uses of calcium cyanamide, apart from agricultural purposes, is its employment for case-hardening of steel, in place of the generally employed yellow prussiate. As to the method of manufacture, the carbide made in the electric furnace is ground, charged into retorts which are in the older plant heated by gas firing, but more recently a special electric method of heating has been devised. Air freed from oxygen by liquefaction and fractionation, and subsequent passing over heated copper, is then passed over the heated carbide. When the action of a valve shows that nitrogen is no longer absorbed, the cyanamide is removed, allowed to cool out of contact with air, and is ground up, when it is ready for use. The product comes on the market under the name of *nitrolim*. Most carbide works give a yield of two tons of carbide per kw. year, and the two tons of carbide will unite with about 500 kilog. of nitrogen to produce nitrolim. Two kw. or $2\frac{3}{4}$ h.p. per year is required to fix one ton of nitrogen. For the other operations about $\frac{1}{3}$ h.p. is required. If, therefore, nitrolim were to be entirely substituted for nitrate of soda, no less than 800,000 h.p. would be required, that is, provided the demand for fertilisers remained constant, whereas we know it is continually increasing. The first large industrial plant was started about $2\frac{1}{2}$ years ago at Piano d'Orta, in Central Italy, for an annual production of 4,000 tons; the capacity is now being increased to 10,000 tons. Another plant is ready to start in Terni, and yet another is in course of erection in San Michel, in the Val d'Aosta. In Austria-Hungary large works are in course of erection by the Societa Generale of Rome, one in Sebenico, with a capacity of 4,000 tons, and also one in Istria. At Almissa a water-power plant of 50,000 h.p. is being erected, also one in Dalmatia. In France the Société Française des Produits Azotés have works at Nôtre Dame de Briançon, with an output of 4,000 tons. In the Rhône Valley, in Switzerland, the Société Suisse des Produits Azotés have also opened works. In Germany the works at Westeregeln and Brühl on Rhine are producing 10,000 tons of nitrolim annually. There is also an installation near Bromberg with an output of 2,500 tons, and the large works of the Cyanid Gesellschaft have been built to deal with 15,000 tons at Alz-Fluss in Bavaria. In the United States the American Cyanamide Co. are constructing works on the Canadian side of Niagara to deal with 5,000 to 6,000 tons per annum, and it is intended later on to enlarge these so as to have an output of 40,000 tons. The chief British enterprise is the North-Western Cyanamide Co., Ltd., with a capital of £120,000, which was incorporated in the middle of the year 1906, to acquire and work licences from the Societa Generale. The works are erected at Odda, near the head of the Hardanjer Fjord. The present capacity of the works is 12,500 tons, and the works are so arranged that they may eventually be enlarged to 50,000 tons. The nitrogen is produced by the largest Linde pump ever erected, which has a capacity of 375 cubic metres per hour, and the latest electrical furnaces have also been installed there. A comparison was made between the atmospheric oxidation process of Birkeland & Eyde, which employs from 25,000 kw., whereas for an equivalent amount of nitrogen in the form of nitrolim only 5,000 to 6,000 kw. are used.

ELECTRICAL SCIENCE

British and American

The Active Deposit from Actinium.—The radioactive material known as actinium produces radioactive deposits on solids kept near it just as the other radioactive materials do. As a rule, the deposits from the various radioactive substances take place most heavily on metallic conductors kept negatively charged to a somewhat high potential. For example, if two wires be inserted into a vessel containing thorium emanation, one charged positively, the other negatively, the amount of active deposit obtained on the negative wire is more than one hundred times that on the positive, if the enclosed gas in the vessel is at about atmospheric pressure. If the pressure of the gas is reduced to a few millimetres of mercury, the disproportion is, however, not so great. If the same experiments be performed on actinium, the latter of the above effects is reversed; that is, though the active deposit on the negative wire is twice that on the positive wire at atmospheric pressures, the negative wire gathers twenty times as much as the positive at a pressure of a few millimetres. This effect is investigated by S. Russ in a Paper in the *Philosophical Magazine* for June. Two brass wires connected to the ends of a 320-volt battery were led through insulating ends into a wide, horizontal, closed brass tube, which was connected to the middle point of the battery. The actinium was placed at about the middle of the horizontal tube, and the wires exposed in the chamber for about two hours. The activities of the deposits on the wires were estimated by measuring the saturation current each produced when placed in a cylindrical ionisation chamber connected with an electrometer. Gas pressures varying from an atmosphere to two millimetres of mercury were employed in the depositing tube, and the ratio of the activities of the negative and the positive wires obtained at each pressure. This ratio was about 2 at 76 cm. of mercury, about 60, its maximum, at 5 cm., and 22 at 0·2 cm. The author next arranged that the plus and minus electrodes could be moved together towards and away from the actinium, the apparatus taking the form of a vertical cylinder with the actinium resting on the bottom. Several remarkable results were obtained. As distance from the actinium increased, while the gas was maintained at atmospheric pressure, the deposit on the negative plate steadily diminished, while that on the positive plate increased to a maximum and fell again. The ratio of the two deposits fell continuously. If the gas were kept at a pressure of 2 millimetres of mercury the deposit on the positive electrode diminished slowly, and that on the negative plate increased steadily. To account for the effects observed at atmospheric pressure the author suggests that the positively charged active deposit particles may become neutralised, and in fact even become reversed in sign in their passage through the gas. To account for the increase in the ratio at low pressures it must be remembered that at the moment of formation the active deposit particles have a high velocity; a certain number of collisions may be necessary to reduce their speed, so that the existing electric field may be capable of directing them to the electrodes. Hence it may be expected that if the distance of the plates from the actinium were made sufficiently large at the lower pressure similar results to those obtained for the atmospheric pressure would be observed. The author found this expectation borne out on using a larger cylinder.

Continental

Harmonic Oscillations of Spark Discharges.—The difficulty of obtaining pure sine waves from spark discharges is further illustrated by G. A. Hemsalech's latest contribution to the subject in the *Comptes Rendus* for May 25th. He uses both the photographic method and the air-blast method. The photographs, in which the spark is placed on the other side of a slit, and the plate is moved at a high speed, show striæ accompanying each discharge, much as they do in photographs of lightning flashes taken on moving plates. These striæ occur at equal intervals, and therefore immediately suggest upper partial discharges. Battelli and Magri attribute them to the subsequent projection of metallic vapour. This objection is answered by Hemsalech by saying that he, too, finds traces of metallic vapour, but that these traces, proceeding with a slower speed than that of the harmonic discharges, show a perceptible curvature. The air-blast breaks up the spark into a series of minute arcs, which show the band spectrum of nitrogen. A magnetic field deflects the discharge, but does not affect the vapour jets. Decided harmonics are obtained with a coil 100 cm. long and 20 cm. wide, wound in two layers. A flat coil with the same wire in 25 layers gives no harmonics.

Alternate-Current Permeabilities.—L. Schames, in the *Physikalische Zeitschrift* for May 1st, points out a peculiar anomaly in the determinations of magnetic permeability for alternating currents. Such permeabilities, determined for various frequencies and damping ratios, are usually deduced from complicated conditions, and always result in values which represent the mean taken over the current curve. Such values cannot be directly compared with direct-current permeabilities. The author gives a method of obtaining the true permeabilities over a half-period. It gives the mean value, 1,520, for soft iron, which has a permeability 1,300 for direct current. The two curves showing the permeability as compared with the field for direct and alternating current respectively intersect at $H=2·8$. Below that value the direct-current permeability is the higher by 20 per cent. In the strongest fields the two curves will approach again asymptotically.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published June 4th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

8,255. S. Z. DE FERRANTI. The object of this invention is to improve the quality of steel produced in the electric furnace, and at the same time to hasten the process. Heat is produced in the furnace by chemical combustion as well as by electrical means, and to ensure that the metal is brought into intimate contact with the various reagents it is actively circulated electrically. Both the heating and the circulation of the metal are produced inductively by means of alternating currents. A three-phase furnace is described in the specification, in which the three laminated iron cores pass right through the bath; the metal then circulates round the three limbs, and a large current is induced in the metal, heating it to a very high temperature. In another arrangement, the three-phase magnetic circuit is situated below the bath only, by which means effective circulation with little heating is obtained. The energising coils are wound with a tubular conductor, through which a cooling liquid circulates. Additional heating is obtained by injecting combustible gases on to the surface of the metal. Ten claims, eight figures.

10,699. T. MARRIOTT. A process for rendering soft petroleum pitch ductile like the best grades of natural bitumen. The product is suitable for filling cable trenches, as it is not only ductile but is not so susceptible to heat as untreated soft pitch, and will not easily deteriorate. Kaolin or some other high-grade clay is added in the form of fine powder to a soft petroleum pitch, in the proportion of 3 to 4½ per cent. of kaolin. This mixture will not crack on sudden changes of temperature, and is not brittle. Two claims.

20,202. SIEMENS BROS. DYNAMO WORKS, LTD. (*Siemens-Schuckerterke Ges.*). An alternator may be compounded, by adding additional field windings, and supplying these with continuous current from the rotor of a small rotary converter coupled mechanically to the alternator so as to rotate synchronously with it, and in a definite angular position to it. The rotor of the rotary converter is supplied with alternating current by means of slip-rings, the said current being obtained from the secondary windings of a series transformer, the primary windings of which are traversed by the load current. The continuous-current voltage generated by the rotary converter will be proportional to that component of the flux (produced by the alternating current in the rotor) which is at right angles to the axis of the brushes on the commutator. Thus the compounding effect will be proportional to the watt-component only of the alternating current. If the brushes are shifted the compounding effect is correct for a certain power factor only. In the latter case also a compensating winding could not be used. According to the present invention, the commutator of the converter is supplied with two pairs of brushes for each pair of poles, and two separate continuous currents are taken from the converter to excite two compounding windings on the alternator. One of these currents will be proportional to the watt-component and the other to the wattless component of the alternating current, as the axes of the two pairs of brushes are set at right angles. The stator of the rotary converter may or may not have any field coils, as the alternating current supplied to the rotor excites the field. Compensating windings for each of the two continuous currents should be provided, and the windings compensating along one axis must be excited with the current taken from the brushes in that axis. Two continuous currents obtained by the above method can also be utilised for the excitation of boosters in connection with buffer batteries in single- or polyphase plants. Four claims, four figures.

25,967. P. M. LINCOLN. A load equalising arrangement for use on alternating-current distributing systems in which the generators are subject to sudden and heavy load variations. A rotary converter and a booster generator are coupled together electrically and mechanically. The booster generator is connected to the alternating-current mains through a transformer, and the continuous-current side of the rotary converter is connected to a storage battery. The E.M.F. of the booster generator is in phase with the E.M.F. of the rotary converter and also with that of the mains, and the booster generator thus directly opposes or directly assists the mains according to its field excitation. Under normal conditions the fields of the machines are so adjusted that the cells are being neither charged nor discharged. By means of a piece of apparatus operated from a series transformer in the main circuit, the fields are so automatically altered on a variation of load that the cells are charged on light loads, and discharged when the load is heavy, assisting the main generators in the latter case by supplying current through the rotary converter, booster generator, and transformer. Two claims, one figure.

1908 Patent

1,231. B. KAUFMANN. In the manufacture of metallic paper or metal foil substitute, such as is used in the manufacture of condensers (see ELECTRICAL ENGINEERING, May 14th, page 741), the paper is passed through an ordinary coating machine, which lays on the metallic film. It was found that certain papers could not be used with the ordinary rollers, but this objection is overcome by using rollers with a very finely engraved surface. Two claims.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1907 Patents

8,842, SCHATTNER. Electric motor controllers.
11,288, FYNN. Alternate-current motors.
11,347, HEYS (*General Acoustic Co.*). Telephonic dictating system.
11,352, BRUCE. Electrical signalling apparatus.
11,459, TUCKER. Electric switches.
11,471, COWPER-COLES. Electrodeposition of metals.
11,520, TUCKER. Electric switches.
11,695, AMALGAMATED RADIO-TELEGRAPH CO. (*Seibt*). Radio-telephony.
11,769, GILLMOR. Joints in railway or tramway rails
11,794, LANG. Control of electric motors.
11,808, GRAHAM. Telephonic apparatus.
11,874, SIEMENS BROS. DYNAMO WORKS & POYNDER. Systems for the storage of power.
12,238, BRITISH THOMSON-HOUSTON CO. (*Allgemeine Elektricitäts-Ges.*). Electrically operating railway signals and points.
12,368, LEHMANN. Amperemeters and voltmeters.
12,633, GALLETTI. Production of electric oscillations.
12,634, GALLETTI. Production of electric oscillations.
12,635, GALLETTI. Wireless telegraphy.
12,656, GALLETTI. Wireless telegraphy.
15,412, WALTER. Receivers for wireless telegraphy.
18,842, PICKARD. Wireless telegraphy.
20,229, ALLGEMEINE ELEKTRICITÄTS-GES. Motor starters and regulating rheostats.
21,860, SIEMENS BROS. DYNAMO WORKS (*Siemens Schuckert-werke Ges.*). Insulation of transformers and other apparatus.
23,585, FAIRWEATHER (*Gluhlampenwerk Anker Ges.*). Electric illuminating bodies.
23,778, DAY (*Fabrik Elektrischer Zünder Ges.*). Manufacture of resistances.
24,017, ARCIONI. Measurement of electric power.
24,074, ARCIONI. Measurement of electric power.
28,201, LANG. Spark plugs.

1908 Patents

268, EISENSTEIN. Production of high-frequency electric oscillations.
290, SIEMENS BROS. & CO. (*Siemens & Halske Akt.-Ges.*). Multiple switches applicable to automatic telephone exchange selectors.
608, GARFORTH & BOUSFIELD. Switch-boxes.
2,308, SIEMENS & HALSKE AKT.-GES. Electrically selecting one of several receivers.
2,481, SIEMENS BROS. DYNAMO WORKS, LTD., & WHEAT. Holders for incandescent lamps.
3,066, WOLHAUPTER. Joints for railway rails.
3,505, MERTENS. Current-collector for electrically-propelled vehicles.
3,689, MAIR. Push-button apparatus for operating electric lifts.
4,139, BLOXAM (*Markische Maschinenbauanstalt Ludwig Stuckenholz Akt.-Ges.*). Lifting magnets for cranes.
4,166, EVANS. Multiple rate electricity-meters.

Complete Specifications open to Public Inspection before Acceptance.

1908 Patents

2,480, F. KRUPP AKT.-GES. Elevating gear.
3,634, F. KRUPP AKT.-GES. Elevating gear.
9,637, SIEMENS-SCHUCKERTWERKE GES. Dynamo-electric machines with commutation poles.
10,577, DONATI. Alternating-current regulators.

Expiring Patents

No patents of electrical interest expire during the current week.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ltd.	10	7	7½	10½—11	
Do. 4½% Cum. Pref.	10	4½	4½	9⅝—10⅝	
Do. 6% Cum. Second Pref.	10	6	6	10½—11	
Do. 4½% Debenture, Red.	Stock	4½	4½	102—105	
Bromley (Kent) E.L.& Power Co.,Ltd.	5	5½	5½	4½—5	
Do. 4½% 1st Deb. Red.	Stock	4½	4½	94—97	
Brompton & Kensington E. S. Co.,Ltd.	5	10	10	6½—7½	
Do 7% Cum. Pref.	5	7	7	6¾—7¾	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4	95—101 xd	+1
Ch. Cross, W. E. & City E. S. Co.	5	5	5	3½—4	+¼
Do. 4½% Cum. Pref.	5	4½	2½	4⅛—4⅜	
Do. 4% Deb. Red	Stock	4	4	96—99	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½	3¾—4¼	
Chelsea Electric Supply Co., Ltd.	5	4½	4½	3—3½	
Do. 4½% Deb. Red	Stock	4½	4½	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6½	9¼—10¼	+¼
Do. 6% Cum. Pref.	10	6	6½	12—13	
Do. 5% Deb. Red	Stock	5	5½	124—127	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	102—105	
City of Durham E. P. Dis. Co.	5	4	2½	2½—3	
Do. 5% Pref.	5	5	3½	3¾—4¼	
County of London Elect. Sup. Co. Ltd.	10	5	5½	7⅞—8½	
Do. 6% Cum. Pref.	10	6	6½	10⅝—10¾	
Do. 4½% Deb. Red	Stock	4½	4½	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½	98—101	+1
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	0—¼	−⅛
Do. 6% Cum. Pref.	5	3½	—	⅛—1	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	63—73	−2
Folkestone Elec. Supply Co., Ltd.	5	5½	5½	4⅞—5¼	
Do. 5% Cum. Pref.	5	5	5	5—5⅛	
Do. 4½% 1st Deb. Red	Stock	4½	4½	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½	6—6¼	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½	90—93	
Kensington & Knightsbridge E.L.Co.	5	10	10½	7—8	
Do. 4% Deb. Red	Stock	4	4	96—99	
Kens. & N'tng Hill E.L. Cos. Db.Rd.	Stock	4	4½	97—101	
London Electric Supply Corporation	3	4	2½	⅝—1⅛	
Do. 6% Pref.	5	6	6½	4¼—4½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4½	90—93	
Metropolitan Elec. Supply Co., Ltd.	5	5	6¼	5⅛—5	+⅛
Do. 4½% Cum. Pref.	5	4½	4½	4½—5	+⅛
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D	100 & 500	4½	4½	96—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4½	7¾—8¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½	96—99	
Newcastle-upon-Tyne Elec. Supply	5	5	8½	5½—6	
Do. £2 Pm.	5	8	8½	5½—6	
Do. 5% Pref. (fully paid)	5	5	5½	5¼—5½	
Do. 10/- Pm.	5	5	5½	5¼—5½	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7½	11¼—12¼	
Oxford Electric Co., Ltd.	5	7	7½	5⅞—6¼	
Do. 4% Deb. Red.	Stock	4	4½	94—98	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10½	7½—8½	
Do. 7% Non-Cum. Pref	5	7	7½	6½—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—⅜	
Do. 4% Deb. Red	Stock	4	4½	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4½	2¾—2¾	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅝—⅝	
Do. 7% Cum. Pref.	1	7	7½	1⅛—1⅛	
Do. 4½% 1st Deb. Red	Stock	4½	4½	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5½	1—2	
Do. 5% Cum. Pref.	5	5	5½	1⅝—2⅛	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10½	7½—8	
Do. 4½% Cum. Pref.	5	4½	4½	4⅝—5⅝	+⅛
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4	88—91	
Central London	Stock	4	3½	81—84	
Do. 4% Preferred	Stock	4	4	90—92	
Do. Deferred	Stock	4	2½	64—67	
Do. 4% Debentures	Stock	4	4	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4	81—84	
City and South London Cons.	Stock	2½	4½	40—42	
Do. 4% Perp. Deb.	Stock	4	4	100—103	
Do. 5% Perp. Pref. 1891	Stock	5	5	113—116	
Do. 5% Perp. Pref. 1895	Stock	5	5	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5	110—113	
Great Northern & City Pref. "A"	10	4	11½d.	⅜—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4½	6—7	
Do. 4% Perp. Deb.	Stock	4	4	89—91	+2
Mersey Cons.	Stock	nil	—	1—3	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	1½	42—43	−1½
Do. 3½% Preference	Stock	3½	3½	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½	75—78	
Do. 3½% Convertible Pref.	Stock	3½	3½	73—76	
Metropolitan District	Stock	nil	—	14—15	
Do. 6% Perp. Deb.	Stock	6	6½	120—125	+6
Do. 4% Deb.	Stock	4	4½	73—78	+3
Do. Perp. Extension Pref. (5%)	Stock	nil	—	23—28	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5½	39—43	
Whitechapel and Bow 4% Deb.	Stock	4	4½	103—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-	⅜—⅝	
Do. 5% Cum. Pref.	1	5	5½	⅜—⅝	
Do. 4½% Deb. Red.	Stock	4½	4½	85—90	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½	93 96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	
Do. 6% Cum. Pref.	10	6	6½	3¼—4¼	+⅛
Do. 5% Perp. Deb.	Stock	5	5½	91—95	
Do. 4½% 2nd Deb.	Stock	4½	4½	72—76	+1
City of Birmingham Trs. Co., Cm. Pf.	5	5	5½	4¼—4¾	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4½	97—100	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. *= Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%	%		
Dublin United Trams Co.	10	6	6½*	12½—13½	
Do. 6% Pref.	10	6	6½	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½	94—97	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅝—1⅛	
Do. 4% Deb.	Stock	4	4½	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5½	91—94	
London Street Tramways Co.	4	4/9	4/6	1⅝—1⅞	
London United Trs., Ld., Cm. Pf.	10	5	5½	7—8	
Do. 4% 1st Mort. Deb. Red	Stock	4	4½	81—86	+1
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5½	11—13	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½	94—97	
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—⅝	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	¼—⅝	−⅛
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	½—⅝	
Do. 3½% Mort. Deb.	100	3½	3½	89—92	
Potteries Electric Traction Co. Ltd.	1	4	4½	⅛—¼	
Do. 5% Cum. Pref.	1	5	5½	⅛—¼	
Do. 4½% Deb. Red	Stock	4½	4½*	91—94	
Provincial Tramways Co. Ltd.	10	3½	4½	4½—5½	
Do. 6% Cum. Pref.	10	6	6½	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6½	¾—1	
Do. 4% Deb. Red.	Stock	—	4½	77—81	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5½	73—78	
Yorkshire (West Riding) Elec. Trams	5	nil	—	⅜—1½	−¼
Do. 6% Cum. Pref.	5	nil	—	3½—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	59—62	
Do. 6% Pref. Ord.	Stock	6	30/-*	103—105	−1
Do. Def. Ord.	Stock	1¾	1½	16½—17	
Commercial Cable Co., 4% Deb. Red.	Stock	4	4½	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4½	3—3½	−¼
Do. 10% Cum. Pref.	5	10	10½	8—9	
Do. 4½% Debs.	50	4½	4½	100—103	
Direct United States Cable Co. Ltd.	20	4½	4/-	13½—14	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½	100—102	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4½	100—102	
Do. do. (Mauritius Sub.)	25	4	4½	99—101	
Eastern Ext. Australasia & China	10	7	7/6	12¾—13½	
Do. 4% Mort. Deb. Perp.	Stock	4	4½	100½—102½	+½
Eastern Telegraph Co.	Stock	5¾	7½	130—135	
Do. 3½% Pref.	Stock	3½	3½	83½—86½	
Do. 4% Mort. Deb.	Stock	4	4½	100½—102½	+½
G. N. Tel. Co. (Copenhagen)	10	20	20½	27—29	
Indo-European Telegraph Co. Ltd.	25	13	65/-	52—55	
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	
National Telephone Co., Ltd., Pref.	Stock	6	6½	108—110	
Do. Deferred	Stock	5½	6½	110—112	+½
Do. 6% Cum. 1st Pref.	10	6	6½	10½—12½	
Do. 6% Cum. 2nd Pref.	10	6	6½	10½—12½	
Do. 5% 3rd Pref.	5	5	5½	5⅜—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½	99—101	
Do. 4% Deb. Red.	Stock	4	4½	102—104	+½
Western Telegraph Co., Ltd.	10	7	7½	13⅜—13⅞	+⅛
Do. 4% Deb.	Stock	4	4½	100½—102½	+½
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅛—⅜	
Do. 6% Cum. Pref.	1	6	6½	⅜—⅝	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅜—3¾	
Do. 6% Pref.	1	6	7½d	1⅞—1⅞	
British Insulated & Helsby Cables, Ltd.	5	10	10% & bonus	5¾—6½	
Do. 6% Cum. Pref.	5	6	6½	5¾—6½	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½	93—98	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅞—1⅛	
Do. 4% Mort. Deb. Red.	Stock	4	4½	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅞—1	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½	70—75	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½	55—60	
Callender's Cable and Const. Co., Ld.	5	15	15/-	9¾—10¾	
Do. 5% Cum. Pref.	5	5	5½	5¼—5⅝	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½	107—109	
Consolidated Electrical Co., Ltd.	1	3	3½	⅜—½	
Crompton & Co., Ltd.	3	5	5½	1⅜—1⅝	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5½	92—95	
Dick, Kerr & Co., Ltd.	1	10	10½	1⅞—1⅞	
Do. 6% Cum. Pref.	1	6	6½	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½	101—104	
Edison & Swan United "A," £3 paid	5	4½	2/6	½—¾	
Do. do. (fully paid)	5	4½	4/2	1¾—2¼	
Do. 4% Deb. Red.	Stock	4	4½	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5½	85—87	
Electric Construction Co., Ltd.	2	—	—	½—¾	
Do. 7% Cum. Pref.	2	7	—	1¼—1½	
Do. 4½% 1st Mort. Deb.	Stock	4	4½	64—68	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5½	7¾—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4½	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15½	10¼—11½	
Do. 4½% Cum. Pref.	5	4½	4½	5—5¼	+⅛
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½	104—106 xd	
I. R. & G. P. Co., Ltd.	10	10	10½	15½—16½	
Do. 4% Deb. Red.	100	4	4½	98—100	
Tel. Const. & Maintenance Co.	12	15	17½	29—31	
Do. 4% Deb. Bds. Red	100	4	4½	101½—103½	+½
Willans & Robinson, Ord. Shres	1	nil	5½	⅜—1½	
Do. 6% Cum. Pref.	5	nil	6½	3⅝—3¾	
Do. 1st Mtg. Deb. 4% Red.	100	4½	4½	70—74 xd	

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LOCAL NOTES

ABERDEEN: *Tramway Accounts.*—The financial year of the municipal tramways undertaking ended last week, and the receipts amounted to £71,087, a decrease of £699 compared with those of the previous year. The total, however, is above the estimate, the receipts for the preceding twelve months having been greatly augmented by the exceedingly heavy traffic in consequence of the University celebrations. The number of passengers carried was 16,634,304, a decrease of 236,227.

Supply to Tramway Co.—At the last meeting of the Corporation some correspondence was read between the Town Clerk and the Secretary to the Aberdeen Suburban Tramways Co. with reference to the supply of energy by the Corporation. The company suggested that the whole matter should be referred to arbitration, but no decision has yet been come to by the Corporation, the letter being remitted to the Electricity Committee.

Underground Telephone System.—Work has been commenced upon the underground telephone system in Aberdeen by the Postmaster-General's department. Some 21 miles of streets will be opened for the purpose of the new telephone system by which overhead wires will be abolished.

BATH: *Sale of Electrical Undertaking.*—As we have already announced the Corporation has decided to sell its electrical undertaking to a company. Official notice is now given of the intention to transfer the undertaking, subject to the consent of the Board of Trade, to the Bath and District Electric Supply Co. for 30 years, the consideration being a sum of £162,939, of which £22,500 has been paid as a deposit and the remainder will be paid by 30 annual instalments covering principal and interest of 3½ per cent. per annum on the balance remaining unpaid reserved as rent during the period of the lease.

BATLEY: *Electricity.*—For the financial year just ended the profits upon the Corporation electricity undertaking were £212, compared with £434 last year. The decrease is accounted for mainly by the increase in the price of coal and in rates, and also by payments made out of revenue which have formerly been paid out of capital.

BIRMINGHAM: *Electricity Accounts.*—At the last meeting of the Corporation the report dealing with the accounts of the undertaking for the year ended March 31st, 1908, was presented. The Chairman of the Electricity Committee, Mr. Ellaway, said that the chief features of the report were the growth of output and the further decrease in the works costs. The increase in the supply for tramways had been exceeded by about one million units, whilst there had also been a noticeable increase in the supply for private lighting and power. In the previous year there had been an increase of 30 per cent. in the output; during the past year the output had increased by 37 per cent. in units and 25 per cent. in money value. The increase in motor connections amounted to 3,491 h.p., and he drew attention to the fact that whereas two years the h.p. of motors connected was just over 3,000, the total was now over 9,000. The works costs last year came out at 0·766d. per unit, compared with 1·06d. in the previous year, and the reductions would have been larger but for the fact that coal cost £2,000 more, owing to the rise in price. These works costs compared satisfactorily with other large towns, for in Nottingham they were 1·01d.; Manchester, 0·83d.; Liverpool, 0·79d.; Bradford, 0·73d.; Leeds, 0·69d.; Sheffield, 0·68d.; and Salford, 0·65d. None of these figures include capital expenditure, so that the comparison was on the same basis. The undertaking had now paid off nearly £100,000 of capital, it had a reserve fund of £70,000, and they were replacing obsolete plant to the extent of £30,000. In answer to questions as to the writing off of the value of obsolete plant at the Dale End station to the extent of £20,000 out of revenue, Mr. Ellaway said the Electricity Committee had no alternative but to do this, for the Local Government Board would not grant a loan for the new plant, and, at the same time, allow them to keep the £20,000 on the books as part of their capital.

Tramway Accounts.—The report of the Tramways Committee shows a capital expenditure upon permanent way, to date, of £577,320, or a cost per car mile of single track of £6,800. Street widenings have cost £234,644, of which £80,000 have been transferred to the Public Works Department. The overhead equipment has cost £50,798, or £1,500 per mile of single track, but this includes the wiring of the depôts. Traffic expenses during the year, which is the first complete one of municipal work, came to £76,069, whilst the general expenses amounted to £27,089, which latter sum includes law charges and compensation to the extent of £6,879, this being largely made up by compensation paid in respect of the Warstone Lane accident. The total expenses amounted to £168,444. The receipts from Corporation cars amounted to £324,898, from the Birmingham and Midland Tramways Joint Committee, in respect of the company's cars running over the Corporation's lines, £31,069, and sundry traffic receipts, £718, making a total of £356,685. From this has to be deducted £70,430, payable to other authorities in respect of Corporation cars running over their lines, leaving the net traffic receipts at £286,254. After meeting interest and sinking fund, &c., it is proposed to carry £37,000 to reserve and contribute £35,000 towards the relief of rates. The average fare paid per passenger was 0·9d., and the cost per passenger, including interest and sinking fund and a fair amount for depreciation, was 0·74.

BLACKPOOL: *Electric Lighting Accounts.*—The accounts of the Electricity Committee for the financial year just ended show a revenue of £36,565, and an expenditure of £16,140. There are now 1,126 consumers upon the electric lighting mains. The number of public arc lamps is 278, and public incandescent and Nernst lamps number 726. During the year an extra capital expenditure was involved of £9,279, making a total to date of £199,052, of which £42,423 have been paid off. The reserve fund stands at £6,153.

BOLTON: *Electric Driving.*—The Musgrave Spinning Co. are introducing electric power in their three large mills here. Messrs. Dobson & Barlow, the well-known textile engineering firm, have put down motors in their new works at Bradley Fold, near Bolton. They have been supplied by the British Westinghouse Co., Ltd., of Trafford Park, Manchester, the power being obtained from the Lancashire Electric Power Co.

BUENOS AYRES: *Tube Railways.*—The *Review of the River Plate* states that the only tender received for the construction of tube railways in Buenos Ayres was presented by the Consortium d'Entrepremeurs du Metropolitain de Paris, associated with the French branch of Thomson Houston, both represented here by Supervielle & Co. The tender gives three proposals:—(1) Construction of two lines 1·67 m. gauge, with tunnels lined with brick, $18,520,598 gold. (2) Gauge 1·44 m., tunnels lined with brick and iron rings, $17,529,929 gold. (3) Gauge 1·44 m., lining brick, $16,412,045 gold. The offer lays down numerous conditions and to finish the work in 3½ years. A fine or bonus of $10,000 a week for delays or advancement in finishing the work is also proposed.

BURSLEM: *M.E.A. Convention.*—The chairman of the Electricity Committee and the Electrical Engineer have been appointed to attend the annual convention of the Incorporated Municipal Electrical Association at Nottingham.

BURY: *Tramwaymen's Holiday.*—The Tramways Committee have decided to grant their employees a week's holiday with pay, yearly, under certain conditions. There was some opposition in the Council to the concession, which, it is stated, will cost the Corporation about £250 per year.

COLCHESTER: *Tramway Deficit.*—The Tramway Manager's annual report states that for the year ended March 31st there is a deficit upon the tramway undertaking of £2,929 against £2,089 last year.

CROYDON: *Electricity Accounts.*—The report of Mr. A. C. Cramb, the Borough Electrical Engineer, on the eleventh year of working of the electrical department shows a total capital expenditure to March 31st of £339,203, the expenditure during the year being £6,730. The capital expenditure during the previous year was £19,125. Considerable attention has been given to the question of stores, with a view to reducing the amount in hand. For the first time repayments to sinking fund have exceeded the amount spent on new works, the respective amounts being £11,081 and £6,730. The total expenditure during the year was £31,133, an increase of £2,916 over that of the previous year, whilst the total receipts amounted to £66,937 10s. 7d., an increase of £1,927. Coal cost £13,454, an increase of £1,674. The coal bill would have been considerably increased but for the large stock of coal purchased under old contracts, which effected a saving of several hundred pounds. Certain purchases during the spring had, together with the stock brought in, the general effect of preventing the coal bill reaching a still higher figure. The net surplus on the year's working is £12,242, as compared with £8,927 12s. 3d. for 1907. Against this sum, however, is the cost of coal bunkers and conveyor, £2,100 already incurred. The price per unit obtained for private supply, viz., 3·6, has decreased 0·2d.; the number of consumers is 2,902, an increase of 256; the units generated increased from 6,027,338 to 7,005,141, and the units sold from 4,936,857 to 5,875,003; whilst efficiency of distribution has increased from 82·8 per cent. to 84·03 per cent. The maximum load on the station for both general supply and traction was 3,255 kw., against 3,381 kw. for the previous year, and the load factor has increased from 16·66 per cent. to 20·60 per cent. The capacity of the works remained stationary at 5,750 kw. The reduction in the maximum load on the works is attributed to the adoption of metal-filament lamps in shops. With the amount allocated last year the reserve fund now stands at £22,410. With regard to future requirements, the report points out that the only outstanding loan is that granted in April, 1907, amounting to £21,812, which has been almost expended. Application has been made for a further loan amounting to £13,500, the whole of which is required for the distributing system. Mr. Cramb concludes his report with a reference to the general position of the undertaking. He says that a fair increase in the business of the undertaking has been made, and the more general use of metal-filament lamps has given great satisfaction and effected a large economy in the case of many consumers' accounts. This, of course, had the effect of minimising the rate of increase of units sold for lighting during the past year. It is probable that

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there will be a far greater reduction in the amount of electricity sold for private lighting to existing consumers during the present year. The following figures of the totals of 12 lighting consumers' accounts for the last two years show the saving now being made by the adoption of metal-filament lamps, and in all cases with greatly increased light:—1907, £612 15s. 10d.; 1908, £447 13s. 5d.; decrease, £165 2s. 5d. The saving effected in individual cases has reached as much as 48 per cent. There has been a satisfactory increase in the amount of electricity sold for power purposes, and there is no doubt that the electric motor is rapidly increasing in popularity. The time switch system of charging for motive power has proved satisfactory, both to the consumer and the undertaking.

DARLINGTON: *Tramway Accounts.*—The Borough Accountant's statement of the financial position of the tramway undertaking to March 31st, 1908, shows a net profit of £2,314. It has been recommended that £465, capital charges which the Local Government Board has declined to sanction as part of loan expenditure, shall be written off the surplus.

DOVER: *Electricity Estimates.*—The estimates of revenue and expenditure in connection with the electricity undertaking during the coming year show a total expenditure of £9,059 and estimated receipts of £20,477. The deficit for the year just ended, namely, £2,147, is deducted, together with interest on loans, sinking fund, and bank interest, making a total of £13,711. There is consequently a deficit of £2,293 anticipated.

DUDLEY: *Electricity Accounts.*—There has been a gross profit of £5,977 upon the working of the electricity undertaking during the year just ended. Deducting interest and sinking fund, &c., there is a net profit of £335. The total capital expenditure to date is £86,808, compared with £81,410 for the previous year. There has been a steady growth in the number of new connections, and especially in connection with power supply, whilst the supply to the tramway company has also considerably increased.

DUNDEE: *Electricity Estimates.*—The estimates for the current year of the electricity undertaking show receipts amounting to £35,865, whilst the expenditure is set down at £35,850. The cost of current to the tramways department for traction purposes has been reduced from 1¼d. to 1½d. per unit, which will represent a reduction of £1,300 per annum.

EAST MOLESEY: *Telephone Extensions.*—The Secretary of the General Post Office has written, with reference to a decision of the District Council that telephone wires must be laid underground, pointing out that the cost of underground work is roughly four or five times that of an overhead line. The Postmaster-General had found by experience that it was the best policy both for the Post Office and for the general public to defer telephone extension in a new district until the road authority had agreed to his proposals as to the mode of construction. The Clerk has been instructed to inform the Postmaster-General that the Council cannot see its way to alter its previous decision.

EDINBURGH: *Telephone Charges.*—A deputation from the Edinburgh Merchants' Association recently waited upon the Corporation to urge the enforcement of the agreement between the Corporation and the National Telephone Co., special objection being taken to the introduction of the measured rate system. It was pointed out to the deputation, however, that under the present agreement with the Telephone Co. any subscriber has a right to demand an unlimited service at £10 per annum. A suggestion was made that a municipal service should be instituted in competition with the company, but in view of the fact that a licence would only be granted by the Government until 1931, the proposition is not to be entertained.

ERITH: *Tramways.*—A deputation from the Urban District Council is to wait upon Bexley Urban District Council with reference to the inter-running of the trams on the two systems.

FINCHLEY: *Electricity Accounts.*—At the last meeting of the Urban District Council, the annual statement and accounts of the electricity undertaking were presented. The total income, less bad debts, was £11,489, of which £8,002 was contributed from private lighting, £1,685 from public lighting, and £642 from power. The working expenditure amounted to £5,939, and after payment of interest and sinking fund the net result on the twelve months' working was a deficiency of £292. The capital expenditure on the year was £12,638. The number of units generated was 897,502, as against 890,000 in the previous year. The total units sold to consumers had increased from 464,212 to 485,060. Public lighting had consumed 244,700 units, as against 238,500 in the previous twelve months. The number of consumers had increased from 1,089 to 1,476. The income from power, &c., was about only half as much as in the previous year, owing to the fact that the Council had lost the bulk supply to the Metropolitan Electric Tramways Co. This loss, however, had been more than made up by the increase in private consumption, and the receipts per unit had increased from 3·6d. to 4·275d. Public lamps had been supplied at a cost of 1·52d., as compared with 1·635d. Although better light at less cost was given by metallic filament lamps, the cost of attendance, &c., had increased from £502 to £587. The gross income from all sources was £11,559, as compared with £10,031 in the previous year. On the other side of the account the cost of generation was £2,490, or 0·82d. per unit sold, as against £2,175, or 0·74d. per unit. This increase was due to the fact that coal had gone up 5s. per ton. The total cost of distribution was 0·084d. per unit, as against 0·033d., while the total expenses of management amounted to 0·397d. per unit, as against 0·598d. The gross profit was 48·3 per cent., as against 46·8 per cent. in the previous year and 39·3d. the year before. The absence of any provision for depreciation was commented on. The chairman of the Electricity Committee, replying, said the grievance they had in Finchley was that the period for repayment of loans was too short as compared with similar municipal undertakings in the metropolis and elsewhere.

GLASGOW: *Tramway Returns.*—The receipts from the tramway undertaking for the year just ended were £907,494, an increase of £20,113 over those of the previous year. The car miles run were 20,766,722, an increase of 416,355, and the revenue per car mile increased by 0·023d., making an average of 10·488d. The traffic receipts per passenger worked out at 0·960d., an increase of 0·01d. The passengers carried were 226,948,290.

Tramway Extension.—The Tramways Committee on Thursday received a deputation from the Clydebank Town Council in connection with the proposed extension of the tramways and the erection of two new bridges over the Forth and Clyde Canal.

GRIMSBY: *Electricity Accounts.*—At the last meeting of the Town Council a profit of £2,085 was reported upon the municipal electricity undertaking for the year ended March 31st, 1908. The Electrical Engineer, Mr. W. A. Vignoles, recommends that this amount be carried forward for the reason that the committee were carrying out an improvement for which the Local Government Board would not sanction a loan. After some discussion the Council decided to allocate £500 of the surplus to the relief of rates.

LINCOLN: *Electricity Accounts.*—At the last meeting of the City Council, the Chairman of the Electricity Committee stated that the undertaking was growing quickly and paying its way. The output for the past year amounts to nearly one and a half million units, and £1,000 has been provided towards the relief of rates. With regard to the tramway system, he said that although this had been much abused, it had provided over £2,500 for depreciation and sinking fund, and the small loss of £70 had been met by the Electricity Committee. This £70, however, could not be regarded entirely as loss, as the Electricity Committee had made a profit upon the current sold to the tramways department.

LLANDUDNO: *Tramway Extension.*—The extension of the Colwyn Bay tramways from Rhos to Station Road, Colwyn Bay, was inspected by Col. Yorke on behalf of the Board of Trade last Friday, and the line was opened to the public on the following day.

LONDON: *Islington: Infirmary Generating Costs.*—At the last meeting of Board of Guardians, Mr. Parker asked what was the cost per unit of the electric lighting as generated at the Highgate Hill Infirmary. Mr. Lambert said that although the cost of the electric lighting at the infirmary had been said to be about 8d. per unit, as a matter of fact it did not exceed 2d. per unit, and this figure included all administrative expenses.

Paddington: Reinstatement of Trenches.—At the meeting of the Borough Council, the Works Committee reported that for several years past the Council and the late vestry had reinstated trenches opened by the electric lighting, gas, and similar companies, and charged for the work on the basis of schedules which had been adopted from time to time. The Legal Committee had informed the Works Committee that the charges should in future be on the basis of the actual cost of the work. The Works Committee endorsed this view, and the recommendation was adopted.

Southwark: Underground Telephone Lines.—The Works Committee of the Borough Council have considered a joint report drawn up by the Town Clerk and Borough Engineer upon the subject of the conditions attached to the consent of the London County Council, to the laying by the National Telephone Co. of short underground connecting lines. The report states that so far as the conditions relate to interference with the County Council's tramways, there appeared to be little objection to the Spring Garden authority exercising a proper control, but any attempt to interfere with the exercise by the local authority of their right to say in what positions and at what times the boxes and lines are to be laid, and how the property of the local authority is to be dealt with, regardless of the wishes of the local authority, could produce nothing but constant friction and inconvenience. The Works Committee support this view, and will object to the County Council imposing upon the National Telephone Co. any conditions with reference to matters which are within the jurisdiction of the Borough Council as road authority, except in so far as may be necessary for the protection of the County Council's property in the tramways or otherwise.

Westminster: Breaking up of Roads.—The Works Committee reported at the meeting on June 4th having considered a letter from the Gas Light and Coke Co., asking the Council to nominate one or two of its representatives to receive a small deputation from some of the public companies (gas, electricity, and water), whose duties involve interference with the surface of thoroughfares, in order to discuss, and, if possible, arrive at a settlement of the questions relating to paving charges, which have so long been in dispute. The Committee have agreed with the

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suggestion, and have appointed the Mayor, their chairman, and vice-chairman (Alderman Spencer-Smith and Councillor Abady), together with the Town Clerk and the City Engineer, as the Council's representatives at the proposed conference.

Woolwich: Electricity Undertaking.—There are some interesting facts relative to the position of the Borough Council's electricity undertaking in the report of the district auditor (Mr. A. Carson Roberts) on the accounts for the year ended March 31st, 1907, which was presented at a meeting of the Council on June 4th. In connection with the revenue position, it is explained that a loss of £15,744 for the year is shown by the accounts, but the loss shown would have amounted to nearly £17,000 if loans had been raised sufficient to cover the capital expenditure as it was incurred, and the proper share of their redemption charged in the year. The rates will have to provide rather more than the gross earnings of the undertaking, which, apart from the charges for wiring and motors, amounted to £16,824. The rates raised in aid of the undertaking yielded £9,794, but the deficiency brought forward at March 31st, 1906, exceeded this amount by over £1,000, and the accounts show a deficiency at March 31st, 1907, of £16,835. This, however, falls short of the true deficiency at that date, as no account had been taken of the proportion of standing charges which had accrued but not fallen due for payment, bringing the revenue deficiency up to £21,200. In the year just closed he was informed that the rates raised in aid of the undertaking have averaged over 9d. in the £, and have yielded £29,771, a sum sufficient to cover the arrears of deficiency, including accrued proportions, and to provide £8,571 towards the loss on the year's working. Loans have been raised sufficient to cover the capital outlay for the time being.

Woolwich Tramways.—For some months, consideration has been given to the question of the electrification of the L.C.C. tramways from Beresford Square to Greenwich in order to supersede the existing horse tramways between the electrified portions at Greenwich and Woolwich. The Borough Council is to urge the L.C.C. to take the necessary steps for the construction and electrification of the tramways along a route which the former body has approved; it is 1 mile, 2 furlongs, and 160 yards long, and which will involve a net estimated cost for the acquisition of property and for executing necessary street works of £10,000.

NEWPORT: *Gas v. Electricity.*—The Newport Gas Co. has invited the Corporation Electricity Committee to take part in a trial of the relative values for public lighting of incandescent gas and incandescent electric lamps, but the Corporation has decided that they do not think it necessary to take part in such a test.

NOTTINGHAM: *Electricity Accounts.*—The report of the Electricity Committee for the past year states that no additional machinery has been required, owing to the increasing number of consumers who have taken advantage of the metallic filament lamps. The capacity of the plant in the three generating stations is as follows: Talbot Street, 8,925 h.p.; St. Ann's, 6,040 h.p.; Eastcroft Destructor Works, 720 h.p.; making a total of 15,685 h.p. The output during the year amounted to 11,116,835 units, an increase of 1,586,759 units over the output for the previous year. The total costs work out at 1·62d. per unit, a decrease of 0·07d. over the previous year, in spite of a 25 per cent. increase in the cost of coal. The connections are now equivalent to 349,699 eight c.p. lamps, compared with 321,240, and there are now also connected to the mains 3,418 h.p. of motors, an increase of 484 h.p.

PLYMOUTH: *Tramway Receipts.*—The receipts from the municipal tramway undertaking for the year ended March 31st, 1908, amount to £32,932, against £32,454 for the previous year. The expenditure amounted to £24,550, against £23,049 for the previous year, leaving a gross profit of £8,381, against £9,404 in 1906-7. To this has to be added the sum of £1,182 received from the Plymouth, Stonehouse, & Devonport Tramways Co., and £75 from the district funds towards capital charges. The total gross profit, therefore, amounted to £9,639, from which has to be deducted interest and sinking fund charges amounting to £8,866, leaving £772 as net profit, compared with £1,352 in the previous year.

PUDSEY: *New Tramway Service.*—The extension of the Leeds tramways from Stanningley to Pudsey was opened on Thursday by the Mayor of Pudsey. The extension, which is a little over a mile in length, has cost £15,000.

RATHMINES & RATHGAR: *Electric Lighting Undertaking.*—The accounts for the year ended March 31st, 1908, show that after meeting extra capital charges there is a loss of about £50 on the undertaking, which is accounted for by bad debts. The income from private lighting, there having been a large number of new consumers, has increased by about £1,000 over the income of last year.

SHEFFIELD: *Electricity Accounts.*—A statement has been prepared by Mr. S. E. Fedden, comparing the position of the Corporation electrical undertaking at present with the position in 1899, when the Sheffield Electric Light & Power Company's undertaking was acquired. In 1899 the total revenue was £24,342, against £78,355 in 1908; the average price obtained at these two periods was 3·88d. and 2·17d. per unit respectively; the number of consumers were 967 and 3,383; the cost per unit 1·6d. and 0·72d.; the output 1,295,900 units and 8,300,948; and the maximum load in kilowatts 1,073 and 6,243. In 1899 there was not a motor connected to the mains, but at the present time the number of motors is 1,037, having a horse-power of 9,674, and the average price obtained for this supply is 0·943d. per unit. The sum of £117,252 has been paid into sinking fund for redemption of debt, whilst the interest on loans for the nine years ended March 25th, 1908, was £188,430. Motors to the value of £2,200 have been purchased out of revenue, and a sum of £10,000 has been placed to renewals fund. The present available surplus from the undertaking is £16,329.

SOUTHGATE: *Electric Lighting.*—Mr. E. T. Ruthven-Murray, the engineer of the North Metropolitan Electric Power Supply Co., has discussed at considerable length with a committee of the Urban District Council the financial and other details of a suggested scheme for the supply and distribution of electricity within the district. The result of the conference was that Mr. Ruthven-Murray is to submit an alternative scheme for the committee's consideration in the course of the next few days.

STAFFORD: *Electricity Accounts.*—The report of the Electricity Committee states that the total capital expenditure to date amounts to £33,063, of which £9,961 have been repaid. The total number of units sold during the year to March 31st, 1908, was 361,622, compared with 307,321 units in the previous year. The total revenue was £4,371 against £3,971, whilst the expenditure was £1,784 against £1,526. Against the gross profit of £2,587 have to be set to capital and other charges, viz., £2,090.

SWANSEA: *Electricity Accounts.*—A financial statement which has been presented to the Corporation dealing with the electricity undertaking shows a profit during the past year of £1,230, and after meeting sinking fund and interest charges, there is a balance of £789.

TONBRIDGE: *Electricity Accounts.*—It is stated that the deficit upon the municipal electrical undertaking for the past year is £311.

WALSALL: *Dispute with Tramway Company.*—A resolution will shortly be put before the Town Council recommending that notice be given to the Wolverhampton & District Tramway Co. terminating the agreement by which the Corporation has running powers over the company's lines into Willenhall, unless more satisfactory terms can be arranged.

WEST BROMWICH: *Electricity Accounts.*—The Electrical Engineer's report upon the electrical undertaking for the twelve months ending March 31st, 1908, shows that the total number of units sold were 1,824,887, an increase of 25,534 over those of the previous year. The output for power supply shows a 26 per cent. increase. There has been a decreased demand for lighting, chiefly caused by the effect of metallic filament lamps. There is also a further decrease in the supply for traction purposes, owing to the loss of two sections of the South Staffordshire Tramways outside the borough, which had previously been supplied. The total units generated during the year amount to 2,187,396, an increase of 42,005 compared with the previous year. There has been an increase of 26 consumers connected during the year, with an equivalent of 8,285 8-c.p. lamps, the corresponding figure for the previous year being 20 consumers and 5,956 8-c.p. lamps. The total connections, including public lighting, at March 31st, amounted to 44,673 8-c.p. lamps, or about 1,300 kilowatts, the total possible demand, including the maximum traction demand, being 2,050 kilowatts. The maximum load during the year was 1,000 kilowatts, on December 23rd, the lighting and power being 560 kilowatts and the traction demand 440 kilowatts. The combined load factor for lighting and traction is 20·8 per cent., which is an increase of 1·5 per cent. over last year's figure. The lighting and power load factor is 14·4 per cent. and the traction 14·5, which is an increase of 1·1 per cent. for lighting and power and a decrease of 1·0 per cent. for traction. In his report upon the works, the Electrical Engineer states that the storage battery has been of considerable service during the past year, and the watt hour efficiency over the whole time is 74 per cent., the maker's guarantee being 75 per cent. An analysis of the accounts shows that the cost per unit has increased by 0·03d. The amount paid for repairs and maintenance, 0·164d. per unit sold, shows an extraordinary increase of 0·054d. per unit, due to the fact that one of the 250 kilowatt armatures has had a new commutator fitted at a cost of about £105. Repairs have also been carried out to the shunt windings of a 200 kilowatt machine, at a cost of £85. The items of additional expenditure over and above those of the previous year are as follows:—Fitting new commutator to 250 kw. armature, £105; re-winding field coils of 200 kw., £85; purchasing CO_2 recorder and fixing, £35; repairs to balancer, £30; amount withdrawn at Local Government Board inquiry, now charged against revenue, £150; battery maintenance, increased amount compared with last year, £106; louvres for ventilating works, £48 10s. In the reduced costs attention is drawn to the amount, £108, now paid for oil, waste, water, and engine-room stores, which is only a few pounds more than the similar charges on the first year's working of the undertaking, and is £330 less than for the year ending March, 1905, whereas the output has increased by 400,000 units. There is a decrease of £132 from the sale of current for public lighting, reducing the average price from

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0·35d. to 0·55d. per unit. The total revenue was £12,793, and the working costs £6,737. Interest and sinking fund absorbed £4,027, leaving a net profit of £2,030.

WEST HARTLEPOOL: *Electricity Accounts.*—After providing for interest and sinking fund charges, the electricity accounts for the past year show a profit. The repayment of capital during the year amounted to £3,098, *i.e.*, 3¼ per cent. on the capital expenditure, and interest, at 3 per cent., amounted to £2,902. The average price paid for coal during the year was 13s. 5d., compared with 12s. 1½d. during the previous year, and had the price remained steady, the credit balance would have been £350.

WIMBLEDON: *Electric Lighting.*—An agreement has been come to with landowners respecting the construction and maintenance by the Council of a weir across the River Wandle for the purpose of improving the supply of water for condensing purposes to the electricity works. A sub-committee has been appointed to consider and report upon the present methods of street lighting and what improvement, if any, it is desirable to make therein. The Foster Arc Lamp & Engineering Co., Ltd., wrote asking at what price the Council would supply energy for power purposes to their works on the basis of a minimum consumption of 20,000 units per annum. A reply is to be sent to the effect that energy will be supplied for power purposes at the rate of 1½d. per unit.

WOLVERHAMPTON: *Tramway Accounts.*—The tramway accounts for the year ended March 31st, 1908, show a total income of £44,431, and expenses £26,460. Interest and repayment of loans absorbed £11,064, income tax on profits £150, leaving a net balance of £6,762. Of the balance, £4,416 have been transferred to renewals fund and £34 has been allocated towards the loss on the motor omnibuses, whilst £1,292 have been utilised for wiping off the deficit on the previous year's accounts. The balance of £392 has been carried to a general reserve fund. Although the receipts show an increase of some £500, compared with that of 1907, the working expenses have increased by £1,500.

YORK: *Electricity Loans.*—A Local Government Board inquiry into the application by the Corporation to borrow £31,604 in connection with the electricity undertaking was held last week, and again adjourned. £24,404 represents excess of expenditure over borrowing powers, and £7,200 represents the suspense account. The previous inquiry had been adjourned in order that the Inspector, Mr. H. R. Hooper, might be supplied with details of capital expenditure to March 31st, 1908. The inquiry was again adjourned for the provision of further particulars with regard to capital expenditure in past years, the Inspector expressing the opinion that he would continue the inquiry until he was quite satisfied upon this point. It was stated that the capital expenditure to date upon the works amounted to £125,254. Being unable to obtain answers to various questions with regard to past capital and its repayment the Inspector suggested that the Corporation should be content with a loan for a much shorter period. This course, he said, had been followed in the past where it had been found impossible to explain what had gone on in previous years, and the period then had varied between 5 and 12 years. No answer was given to this suggestion, and the inquiry was adjourned as mentioned above. It came out that the capital charges at York are at present more than 0·5d. per unit in excess of the generating expenses.

TENDERS INVITED AND PROSPECTIVE BUSINESS

BELGIUM.—Tenders will be received by the Société Nationale des Chemins de Fer Vicinaux, Rue de la Science 14, Brussels, by June 17th, for the installation of overhead electrical equipment and electric rail connections for the Brussels-Grimberghen section of the line from Brussels to Humbeek. Price of specifications, 2 francs; of plans, 24 francs.

The Antwerp Municipal Authorities invite tenders by June 18th for the supply of 1,600 metres of electric cable. A deposit of 2,000 francs (about £80) will be required. Specifications may be obtained from the Hôtel de Ville at a cost of 0·50 franc, or copies may be consulted at the Commercial Intelligence Branch of the Board of Trade.

BULGARIA.—H.M. Vice-Consul at Sofia (Mr. G. O'B. Toulmin) reports that the Bulgarian Direction Générale des Chemins de fer et des Ports invite tenders by June 20th for the supply and installation of electric apparatus required by the Bulgarian State Railways. Tenders must be addressed to "Monsieur le Préfet de Sofia." The estimated cost of the work is 170,000 francs (£6,800), and a deposit of 5 per cent. will be required to qualify any tender. It is very desirable that tenders should be written in French and submitted through a competent agent on the spot. A list of agents established at Sofia may be obtained by British contractors on application at the Commercial Intelligence Branch of the Board of Trade. A copy of the specification (*cahier des charges*), form of tender, drawings, &c., may also be seen at the Commercial Intelligence Branch, or may be obtained at a cost of 3 francs from the Direction Générale des Chemins de fer de l'Etat Bulgare, Sofia.

DOVER.—The Electricity Committee recommend the purchase of a booster at an estimated cost of £700.

BURNLEY.—Coal handling plant is to be erected at an estimated cost of £1,818.

CARLISLE.—The Local Government Board has sanctioned the borrowing of £5,000 for mains, service, and meters in connection with the electricity undertaking.

FINCHLEY.—The Local Government Board has sanctioned a loan of £24,890 in connection with the electricity undertaking.

GILLINGHAM.—Tenders are invited for the supply and delivery of coal at the generating station for the period ending June 30th, 1909. Particulars from the Borough Electrical Engineer, and tenders to the Town Clerk by June 22nd.

HOLYWOOD (COUNTY DOWN).—The question of electric lighting is still under consideration by the Council, and a further report has been called for from the Consulting Engineer.

ILFORD.—The Urban District Council is inviting tenders for wiring the Seven Kings library and hall. Specifications can be obtained and plans seen at the office of Mr. Arthur H. Shaw, Ley Street, Ilford. Tenders close on the 23rd inst.

LONDON COUNTY COUNCIL.—The Council invite tenders for the manufacture, supply, and delivery of tramway feeder pillars. Full particulars from the Clerk (fee, £2, returnable), and tenders by June 23rd.

City Guardians.—The question of lighting the new infirmary buildings at Homerton by electricity in preference to gas was discussed at considerable length at a meeting of the City of London Guardians on Tuesday. The estimated cost of the electrical scheme was stated to be about £1,000, whilst the Gas Light & Coke Co. offer to equip the institution with incandescent gas for £289, but the cost of illumination and maintenance was £210 in the case of electricity against £366 in the case of gas, the candle-power under the electrical scheme being twice that of the gas scheme. Ultimately the recommendation to adopt electric lighting was carried.

Islington.—At a special meeting of the Borough Council on Thursday, held in committee, it was decided that an expenditure of £3,560 was necessary for the purpose of extending the electric lighting undertaking. The Lighting Committee was authorised to incur such expenditure, and the L.C.C. are to be asked to sanction a loan for the amount.

Stepney.—Tenders are invited for ampere-hour meters, demand indicators, and time switches; also arc lamp carbons. (For particulars see an advertisement this week.)

Woolwich.—The Council is to extend distributing mains, at an estimated cost of £45. The Electricity Committee has had under consideration (in pursuance of a policy of reducing the cost of generation on the lines suggested by Sir Alexander Kennedy in his report on the undertaking) the desirability of equipping Globe Lane Station with coal-handling plant, which, it is estimated, will reduce the cost of handling the coal by the present method by about two-thirds. Tenders are to be invited for plant, in order that the Committee may consider more closely the advantages to be derived.

MALVERN.—Tenders are invited for the supply, delivery, and erection of a 50-kw. steam alternator exciter, &c. Particulars from Mr. W. J. Baker, Engineer and Manager, and tenders to the Clerk by June 29th. (See an advertisement last week.)

MANCHESTER.—The Electricity Committee invite tenders for the supply of the following during the twelve months ending June 30th, 1909:—(*a*) direct current motors, (*b*) direct current motor-starters, (*c*) ampere-hour and watt-hour meters, (*d*) fuse-boxes. Particulars from the Secretary to the Electricity Department, Town Hall, and tenders to the Chairman of the Electricity Committee by June 19th. (See an advertisement this week.)

ROTHERHAM.—A Local Government Board inquiry was held last week into an application by the Corporation for sanction to borrow £5,300 for the purposes of the electrical undertaking. It is the intention to instal an additional 500 kw. direct-current turbo-generator.

SHEFFIELD.—A Local Government Board inquiry was held last week into an application by the Corporation for sanction to borrow £20,000 for the purposes of the electrical undertaking. £10,000 is needed for mains and sub-stations, and the remainder is for extensions at the Neepsend power station.

SPAIN.—The *Gaceta de Madrid* announces that the Dirección-General de Obras Publicas are prepared to receive offers for the construction and working of an electric tramway from La Coruna to Burgo. Tenders, which should be accompanied by a deposit of 3,658 pesetas (about £128) will be received up to July 31st. An application for this concession has already been filed by the Compania de Tranvias de la Coruña, which will have preference on equal terms. Forms of tender, &c., may be seen at the Commercial Intelligence Branch of the Board of Trade.

TONBRIDGE.—Extensions to the electricity works are to be carried out at a cost of several thousand pounds.

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TENDERS RECEIVED AND ACCEPTED

CROYDON.—The Corporation has accepted the tender of Chas. Pullan (Bradford), at £428, for the electric lighting installation of new buildings in connection with the Mental Hospital.

DUNDEE.—The Electricity Committee recommend the purchase of 10,500 tons of Polmaise coal from the Russell Collieries.

The following tenders have also been accepted in connection with the erection of the new power station buildings at Stannergate: Mason and brick work, Messrs. A. & T. Craig, £3,519 14s. 11d.; structural iron-work, Clyde Structural Iron Co., Ltd., £4,315; chimney stack, J. J. & P. M'Lachlan, £1,107 5s. 3d.; carpentery and joinery works, James Pollack, £559; slater's work, James Laburn & Son, £153 14s. 8d.; plumbing work, P. Anderson & Sons, £673 19s.; plaster work, James Laburn, £174 16s.; painting work, David Morrison, £77 10s.; steel casements, Henry Hope & Sons, Ltd., £272 4s. 4d.; patent glazing, British Luxfer Co., £288.

LONDON: *Woolwich.*—The Borough Council has received the following tenders for a motor-alternator:—

Manufacturing firm.	Amount of tender. £	s.	Speed r.p.m.	Time for completion. Months.	Guaranteed efficiency. full load.	¾ load.	½ load.	¼ load.	Remarks. Power factor.
Vickers, Son & Maxim	754		375	3	81·0	78·8	73·5	61·4	—
Bruce Peebles & Co.	775		375	4	83·5	80·5	75·0	—	0·8
Siemens Bros. Dynamo Works	775	5	375	3½	81·0	75·6	68·6	51·6	0·8
British Thomson-Houston Co. (accepted)	784	10	375	3	82·8	81·5	77·8	67·6	0·8
British Westinghouse Co.	789	15	375	5	83·0	80·0	76·0	62·0	—
General Electric Co.	790	15	375	3	83·5 83·0	— 80·0	— 75·5	— 62·5	0·8 1·0
J. H. Holmes & Co.	804		400 (max.)	4	82·5	79·0	73·0	56·0	—
Brush Electrical Engineering Co. (alternative)	833	10	500	4	83·75	82·0	78·25	68·0	—
Lancashire Dynamo and Motor Co.	878	10	not stated	3½	83·5	82·0	78·5	68·0	—
Dick, Kerr & Co.	922		428	(4 f.o.r.)	(incomplete tender).				
Brush Electrical Engineering Co.	995		375	4	83·75	82·0	78·25	68·0	—

Each of these tenders includes a provisional sum of £40 to cover any special expenses which may become necessary during the execution of the contract. The tenders sent in by Messrs. Holmes & Co., the Lancashire Dynamo Co., and Dick, Kerr & Co. do not refer to the wages conditions, but the remainder comply in every respect. The Electricity Committee, reporting on the tenders at the last meeting of the Borough Council, said that the most potent factors in the selection of the machine were those of efficiency and time of delivery, and as it was required for long hour running generally at the lower loads, the higher the efficiency under these conditions the greater would be the saving to the Council. A further saving would be effected by quick delivery.

Holborn.—The Council has received the following tenders for electrical fittings for the new Council offices:—J. W. Singer & Sons, Ltd. (accepted), £368 17s.; D. Hulett & Co., Ltd. (old brass finish), £390 6s., (bronze finish), £451 15s.; Hart, Son, Peard & Co., Ltd., £472 7s.; Galsworthy, Ltd., £477 8s.; Thos. Elsley, Ltd., £542 15s.

PARLIAMENTARY INTELLIGENCE

LONDON ELECTRIC POWER BILLS.—Our report of the proceedings before Lord Cromer's Committee will be found on pages 881 to 884.

NOTTINGHAMSHIRE AND DERBYSHIRE TRAMWAYS BILL (No. 2).—The Midland Railway Company have deposited a petition in the House of Commons against this Bill.

PROGRESS OF ELECTRICAL BILLS.—Tramways Order Confirmation Bill (No. 2) and King's College, London (Transfer) Bill were passed by the Unopposed Committee of the House of Commons last week.

COMPANIES' MEETINGS AND REPORTS

ANGLO-PORTUGUESE TELEPHONE.—At the annual general meeting on Thursday the report and accounts given in our last issue were adopted. Mr. H. Allen, who presided, referring to the question of working expenses, said that the telephone business differed from most other commercial enterprises as, after a certain point was reached in the number of subscribers to an exchange, an increase in business brought with it a more than proportionate increase of working costs. Having regard to all the circumstances under which their business was conducted, he did not think they could anticipate over any appreciable period a lower ratio of expenses to receipts than about 50 per cent. An extension of underground work in Lisbon had been put in hand, and although it was a costly operation at the outset it would be distinctly remunerative in the long run. During the year about £9,000 had been spent on capital account without in any way encroaching upon their reserve capital of £10,000, which still remained intact. For the third year in succession they had set aside £5,000 from profits to the reserve fund. The principal work completed during the year was the extension of the switchboards at Lisbon and Oporto, giving an increased capacity for 900 subscribers in the former and 240 subscribers in the latter. The total number of calls during the year was 7,750,000, which gave an average receipt of 1¼d. per message, demonstrating the important fact that the Portuguese public got value for their money.

ARON ELECTRICITY METER.—The report for the six months to March 31st, 1908, states that after providing for general charges and depreciation, there is a net profit of £11,485, making, with the balance carried forward from the last accounts of £6,228, a total available profit of £17,714. The directors recommend the payment of a further dividend of 7 per cent. on the cumulative preference shares towards paying off the arrears, and a transfer to the reserve towards goodwill and patents of £5,000, leaving to be carried forward £3,971. On December 12th, 1907, a 6 per cent. preference dividend was paid, representing 3 per cent. for the six months to September 30th, 1904, and 3 per cent. for the six months to March 31st, 1905. The directors are pleased to record a further progress of trade in all branches, which is ascribed to an increased demand for the company's meters and clocks. The factories have again had to be enlarged in order to cope with the increased business. A taximeter has recently been placed on the market which has been approved by the Commissioner of Police and passed by the National Physical Laboratory. The meeting is on Tuesday.

BIRMINGHAM & MIDLAND TRAMWAYS.—The report for the year 1907 states that the total revenue for the year from all sources amounted to £85,837, compared with £92,582 for the preceding year, but the latter figure included the receipts for the first six months of the year of the Dudley Road Tramway in Birmingham, which has since passed into the hands of the Corporation. The expenses for the year amounted to £38,652, compared with £44,951 for 1906. After providing for all expenses chargeable to revenue, including rents, repairs, and maintenance, placing £1,500 to depreciation and renewals accounts, and adding the £552 brought forward from the last account, there remains £44,236. The directors propose to place to the debenture redemption fund £3,550, to pay a dividend on the preferred ordinary shares at the rate of 4 per cent. for the year ended December 31st, 1907 (less tax), and to carry to next account £85. The total expenditure on capital account during the year amounted to £24,820, and included the completion of the car sheds and workshops at Tividale, the Bearwood Road sub-station, and additional plant and cables in connection with the development of the electric light undertaking. The meeting is to-day.

BRUSH ELECTRICAL ENGINEERING.—The report for the year ended December 31st, 1907, states that effect has been given in the balance-sheet to the reduction of capital approved by the shareholders in August, 1907. The amounts standing to the credit of the general reserve and depreciation reserve funds, as well as the balance of profit brought forward from the year 1906, have also been absorbed. The patents and good-will account is now represented by the round figure of £100,000, while the company's investments, which were entered in the 1906 balance-sheet at £164,522, now stand at £101,335. The general profit and loss account shows a gross profit of £63,294. After debiting general charges and maintenance, the amount carried to net profit and loss account is £32,294, and after paying debenture and other interest, the net balance is £10,229. Consistently with the character of the present balance-sheet, which is essentially one of reduction and adjustment, the directors recommend that this balance be applied to initiate a new general reserve fund. The output from the works during 1907 has been the largest in the history of the company, but the directors regret that the profits realised have not been commensurate. This is chiefly due to the fact that competition in the electrical engineering industry continues to be very keen, while the after effects of the strike at the company's Loughborough works have been severely felt. The company has also suffered in its operations by the lack of adequate working capital. The contracts upon which it has been engaged have involved a large

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lock-up of money while in progress, and this situation has had to be met by temporary loans from bankers and others, which, owing to the financial stringency that prevailed for so long a period during 1907, carried a high rate of interest. A portion of these loans was obtained from the British Electric Traction Co., Ltd., without security, and, as part of the arrangement then made, the directors have waived their option to call upon the British Electric Traction Co. to accept £2 ordinary shares at par in satisfaction of the advance of £30,740 made by that company in 1901, and have agreed to repay the said advance by twelve half-yearly cash instalments commencing in January, 1909, and carrying interest at the rate of 3½ per cent. per annum. With a view to placing the company in a position to carry on its business under more favourable and economic conditions, the directors put forward in January last a scheme to consolidate the existing £250,000 first and second debenture stocks, and to make a further issue of £100,000 four and a half per cent. debenture stock. This proposal, however, was not supported by the first debenture stockholders, and the directors have now arranged to make an issue of £125,000 five per cent. prior lien debenture stock, which will be specifically secured upon the freehold and leasehold lands, buildings, and fixed plants of the company at Loughborough. The reduction of capital embodied in the present balance-sheet makes the company's preference and ordinary shares of the face value of £1 6s. 8d. In order to arrive at a more marketable denomination it is proposed to subdivide these shares into shares of 6s. 8d. each, and to consolidate every three of the latter into one £1 share, thus giving the shareholders four £1 shares for every three shares at present held. Similarly, the unissued 74,268 ordinary shares of £2 each will be converted into 148,536 ordinary shares of £1 each. An extraordinary general meeting to consider resolutions to give effect to such subdivision is to be held after the general meeting. The directors have decided to give the preference shareholders the right to convert 25 per cent. of their holding into ordinary shares. The meeting is on the 16th inst.

CITY OF BUENOS AIRES TRAMWAYS.—A meeting of the debenture-holders was held on Friday to consider a resolution assenting to a proposition by which the company's rights to a specific charge on certain lands and stations of the company, granted in a contract with the Anglo-Argentine Tramways Co. in 1904, are to be waived in view of the fusion of all the tramway undertakings of Buenos Aires. The resolution was carried unanimously.

METROPOLITAN AMALGAMATED RAILWAY CARRIAGE & WAGON.—At the annual meeting on Friday, the report and accounts were adopted. Mr. F. Dudley, the chairman, who presided, said he was happy to be able to congratulate the shareholders once more upon a successful year. The paid-up capital had increased from £1,084,096 to £1,432,940, and the reserve fund now stood at £350,000.

WEST INDIA AND PANAMA TELEGRAPH.—At the ordinary general meeting last week the report and accounts given in our last issue were adopted. Mr. W. B. Kingsford, the Chairman, who presided, said that comparing the results for the year with those of the previous year, there was a decrease in the receipts of about £1,900, but it was fair to mention that in the previous year the receipts had been swollen owing to the earthquake in Jamaica.

NEW COMPANIES

ELECTRO-HYDRO.—This company was registered on May 29th, with a capital of £1,000 in 900 10 per cent. participating preference shares of £1 each, and 2,000 ordinary shares of 1s. each, to carry on in Manchester and elsewhere the business of an electro-medical and electro-hydropathic establishment, to acquire the electrical apparatus, appliances, and utensils, &c., installed at 344 Bury New Road, Manchester, and to adopt an agreement with J. Brown. The subscribers are :—Margarita de Abaitua, D. H. Bailey, J. Brown, S. Boot, T. Cotton, W. B. Brown, Maude Cotton. No initial public issue. The number of directors is not to be less than two nor more than seven; the first are T. Cotton and J. Brown. Qualification, 50 shares. Remuneration, one guinea each per meeting attended. Registered office, 344 Bury New Road, Manchester.

W. FORREST & CO. (SHEFFIELD).—This company was registered on May 30th, with a capital of £2,000 in £1 shares, to take over the business of electrical, mechanical, and general engineers, machinists, millwrights, metal workers, and the like, carried on by W. E. Forrest at Industry Works, Sylvester Gardens, Sheffield, as "W. Forrest & Co." The subscribers are :—F. Naylor, Mrs. F. B. Naylor, Mrs. E. Fox, W. E. Forrest, Mrs. M. A. Forrest, W. H. Storm, F. Crawshaw. No initial public issue. The number of directors is not to be less than two nor more than five; the first are W. E. Forrest and F. Naylor. Qualification, 100 shares. Remuneration as fixed by the company. Registered by Alfred H. Atkins, Ltd., 27-28 Fetter Lane, E.C.

RAILWAY AUDIBLE SIGNAL CO.—This company was registered on May 30th, with a capital of £50,000 in £1 shares, to acquire any patents, inventions, licences, concessions, and the like relating to the production, treatment, storage, application, distribution, and use of electricity, in particular to certain existing inventions relating to signalling on railways, to adopt an agreement with the said syndicate, and to carry on the business of manufacturers of and dealers in signalling apparatus, railway rolling stock, &c. The subscribers are :—S. T. Hargreaves, T. W. Hargreaves, R. Harradine, G. R. Campbell, W. C. Crofts, Florence Ridge, T. H. Archer. Minimum cash subscription, 5 per cent. of the shares offered to the public. The number of directors is not to be less than three nor more than seven; the first are W. Dawson, Cote, Audley Road, Hendon; H. G. Drury, St. Oswalds, Downes Road, Clapton, N.E.; A. Haes, 17 Bishopsgate Street, E.C.; W. A. Hart, 23 Westbourne Villas, W.; and T. Eaton, 21 Corfton Road, Ealing, W. Qualification, 100 shares. Remuneration, £600 per annum, and such further sums, not exceeding £400 in any year, as the company shall determine.

MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted Tuesday night was £59 5s. to £59 15s. per ton (no alteration from last week's price).

ARC LAMPS, LTD.—As we have already announced, Messrs. Arc Lamps, Ltd., are removing to their new works, and we are asked to announce that all goods and empties sent to the firm should in future be addressed to St. Albans.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—Creditors of the Brockie Pell Arc Lamp Co., Ltd., are requested to send particulars of their claims to Mr. H. McLellan, one of the joint-liquidators, at 6A Devonshire Square, London, E.C., by July 6th.

A meeting of the Gardner Electric Drill & Hammer Co. will be held at 138 Salisbury House, London Wall, E.C., on Wednesday, July 8th, at 12 noon, for the purpose of hearing the liquidator's account of the winding up.

A meeting of Merz-Oatway Fire Appliances, Ltd. (1901), will be held at 92 and 94 Paul Street, Finsbury, London, on July 6th, at 12 noon, for the purpose of hearing the liquidator's account of the winding up.

The first meeting of creditors in the bankruptcy of Walter Wardle, electrician, of 14 Osborn Road, Levenshulme, Manchester, will be held at the Official Receiver's offices, Byrom Street, Manchester, on June 17th, at 3 p.m., and the public examination at the Court House, Quay Street, Manchester, on July 3rd, at 10 a.m.

Albert Lord, trading as Lord Brothers, electrical engineers, Ogden's Chambers, 134 Deansgate, Manchester, has been adjudicated bankrupt.

The first meeting in the bankruptcy of E. Goacher, Electrical Engineer, of Worksop, will be held at the Official Receiver's offices, Figtree Lane, Sheffield, on June 19th, at 3 p.m., and the public examination will be held at the County Court Hall, Bank Street, Sheffield, at 2 p.m., on June 25th.

MISCELLANEOUS CITY NOTES

CANADIAN GENERAL ELECTRIC CO.—The directors have declared a dividend of 1¾ per cent. upon the common stock of the company for the three months ending June 30th, 1908, being 7 per cent. for the year.

MEXICAN LIGHT, HEAT & POWER CO.—A dividend of 1 per cent. upon the outstanding ordinary shares has been declared.

APPOINTMENTS AND PERSONAL NOTES

Mr. J. B. Hamilton, the General Manager of the Leeds Corporation Tramways Department, has been presented with a silver rose-bowl and set of candlesticks by the officials and staff of the tramways department on the occasion of his silver wedding.

The three candidates for final selection for the post of tramway manager to the South Shields Corporation were Mr. L. E. Harvey, assistant tramway manager at Sunderland; Mr. R. Chadwick, chief assistant tramway manager at Birkenhead; and Mr. F. Taylor, assistant tramway engineer at Bolton. There were 64 applications. The voting resulted as follows :—Mr. Harvey, 29 votes; Mr. Chadwick, 10; and Mr. Taylor, 6.

The principal prize of two hundred guineas, offered by the American Co-operative Electrical Development Association for a canvassers's handbook, dealing with data useful to canvassers and central station managers, has been awarded to Mr. R. Borlase Matthews, London.

Mr. C. W. Mallins, hitherto Traffic Manager of the Liverpool Corporation Tramways, has been appointed General Manager. Further particulars will be found on p. 910.

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QUALIFICATIONS OF FACTORY INSPECTORS

IN the House of Commons on Wednesday last week, on the motion for the adjournment for the Whitsun holidays, a discussion took place upon the increasing number of fatal and non-fatal accidents in factories under the Factories and Workshops Act.

Mr. GLOVER (St. Helens) moved a resolution to the effect that the increase was of such a character as to demand immediate attention, more particularly in so far as it referred to the organisation of the Factory Department of the Home Office. During the past eight years fatal accidents had increased by no less than 308, and non-fatal accidents from 1897 to 1907 had increased by 66,767. These were figures, he thought, which proved that the Government should consider this question seriously. It was impossible for the present staff of inspectors to keep proper observation on the large number of factories coming under the Act, namely, 255,189. He criticised strongly the methods of appointment of inspectors, and urged the appointment of men who had had practical experience of the works and machinery which they had to inspect.

Mr. SEDDON (Newton, Lancs.) ridiculed the method of appointing inspectors under an examination system which included familiarity with the poets and an appreciation of distinction between miracle plays and mysteries, but which did not make essential any practical knowledge of machinery.

Mr. TENNANT (Berwickshire), whilst not going so far as the previous speaker, not being one who believed in the doctrine that a factory inspector was better without academic education, suggested that mechanics and chemistry should be added to the compulsory subjects set in the examination for inspectors.

Mr. HARWOOD (Bolton) expressed the opinion that the problem of safeguarding life in factories needed a knowledge of machinery, and for this reason only specialists should be appointed. He urged the separation of the duties of factory inspectors into those dealing with the ordinary routine work, and others to inspect systematically factory by factory in order to see that every danger was safeguarded.

Mr. HERBERT GLADSTONE, the Home Secretary, in reply to the discussion, said that if he could be convinced that the present system of appointing factory inspectors did not produce the right men, he was perfectly ready to change it. The present system provided for an initial examination of candidates by nomination in certain compulsory and optional subjects. Those who passed were appointed as probationer-inspectors for two years, during which time they worked under an inspector and gained practical experience in all questions relating to factory law, sanitary science, mechanics, &c. At the end of the probationary period the candidates had to undergo a final examination before they were made full inspectors. He deprecated the system of open examination, for under it candidates would come up in tribes for examination. Everybody seemed to think he would make a factory inspector. With regard to the staff, the Department had devised a scheme by which a second deputy chief inspector and second medical inspector had been appointed, whilst with the sanction of the Treasury they had also appointed 16 new inspectors, 5 lady inspectors, and 11 inspectors' assistants. He believed this would have the effect of giving the head of the departments more time to consider the general question of organisation and disposition of work. At the same time, there was no doubt that the Workmen's Compensation Act had had the effect of increasing the number of accidents, for it was possible that both employers and workmen became rather more careless through the knowledge of insurance on one hand and compensation on the other. He quite agreed that the large increase in non-fatal and fatal accidents was disturbing, although he preferred to regard fatal accidents as a more reliable guide to the efficiency of the Home Office supervision. During the ten years from 1899 to 1908 they had increased by 62 per cent., and the increase from 1905 to 1907 was 10·9 per cent. With regard to the appointment of practical men, he reminded the House of the complexity of the duties imposed upon factory inspectors and of the large number of trades with which they had to deal. There were about 10,000 different trades in the country, and he looked upon a practical man as a man with a head upon his shoulders which enabled him to take a reasonable and practical view of all trades. The present system had been ridiculed, but no case of failure or shortcoming had been brought to his notice during the time he had held his present office. Nevertheless, he would welcome an impartial inquiry, whether by Departmental Committee or Select Committee.

Mr. RAMSEY MACDONALD (Leicester) said he preferred a Select Committee, but Lord BALCARRES (Chorley) favoured an inquiry by Departmental Committee, as did also Sir F. BANBURY (City of London). The motion was then withdrawn.

A Science Museum.—In the House of Commons last week, in reply to Sir William Anson, Mr. McKinnon Wood said he thought it would be eminently desirable that there should be a science museum in immediate proximity to the Imperial College of Science and Technology, and if the Commissioners of the 1851 Exhibition felt themselves in a position to co-operate, he should be happy to bring the matter under the notice of the Chancellor of the Exchequer.

THE ACCOUNTS OF THE NATIONAL PHYSICAL LABORATORY

THE accounts of receipts and expenditure of the National Physical Laboratory with balance-sheet for the year 1907 have now been issued as a Parliamentary "white paper." According to the revenue account, the administration expenditure amounted to £1,078, including a rent of £31. Salaries, wages, &c. (including the director's salary of £1,300) amounted to £12,198, and £1,290 is set down under the head of general expenses. The expenditure of the observatory, physics, metallurgical, and engineering departments are given separately as £244, £570, £294, and £185 respectively. The figure for the physics department includes £137 for the electrical measurements division and £165 for the electrotechnical division. Other miscellaneous expenses bring the total expenditure up to £16,257, and in addition to this £500 was transferred to equipment fund for maintenance and additions. The income was made up as follows:—Treasury grant, £6,000; donations and subscriptions, £1,250; interest on Gassiot Trust Fund, £450; charges for work done (including £7,804 from fees for tests), £9,324; other receipts, £35. Total, £17,058. There was thus a final balance, being excess of income over expenditure of £302. The capital expenditure on alterations, &c., of Bushy House has been £48,028, including £15,464 during the year, and on equipment (excluding gifts of apparatus) £8,716, including £230 during the year, but of a Treasury grant of £500 for Eskdalemuir Magnetic Observatory only £38 has been spent up to the end of the year.

THE "METALIK" INCANDESCENT LAMP

ON page 814 of our issue of May 28th, in referring to some experiences with the metal filament lamp known as the "Metalik," we alluded to a case where the lamps were still unblackened after burning 1,356 hours. Mr. Boddy has kindly pointed out that this figure should have been 1,856 hours, and at the same time gives us some further particulars of the case in question. It appears that these lamps are of the 220-volt 50-c.p. size, placed in a sloping position on an alternating-current circuit with a not very constant voltage, and a later communication which we have seen from the engineer to the same undertaking speaks of a lamp which is still in good condition after 2,775 hours. This appears to be something like a record for high-voltage lamps. Some records of candle-power tests on continuous-current are also given. The candle-power in one case of the lamp when new was 35 British c.p., and increased to 43 c.p. after 250 hours' burning, while the consumption was constant at 58 watts. We have also seen a letter from Mr. T. Roles, City Electrical Engineer, Bradford, stating that two sample 50 c.p. Metalik lamps showed an average life of 1,407 hours, and would have run longer had not the filaments become shorted by twisting. Other Corporation engineers who have reported favourably on these lamps are Mr. Long, of Norwich, and Mr. A. C. Cramb, of Croydon. Excellent accounts of their burning are also received from consumers in Liverpool. Messrs. G. M. Boddy & Co. have also sent us their schedule of discounts to the trade and to Corporations on quantities of lamps taken in 12 months, and inform us that they have brought out descriptive cards, with particulars, which can be printed with the agents' names and addresses.

CATALOGUES AND PAMPHLETS RECEIVED

PORTABLE ACCUMULATOR LAMPS.—A list from Accumulator Industries, Ltd., of Woking and London, describes a new pattern of accumulator hand-lamp, the principal features of which are a gimbal reflector capable of reflecting light in any direction without movement of the incandescent lamp. The cells are fitted with a floating head discharge indicator, and 4-volt metal filament lamps are used.

INCANDESCENT LAMPS.—A card from the British Thomson-Houston Co. illustrates the B.T.-H. "Meridian" No. 4 large bulb carbon filament lamp, with special shade, forming a globe of soft white light, with an excellent distribution of illumination.

DRY BATTERIES.—Messrs. Siemens Brothers, Ltd., of 12 Queen Anne's Gate, S.W., have issued a comprehensive new catalogue of their well-known "Obach" dry cells. In addition to the ordinary type, a special cell is made for motor-car ignition. For this purpose three- and four-cell batteries are made up in one case, and it is recommended that two such batteries be used alternately by means of a change-over switch, and that an adjustable resistance be included in the circuit and gradually cut out as the battery voltage falls. The company's Hellesenall is also listed, as well as the "transport" cell, into which the electrolyte is liquid and can be emptied out when not in use.

ELECTRIC DRILLS.—An attractive mail card from the Armorduct Manufacturing Co. calls attention to the firm's well-known "little hustler drills," which are described as the key to economy in drilling.

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THE ELECTRICAL INDUSTRY IN GERMANY

THE annual report of the British Consul-General for the district of Berlin contains some interesting figures relating to the electrical industry in Germany. The year 1907, says the report, witnessed a considerable growth in the business of the electrical industry; the financial results of the large electrical companies also proved very satisfactory. The influence of the continued rise in the scale of wages and the price of raw and auxiliary materials was indeed noticeable, but cautious purchasing prevented the increase in prices from being too keenly felt, and also weakened the effect of the sudden fall in the price of copper. The concerns sought to check the growing demands of the workmen by replacing manual labour as far as possible by automatic machinery. This accounts for the remarkable circumstance that the Allgemeine Elektricitäts Gesellschaft, in spite of an increased business, reduced the number of their employees in the year 1907 from 33,900 to 30,670, a reduction of nearly 10 per cent. The scarcity in the money market did not affect the electrical companies to any appreciable extent. Much progress has been made in the application of electric driving. Twelve reversible rolling mills are now electrically driven. The machinery for these has been supplied by German firms, but only six are in Germany. Of the remaining six, one is in England (Middlesbrough), one is in Switzerland, another is in Belgium, and the other three are in Austria. The electrification and extension of the elevated and underground railways in Berlin and Hamburg has afforded the railway departments of the large firms continuous occupation. The introduction of electric traction on the Berchtesgarden-Salzburg line in Bavaria will also bring in business. The next undertaking will probably be the electrification of the Berlin Stadt und Ringbahn. The utilisation of Germany's water-power for the production of electrical energy is also a pressing question. The consumption of electric energy in Berlin for the last two years is shown in Table I.

Table I.

Consumption of Electric Energy in Berlin (in Kilowatt Hours) for the Years 1906 *and* 1907.

	1907	1906
	£	£
Private lighting	28,524,790	24,817,983
Public lighting	3,376,513	2,808,339
Power	48,902,247	43,049,036
Accumulators	5,088,784	4,522,829
Tramways	53,196,218	50,952,760
Used in Works	3,833,264	1,952,901
Total	142,921,816	128,103,848

The extended application of electric driving in Berlin is seen from Table II., which gives the number and the total horse-power of the motors used in various branches of industry in Berlin for the last two years.

Table II.

Number and Capacity of Electric Motors in Berlin.

	1907		1906	
	Number of Motors.	Horse-power.	Number of Motors.	Horse-power.
Lifts	2,342	14,137	1,985	11,611
Ventilators	2,312	737	2,097	659
Metal-working machines ...	2,295	9,768	2,156	9,216
Printing machines	2,228	6,512	2,033	5,904
Wood-working Machines ...	1,998	7,044	1,520	5,762
Butchers' machinery	997	3,585	850	3,064
Grinding and polishing machines	434	1,535	418	1,499
Paper-making machines ...	425	1,272	413	1,246
Laundry machines	365	1,019	296	849
Sewing machines	362	286	303	277
Pumps	330	1,323	302	1,197
Cutting machines	271	174	241	163
Winding machines	165	388	142	344
Leather-working machines ...	151	561	129	465
Dynamos	129	1,338	81	1,271
Miscellaneous	2,164	5,784	1,954	4,892

The improvements in wireless telegraphy during the year were evidenced by the greater distances over which communication was established; for instance, the German cruiser *München* successfully communicated with the station in the Duchy of Oldenburg from Bergen (Norway), a distance of 750 miles, while the North German Lloyd steamer *Bremen* effected a connection with the Nauen station (22½ miles from Berlin) from a distance of 1,500 miles.

The extent of Germany's foreign trade in electrical machinery and other electrical apparatus is shown in Table III. The principal customers were Belgium, the United Kingdom, the Netherlands, Russia, and Austria-Hungary. The imports were divided principally from France, the United Kingdom, and Switzerland. The electrical exports amounted to 2·15 per cent. of the total value of the exports, and the electrical imports to 0·09 per cent. of the total imports.

Table III.

Germany's Foreign Trade in Electrical Machinery and Apparatus during the Year 1907.

Articles.	Imports.	Exports
	£	£
Dynamos, motors and transformers	94,450	1,716,400
Electric cables	76,050	2,260,250
Arc lamps	4,200	145,100
Reflectors, search lights	2,450	134,450
Incandescent lamps	53,150	419,100
Telegraph and telephone apparatus	58,450	765,250
Switchgear	45,200	922,950
Apparatus for surgical and dental purposes	3,700	67,250
Measuring, counting and registering apparatus	27,700	392,100
Dry cells, accumulators, and thermo-electric couples	1,050	38,650
Insulators of earthenware, porcelain, and glass	8,700	20,200

In connection with the analysis of the foreign trade in electrical machinery and apparatus as shown in the above table, it is interesting to note that of the first two items in the table, over 10 per cent. by weight of the exports were for the United Kingdom. Nothing under the heading of the first item was imported from the United Kingdom, but 926 tons out of 1,460 tons of cables imported into Germany came from the United Kingdom. A proportion of each item of the exports was sent into the United Kingdom, but besides the cables mentioned above the imports from the United Kingdom were limited to insulators (17 per cent.), switchgear (15 per cent.), and arc lamps (27 per cent.).

NEW GENERAL MANAGER OF THE LIVERPOOL CORPORATION TRAMWAYS

WE are pleased to announce that the Liverpool City Council at their meeting on the 3rd inst. confirmed the recommendation of the Tramways and Electric Power and Lighting Committee, appointing Mr. C. W. Mallins General Manager of the Liverpool Corporation Tramways. Mr. Mallins has been connected with the Liverpool Tramways for upwards of 34 years, and became Traffic Manager when the Corporation took over the undertaking from the Liverpool United Tramways and Omnibus Co. in September, 1897, since which date an enormous development has taken place in connection with the Tramways, as will be seen from the following figures, viz. :—

	1897. (Last year of Company control.)		1907.
Passengers	38,409,084	...	124,043,239
Receipts	£290,743	...	£572,822
Mileage	6,013,182	...	12,231,799
Vehicles in service ...	267	...	505
Average length of 1d. stage	About 1,200 yards.		2 miles, 737 yards

It may also be mentioned that the sum of £182,662 has been handed over to the relief of the rates, and £975,173 set aside towards the redemption of capital and to a reserve, renewal, and depreciation account. Since the death of the late Mr. C. R. Bellamy, Mr. Mallins has practically carried out the duties of General Manager, and his appointment is the natural outcome of his services in that capacity. Mr. Mallins has placed several of his inventions at the disposal of the Corporation, notably his patent sanding device, which has been the means of preventing numerous accidents and inspiring the drivers with greatly increased confidence in handling their cars on steep gradients; also his patent ticket punch, with which the Liverpool tramways service has been equipped and which is giving every satisfaction, resulting in considerable financial gain to the department.

55-Volt Lighting Mains.—In an article in the *Elektrotechnischer Anzeiger*, the advantages of the 2×110 volt three-wire distribution system for town lighting, as opposed to the 2×220 volt system, are emphasised. The lower voltage is more suitable both for arc-lamps and for metal filament lamps. As an example of low voltage distribution the town of Agram is mentioned. This town, which is near Trieste (Austria), and has a population of 70,000 inhabitants, is supplied at 2×55 volts. Metal filament lamps are used exclusively, the smallest lamps used being 20 (Hefner) candle, 24 watt units.

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ELECTRICAL ENGINEERING

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SUMMARY

A tender for the provision of another 6,000 kw. turbo-generator for the Stuart Street station of the Manchester Corporation has been recommended for acceptance. The turbine will be of the Zoelly pattern, constructed by J. Howden & Co., and will be larger than any turbine of that type yet constructed. The alternator will be made by Siemens Bros.' Dynamo Works, and will be similar to that forming part of the first set. We are able to give some extracts from the specification, showing the conditions with which these machines have to comply. (Page 915.)

The annual report of the Birmingham Electric Supply Department shows that the number of units sold during the year 1907–8 was 20,800,000, as compared with 10,900,000 during the previous year. The working costs have been reduced from 1·06 to 0·766 pence per unit. The whole of the surplus, amounting to over £20,000, was written off towards the value of obsolete plant at the Dale End generating station. (Page 916.)

A new automatic starting device, which operates without any tilting of the lamp, has been devised for use with mercury vapour lamps. The resistance to the discharge, which is practically all concentrated at the cathode, is broken down by applying, at the instant of switching on, a high potential across the lamp; at the same instant, small sparks are produced in the neighbourhood of the cathode, which have the effect of reducing the resistance so that the discharge is started. (Page 916.)

The electric lighting installation at the new Public Offices in Whitehall includes several novel features. The cables in the sub-basement are supported in iron troughs suspended from the ceiling. A special form of sealing box, which admits of the cables being quickly and easily disconnected if required, is employed. Over 6,000 carbon filament lamps are used in the building, there being no metal filament lamps and no arc lamps. The paper lifts are electrically driven, and have push button control. (Page 917.)

Under "Electrical Science," in the British and American Section, there appears a note on a further development of Bellini and Tosi's directive system of radiotelegraphy, described in a Paper before the Physical Society, and an abstract of a Paper on the effects of self-induction in large iron cylinders. In the Papers abstracted in the Continental Section, Ménard criticises the effectiveness of the Roentgen ray test for death. Dumoulin describes the best method of working self-excited alternators in parallel, and Buisson and Fabry investigate the two forms of the iron arc.

In an article in a German contemporary on single-phase motors, Dr. W. Reichel discusses the question

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of the most suitable frequency for single-phase railways, and gives the results of some interesting tests made on the Niederschöneweide-Spindlersfeld experimental line, with a view to determining the influence of variations in the line pressure on the operation of single-phase motors. (Page 919.)

THE electrically equipped rolling stock in use on the Heysham-Morecambe-Lancaster lines of the Midland Railway consists of three motor-cars, two with Siemens and one with Westinghouse equipment, and some special trailers fitted with driving equipment. Although the Westinghouse car is provided with electro-pneumatic control and the Siemens cars with all-electric control, arrangements have been made to enable any car to be driven by the master controller of any other. Each motor coach carries two motors of the maker's nearest standard size to 150 h.p. (Page 921.)

THE first electric train for the London Bridge—Victoria line of the London, Brighton & South Coast Railway Co. was completed last week. It is expected that the remaining trains will be delivered in August, that the experimental running will be commenced in the autumn, and that the actual opening of the line to the public will be before the end of the year. (Page 929.)

THE electrical engineering exhibits at the Franco-British Exhibition can hardly be regarded as fully representative of either the French or British electrical industries. In the railway section, the Metropolitan Railway exhibit a car which has been converted from steam to electrical traction. Comparatively few French firms exhibit heavy electrical engineering plant, but the plant of Sautter Harlé and the Société Gramme may be noticed, the former containing an example of high-speed Diesel engines, and the largest searchlight projector in the world. The British engineering section contains several examples of large gas engines, including those exhibited by Mather & Platt, Crossley Bros., the British Westinghouse Co., and others. C. A. Parsons & Co. exhibit an 1,800 kw. continuous-current turbo-generator, supplied with steam from a battery of Babcock & Wilcox boilers. The combined exhibit promoted by the electric supply companies is not as yet quite complete, but attention should be drawn to the complete miniature furnished flat fitted to demonstrate the domestic applications of electricity. There is also a fine collection of machine tools. A number of objects of electrical interest are also contained in the science section. (Page 930.)

THE Board of Trade inquiry into the circumstances attending the accident on the Bournemouth Corporation tramways on May 1st was concluded on June 10th. At the inquest, concluded on June 11th, the jury returned a verdict of accidental death, the accident having been caused by the car getting out of control, owing to a defective controller. The driver was exonerated from all blame. (Page 934.)

A PATENT specification by V. A. FYNN, published on Thursday last, relates to single-phase motors having a series characteristic, and describes a method of introducing a negative torque after the motor has reached a predetermined maximum speed. The starting torque is not affected, but the motor cannot race on light loads. S. O. COWPER-COLES has patented a method of obtaining a smooth homogeneous deposition of copper or other metals. A specification by L. H. WALTER describes a self-restoring tantalum-mercury coherer for wireless telegraphy, and another by SIEMENS BROS'. DYNAMO WORKS relates to the insulation of high-tension transformers. A method of avoiding the distortion of metal filaments, when being reduced, due to the reaction between the earth's field and the current carrying filament, is the subject of a patent by the GLÜHLAMPEN-WERK ANKER GES. of Berlin. Two other specifications relate to the manufacture of resistance bodies and a wattmeter for measuring power on unsymmetrical three-phase circuits respectively. A patent by E. G. ACHESON for an electric furnace especially adapted for the production of carborundum expires during the current week. (Page 935.)

A NOVEL idea for measuring resistance of a very high order was described before the American Electrochemical Society at their recent meeting. It consists in ionising air by means of radium bromide, and is based on the law that the ionisation current through a gas subjected to a constant source of ionisation is approximately proportional to the potential difference between the plates when this potential is small. In Luxemberg a large electric steel works is in course of construction. Electrochemistry and Electrometallurgy, (Page 937.)

ON the resumption of the proceedings in connection with the London Electric Power Bills before Lord Cromer's committee, on Tuesday, the case for the Bill of the London Electric Lighting Companies was opened. This provides for the utilisation of the six most modern generating stations of the companies, in which additional generating plant will be erected, and from which current will be supplied to the smaller stations. At present eight companies are joined in the promotion of the Bill. It is proposed that a joint committee be formed to manage the whole undertaking, and provision is made for other companies and local authorities to join if they so desire. The undertaking of any company of local authority joining in the scheme becomes the property of the Joint Committee. Capital to the extent of £1,000,000 is proposed, and under the purchase clause the whole of this sum is to be repaid at the end of 42 years by a purchasing authority, which may be the London County Council. Purchase may also take place in 1932, but in that case compensation is to be made as between 1932 and 1952. The promoters have proceeded upon the assumption that it is unwise to look ahead for more than five or six years, and they have calculated figures showing that in this period the additional demand likely to arise will not exceed 25,000 kw., although, as a matter of fact, there is sufficient land and buildings at the disposal of the Joint Committee for the installation of 34,000 kw. They have, therefore, prepared estimates on the basis of 25,000 kw., and they have produced figures to prove that utilising the existing resources of the companies' generation can be carried on at a cheaper rate than a new power company could do it. In the estimates of Mr. J. S. Highfield and Mr. C. P. Sparkes, who are joint engineers to the scheme, provision is made for 12,000 kw. of gas engine generating plant, Mr. Highfield expressing a great belief in the future of this type, as well as oil engines; in fact, he mentioned that the Charing Cross Co. have installed oil engines in one of their sub-stations for generating purposes, with the result that the total generating cost, including capital charges, might be only 0·39d. per unit.—It is stated that the securities of the London supply companies have depreciated in value by £186,000 since the present Committee commenced their sittings, and by nearly £4,000,000 since the introduction of Mr. Merz's first Bill in 1905. (Page 937.)

IN connection with the sale of the Bath Electric undertaking to the Somerset & District Electric Power Co., a scheme has been proposed for embracing the working of the Bath electric tramways under the same management.—It has been decided to convert the whole of the street lighting in Beckenham from gas to metal filament lamps.—A new proposal has been placed before the Brighton Corporation for the running of a through service of East to West trams by a syndicate. The loss on the year's working of the tramways has been £969, against a profit of £2,410 last year.—A profit of £5,647 has been made by the Coventry electricity department for the past year, out of which it is proposed to hand over £1,000 in relief of rates.—The working of the Eastbourne Electricity Department for the past year shows a net profit of £2,214, compared with £1,567 last year.

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The total cost per unit for the year have, however, increased from 1·98d. to 2·11d.—A service of electric tramways in Delhi has just been opened.—The experiment is to be made in Liverpool of running a service of first-class tramcars at increased fares.—The profit on the Newcastle Corporation tramways for the past year has been £96,884, which is slightly less than for the preceding year. The receipts average 11·5d. per car mile. (Pages 929 to 942.)

TENDERS are invited by the London County Council for main and auxiliary switchgear for the Greenwich tramway generating station.—A scheme is proposed for the provision of two additional water-tube boilers and coal conveying plant at the Wolverhampton Electricity Works.—A large order for magnetic tramway track brakes for Australia has been placed with the British Westinghouse Co. (Pages 942 and 943.)

IN his speech at the meeting of the Brush Electrical Engineering Co. on Tuesday, Lord VAUX, of Harrowden, said that although the output of the works for the year had been a record, business had to be accepted at prices leaving a disproportionate profit. Some further debentures are to be issued.—At the meeting of the Aron Electricity Meter Company, Mr. H. HIRST referred to the increase of business anticipated owing to the introduction of the metal filament lamp, especially as regards their new prepayment alternating current meter. (Page 944.)

IN his report on the slight fire which destroyed a locomotive on the City and South London Railway, on May 24th, Mr. A. P. Trotter, Electrical Advisor to the Board of Trade, says that it is impossible to connect the fire with any electrical cause. By being allowed almost to burn itself out, without damaging the carriage coupled to it, or the wooden platform of the station, it afforded an interesting and satisfactory test. (Page 946.)

THE annual report of the Patent Office for the year 1907 has just been issued. As compared with the year 1906 there was a decrease of 3·3 per cent. in the number of applications received. This, says the report, is partly due to the falling off of the activity in connection with the motor-car industry. Judging from the titles only, the inventions relating to motor road vehicles during the year 1907 decreased nearly 35 per cent. A large increase is observable in the subject of wireless telegraphy. (Page 948.)

A NEW form of electrolytic rectifier has been introduced, specially suitable for charging small ignition accumulators. (Page 947.)

IN a report on fire alarm systems by the State Inspector of Buildings in Berlin, attention is called to an automatic system in use on the Continent which has the feature that the detector or thermostat is not only sensitive to an increase of temperature above a defined limit, but is also sensitive to an increase in the rate at which a room is heated over that which could normally occur with the usual heating arrangements. (Page 948.)

A LETTER from the Hart Accumulator Co. deals with a misconception which might arise owing to a liquidation of a company of similar name. (Page 948.)

WE publish this week a detailed and well-illustrated description of the rolling stock on the "electrified" portion of the Midland Railway. Read in conjunction with the article on the overhead equipment published in our last issue, it affords a detailed study of the problem of adapting the newest method of electric driving to standard English railway requirements and established methods of operation. This is particularly demonstrated in the design of the overhead work, which has been made to conform to exacting conditions of clearances to accommodate steam trains composed of all classes of vehicles of full standard size. It is well known that vehicle dimensions have been increased during recent years nearly up to the full capacity of existing structures, so that there are many places where the clearances available for carrying the conductors are measured in inches only. When the conductors are supplied at extra high tension, and the insulators are exposed to locomotive exhausts, it is obvious that the conditions are trying, and permanently successful operation in these circumstances will prove the practicability of the system for general railway work. There are no tunnels on the lines electrified, it is true, and anyone who knows what the inside of a railway tunnel is like will admit that it is well to get some experience from working in the open before designing tunnel work. The rolling stock shows just as much adaptation of design to standard conditions, but there is less novelty here. The ingenious replacement of the standard large and small vacuum brake ejectors by a double speeded motor is worthy of note, as is also the interlocking of the brake and control gear, ensuring that the locomotive shall not be started until braking power is available. This is one among many points in which electric traction lends itself to security of working.

Among the constructive details in which the equipment shows novelty, the system of catenary suspension is perhaps the most important. It may be called the "compound" catenary, and we believe it was first introduced by the Siemens-Schuckert Co. in Germany. As now developed, it gives to each member of the catenary the fullest permissible individual freedom, and therefore the greatest possible equalisation of stresses, whilst keeping the contact wire in a very nearly horizontal line. It also simplifies the arrangement of pull-offs at curves, and special work, and consequently reduces the number of points at which surface leakage may occur, as well as the area exposed to wind, two points of very great importance, which the weather of the Morecambe district will put to severe test. These advantages are mainly in comparison with the "duplex" catenary, in which the two carrier and one contact wire are arranged at the angles of a vertical triangle, a system which has been used on several of the American single-phase lines. The greater lateral space occupied is also against it for English railway work. The return circuit arrangements are mainly distinguished by the deliberate provision of earth returns. As two of the earth-plates used at the three termini are immersed in the sea, and the third in a tidal river, they are tried under the most favourable conditions. As regards the operation of the railway, it is of the first necessity that the rails shall never be at such a potential difference from earth as to administer serious shocks to platelayers and others. With the train service at present contemplated, and the short distances between the earth-plates, such a condition is not likely to obtain on the lines in question, but, having regard to the high impedance of steel rails, the point will require careful attention in less favourable circumstances. Meantime the records of current carried *via* the earthplates will afford useful information, and the earthplates themselves will demonstrate how far alternating current electrolysis has to be reckoned with. Experience will also be gained on the effect on neighbouring telephone and telegraph wires. That earthed tele-

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graph circuits will be considerably affected is tolerably certain, also that the insulation of metallic telephone circuits will have to be very well maintained.

WHILST the Midland Railway deserves all congratulations upon being the first in this country to operate a single-phase line, and has thus justified its long-standing reputation for enterprise and initiative, it must be remembered that the London, Brighton and South Coast Railway was the first to publish its decision to adopt the system, and that it chose for the scene, not a country line with a moderate traffic, but a suburban line with a "tramway" service, entering two London termini, and complicated by joint ownership and running powers with other companies. The differences fully account for the slower progress made on the Brighton Co.'s line, the work on which is in every way more difficult, and in some respects more important. It is well known that this pioneer initiative of the Brighton Company is largely due to the energy of Mr. PHILIP DAWSON, who appreciated the possibilities of single-phase traction at a very early date, and has done an enormous amount of work on the subject, which is not yet within the public view. We believe, in fact, that Mr. Dawson actually placed some of his work at the disposal of the Midland Company's officers. As stated elsewhere in this issue, it is anticipated that experimental running will be commenced on the line between Victoria and London Bridge in the autumn, and that this important suburban line will be opened for public traffic by the end of the year.

LORD CROMER'S Committee resumed its consideration of the London Electric Power Bills, after the Whitsun recess, on Tuesday, when the scheme for "linking up" the existing stations of the electric lighting companies was described by Mr. BALFOUR BROWNE, K.C., and subsequently by Mr. J. S. HIGHFIELD, of the Metropolitan Electric Supply Co., who is to be followed by Mr. C. P. SPARKS, of the County of London Electric Supply Co. Briefly, the proposal is to utilise the most modern of the generating stations owned by the eight companies promoting the Bill, viz., Bow (Charing Cross, West End & City Co.), Bankside (City of London Co.), Deptford (London Electric Supply Corporation), Blackwall Point (South Metropolitan Power Co.), Willesden (Metropolitan Co.), and Wandsworth (County of London Co.), for the erection of additional generating plant, and to supply from these to the less economical power stations. At present only eight companies have joined forces, but if, as the promoters hope, all the other companies fall into line, as well as some, if not all, of the local authorities, then the principle of supplying from one or more large generating stations in bulk at rates cheaper than the energy can be generated in less favourable spots, applies equally to this Bill as to the scheme promoted by Mr. PARSHALL and Mr. HAMMOND. The main difference from the engineering point of view is that, whereas only one large station—eventually to supply the whole of London—is contemplated in the Parshall-Hammond scheme, six power-houses are to be employed in carrying out the companies' proposal, and as several different systems of generation are employed, the work of modifying these to work in unison, if there is really to be interconnection, will be a task calling for all the ability of the engineers at the heads of the various undertakings. From the business point of view, the main difference is that, while the Parshall-Hammond Bill contains provisions for securing the largest power users in the areas of the various companies and local authorities already established as suppliers of electrical energy, no poaching is contemplated in the companies' Bill. The letter asks for authorisation to supply railways, docks, and canals, whether in the companies' own area or outside, but otherwise the consumers and prospective consumers of the companies and local authorities outside the "combine" are to be left alone. The companies say, moreover, that they expect no demand from tramways, and that railways require special plant, which would be put down when the need arose, just as the London Electric Supply Corporation has put down special plant in connection with the electrification of the London Bridge-Victoria line of the London Brighton and South Coast Railway. Thus it is estimated that 25,000 kw. of extra plant will be ample to meet the requirements of the next five or six years, which is less than half of the 60,000 kw. put forward as the first stage of the Parshall-Hammond station. This, the companies' engineers say, is looking far enough forward, in view of the rapid progress that is being made in engineering invention. In fact, it is interesting to note that Messrs. HIGHFIELD & SPARKS already look upon the gas engine as a formidable competitor of the steam turbine, and in their estimates of the 25,000 kw. of new plant, 12,000 kw. of gas-driven plant is included, for the reason that it is more economical to run these during the day load, reserving the steam turbine for the peak load. This idea has found an energetic advocate in Mr. LEONARD ANDREWS, whose estimates were recently published in our columns, and elicited an interesting controversy. Mr. Highfield also spoke of the possibilities of oil engines, and mentioned that the Charing Cross Co. has installed some in a sub-station, where the total generating costs, including capital charges, were 0·39d. per unit. With regard to the terms upon which the local authority may ultimately purchase the undertaking—which have been stumbling blocks in every London Power Bill hitherto—an interesting feature so far is that the London County Council decline the honour which is offered by the Bill of being the purchasing authority. The views of the County Council have yet to be heard, and up to the present the purchase clause has hardly been discussed.

In comparing the two Bills, it must be borne in mind that they approach the subject from an entirely different standpoint as to the demand which has to be met, and consequently the respective estimates are not strictly comparable, and lend themselves to no useful deductions. Either side disputes the premises of the other's calculations, and so far as the companies are concerned, they appear to be taking up the most uncompromising attitude towards the new power company, probably for the reason that they are now working together much more in harmony than was the case three years ago, when Mr. Merz's Bill was on the *tapis*. So far as the fight in the Committee Room is concerned, one looks in vain for an indication of the spirit of "sweet reasonableness" which suddenly manifested itself during the House of Lords proceedings on Mr. Merz's Bill, and brought the promotors into line with the most powerful of its opponents.

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ANOTHER 6000 KW. TURBO-GENERATOR FOR MANCHESTER

A GOOD deal of attention centred round the inauguration of the Willans-Siemens 6,000 kw. turbo-alternator last month at the Stuart Street generating station of the Manchester Corporation (see ELECTRICAL ENGINEERING, May 14th, page 735), and it is interesting to know that the acceptance of a tender for a second set of this size has been practically decided upon. The new set will be somewhat different from that already put down, as it will be driven by a turbine of the Zoelly type, constructed by Messrs. James Howden & Co., of Glasgow, and will be larger than any Zoelly turbine yet made. Messrs. Howden have already built several large turbines of this type, including a 2,000 kw. set for the Powell-Duffryn collieries. The alternator will be made by Messrs. Siemens Brothers' Dynamo Works, Ltd., and will be similar to that forming part of first set. Seven tenders were considered, but until the official confirmation of the acceptance of the tender we must withhold a complete list. It may be of interest, however, to give a few technical particulars of the requirements of the set from the specification.

The turbine is specified to be of the horizontal pattern, either of the impulse or reaction type, and must be adapted for the full range of expansion of the steam. The steam pressure at the turbine stop valve will be 190 lbs. per square inch, and the speed is not to exceed 1,000 r.p.m. The turbine must be capable of developing sufficient power to enable the alternator to deliver an output of 6,000 kw. of electrical energy at its terminals at normal speed, with a steam pressure of 190 lbs., and a vacuum of 27 ins.—either on a non-inductive circuit or on an inductive circuit—with a power factor of 0·85. It must further be capable of developing as an emergency load, with the same conditions as to steam pressure and speed, sufficient power to enable the alternator to give on non-inductive circuits an output of 7,500 kw. for six hours. It must also be capable, when working non-condensing, of developing sufficient power to enable the alternator to deliver an output at the terminals of 6,000 kw. under normal steam pressure and speed. From 100° to 150° Fah. will be added to the temperature of the steam; the turbine must therefore be capable of working under normal conditions at a total temperature of 600° Fah.

The turbine is to be provided with a main governor, which shall be so adjusted that if the whole load be suddenly thrown on or off the variation of steady speed shall not exceed 2 per cent., and of momentary speed 5 per cent. The total variation in the load at the present time on the station may be taken at 15 per cent. The variation in speed of the turbine must not exceed, therefore, half of one per cent. either way on a load varying 7½ per cent. up or down from the mean load. Provision to be made for a 5 per cent. up and down, or a total of 10 per cent. variation by hand adjustment. It is essential that this adjustment should be controllable from the switchboard gallery as well as from the engine-room floor level. The variation in angular velocity during each revolution must not vary by more than one-twentieth of one per cent. with constant load.

A safety centrifugal mechanical governor must be fitted, capable of being operated by hand or working automatically, to act as an emergency governor should the speed exceed 15 per cent. above the normal, and that under no condition whatever shall the turbine race injuriously.

The alternator is to be of the three-phase type, delivering alternating currents with an angle of 120° between each phase. It is to be of the revolving field type with stationary armature, the windings of which are to be star connected, and a connection from the centre point is to be brought out to a terminal on the bedplate for earthing purposes, if required. The alternator is to be of the completely enclosed-in type. For providing the necessary ventilation a separate and electrically-driven fan is to be supplied and fixed, capable of blowing 21,000 cubic feet per minute, or otherwise to enable the alternator to comply with the clause regarding temperature rise. The fan house is existing. It is to be excited by continuous current at a pressure from 200 to 225 volts, supplied normally by its own exciter direct coupled on the end of the shaft, or from the existing Corporation exciting bus-bars. The alternator must be capable of delivering at its terminals at any voltage between 6,400 to 6,600 an output of 6,000 kw. at a periodicity of 50 per second, either on an inductive load with a power factor of 0·85 or on a non-inductive load. It must further be capable of giving an output of 7,500 kw. for six hours as an overload, and the speed is not to exceed 1,000 r.p.m. The periodicity of the alternator is to be 50 complete cycles per second.

The current density in the armature circuits on full non-inductive loads must not exceed 1,300 amperes. The field magnets or rotating part of the alternator may be of the salient pole or cylindrically wound type, but must run perfectly true and be accurately balanced, and the methods of construction throughout must be of a thoroughly sound mechanical nature. Special care must be taken to insulate the field circuit from earth throughout. The current density for the field circuits on full non-inductive load must not exceed 1,700 amperes per square inch. The insulation resistances taken during manufacture and after a six hours' full test shall not be less than the following:—Between armature windings, 3 megohms; between armature windings and earth, 3 megohms; betwen field magnet circuits and earth, 2 megohms. A 13,000 volt alternating pressure will be applied between the armature circuits and earth, and a 1,000 volt pressure between the field circuit and earth, and each test will be applied for one hour continuously, and must be successfully withstood. The inherent regulation of the alternator is to be such that without any adjustment or regulation, but with constant excitation and speed giving 6,500 volts on open circuit, the full load volts on a full non-inductive load shall not rise by more than 3·5 per cent.

On an inductive full load, with a power factor of 0·85, the rise shall be within 14 per cent. The winding and arrangement of the armature is to be such that if the terminals of the alternator be short-circuited the current shall not rise to more than 3½ times the normal full load current or cause any damage or injurious heating to the armature if it is so run short-circuited for one minute. The alternator must carry its full load without undue heating, either from mechanical or electrical causes. The temperature of no part of the armature, field coils, core, must exceed 60° Fah. above that of the immediate surrounding air at the conclusion of the full load non-inductive test of six hours' run. On an inductive circuit, with a power factor of 0·85, after a six hours' continuous run on full load, a figure of 70° Fah. must not be exceeded.

The total electrical energy absorbed in exciting the field magnets' full non-inductive load shall not exceed 21 kw., and when working on an inductive full load with a power factor of 0·85 shall not exceed 35 kw. The exciting current is to be provided by a direct-driven, continuous-current, shunt-wound dynamo to be supplied under this contract, and preferably coupled to the end of the alternator shaft. The exciting voltage to be 200 to 225.

The condensing plant is specified to be of the "Contraflo" type.

The following clauses are extracted from the section of the specifications headed General and Testing:—

It is of the greatest importance that the whole of

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the plant specified shall work without undue noise or vibration. The turbo-alternator must be capable of being easily put into parallel and remaining in step with either of the existing units now installed at Stuart Street, and with any of the existing synchronous plant installed in the various sub-stations. There must be no appreciable "surging" between the alternator of this set and the existing alternators when operating in parallel. The steam consumption of the plant, with a pressure of 190 lbs. per square inch, and a degree of superheat of 120° Fah. at the stop valve, and a 27 in. vacuum on the condenser, on full load, with a power factor of 1·0, shall not exceed 15·75 lbs. per kilowatt hour. A deduction of £300 per lb., and *pro rata* for a part of a lb., shall be made from the contract price for any excess of consumption per kilowatt hour beyond the figure specified above. A bonus of £300 per lb., and *pro rata* for every part of a lb., shall be paid by the Corporation to the contractor for every lb., and *pro rata* part of a lb., by which the actual consumption is less than the consumption specified for above.

BIRMINGHAM ELECTRICITY SUPPLY ACCOUNTS

THE report of the Electric Supply Department of the City of Birmingham for the year ended March 31st, 1908, gives some figures showing how the undertaking has grown in the last three years, and also some comparative figures for the works costs for the year in question and the previous year. The total number of units generated was 24,763,655. The units used on works amounted to 1,024,327. The number of units sold was 20,793,670, as compared with 10,887,684 units during the previous year (1906–7), and 5,383,904 units during the year 1905–6. The maximum load on the plant was 11,020 kw., and the capacity of the plant installed 14,740 kw. The load factor was 21·5 per cent. The following figures, calculated from the revenue account, give an analysis of the costs per unit sold for the year ended March 31st, 1908, and also for the previous year:—

COSTS PER UNIT SOLD.

	Year ended Mar. 31, 1907.	Year ended Mar. 31, 1908.
Generating costs—		
Coal	0·340d.	0·252d.
Oil, waste, water, and stores	0·037	0·021
Wages at generating stations	0·181	0·122
Repairs—buildings	0·004	0·005
Repairs—engines, boilers, &c.	0·070	0·046
Distributing costs—		
Repairs and maintenance—mains, meters, &c., including wages	0·052	0·052
Repairs, maintenance, and renewal of apparatus at substations, including wages	0·038	0·051
Total works cost	**0·722**	**0·549**
Management charges, &c.—		
Rents, rates and taxes	0·115	0·080
Salaries—Engineers' department	0·105	0·070
Salaries—Accountant & clerical staff	0·036	0·022
Stationery and printing	0·009	0·005
General establishment charges	0·041	0·033
Insurance, law costs, &c.	0·032	0·007
Total cost per unit sold (excluding capital charges)	**1·060**	**0·766**
Capital charges—		
Bank interest	0·009	0·024
Interest on mortgage debt	0·623	0·392
Sinking fund	0·397	0·287
Total cost per unit sold (including capital charges)	**2·089**	**1·469**

The total working expenses, as analysed above, were £66,424; but a further sum of £9,159 brought the total expenditure up to £75,583. This sum of £9,159 represents the cost of a battery and of building alterations at the Parker Street substation, and a switchboard for the Water Street generating station. This special expenditure, corresponding to 0·106 pence per unit sold brings up the total cost per unit sold (excluding capital charges) to 0·872d., and including capital charges to 1·575d. The receipts from all sources amounted to £156,789, and of the balance of £81,206, a sum of £20,279 was written off, as the value of obsolete plant at the Dale End generating station, the remaining £60,927 being absorbed by interest and repayment of loans. The average price obtained per unit was 1·809d., and taking the total cost per unit as 1·575d. (including capital charges and special expenditure) a net profit of 0·234 pence per unit is shown, the whole of which, amounting to £20,279, was written off as the value of obsolete plant as stated above.

The following table shows the capital expenditure up to March 31st, 1908:—

	£
Expenditure up to 31st March, 1907	1,102,830
Expenditure since that date—	
Buildings	8,923
Machinery	73,132
Mains and services (including laying)	38,246
Meters	2,157
	1,225,288
Less Plant abandoned	20,279
Total	**£1,205,009**

This last figure, divided by 14,740, the present capacity of the station in kilowatts, gives £81·7 as the cost per kilowatt installed.

A NEW STARTING DEVICE FOR MERCURY VAPOUR LAMPS

IN order to start the discharge in a mercury vapour lamp, it has been usual to tilt the tube in such a way that the mercury is caused to flow along its entire length, and form an uninterrupted bridge between the electrodes. When the stream breaks an arc is established, which fills the whole tube, as this is allowed to drop back into its original position by gravity. This operation of tilting the tube may be performed by hand or by means of an electromagnet. The latter method is for mechanical reasons confined to lamp-tubes not exceeding 21 in. in length. In an article by F. H. von Keller, in a recent issue of the *Western Electrician* (Chicago), a new form of starter is described, with the aid of which a lamp may be started without tilting the tube.

In this method of starting advantage is taken of the fact that in a mercury vapour lamp, as in all other cases of a discharge through a gas, the resistance to the discharge is practically all concentrated at the surface of the negative electrode. This phenomenon was explained by Prof. J. J. Thomson, in his recent series of lectures on "Electric Discharges Through Gases," at the Royal Institution. (See ELECTRICAL ENGINEERING, March 12th, page 410, and subsequent reports.) In the lamp in question a metallic coating is provided on the outside of the condensing chamber at the negative electrode. This coating extends above and below the mercury edge formed inside of the chamber. The metallic coating and the mercury thus form the two plates of a condenser, and the glass is the dielectric. If this condenser is suddenly raised to a high potential, minute sparks are produced between the surface of the mercury and the inside surface of the glass. These are sufficient to render the gas in the neighbourhood of the negative electrode conductive, and the discharge is started. At the instant of applying the high potential across the condenser, the whole length of the tube is also subjected to this high potential. This is done in the following manner. In parallel with the tube is an auxiliary starting circuit, comprising a starting resistance and a quick-break mercury switch. In series with these two parallel circuits is an inductance coil and the usual series resistance. The mercury switch consists of a glass bulb about two inches long, provided with a V-shaped indentation, forming a partial partition, and serving to separate the contained mercury into two globules. Each of these globules makes connection with an outside terminal by means of a small platinum wire. The bulb is exhausted to a high degree of vacuum.

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When the circuit is closed the bulb is in such a position that the mercury forms a bridge connecting the two terminals together. A current of about one ampere then flows through the bulb, the starting resistance and the inductance. The inductance coil actuates an armature which turns the bulb and causes the partition to separate the globule and thus break the circuit. A lasting discharge cannot take place in the bulb as the current is limited to one ampere, and the current is interrupted so suddenly that a high potential rise takes place across the bulb, the lamp tube and the condenser, the metallic coating of which is connected to the iron positive electrode of the lamp. This potential rise created by the inductance on breaking the auxiliary circuit is insufficient by itself to start the discharge across the ¼ in. of space between the globules in the bulb, and also, of course, across the 50 in. of space between the electrodes of the lamp tube, but in the latter the high resistance at the surface of the negative electrode is broken down by the ionising influence of the minute sparks, and the discharge is started. The resistance to the discharge at the surface of the negative electrode asserts itself not only when the lamp is being started, but also at intervals when the lamp is running, thereby tending to put the lamp out. The frequency with which this will occur increases with decreasing current. The inductance in series with the lamp tube reacts upon these impulses of the negative electrode with a high-voltage kick, which keeps the lamp running continuously at its current consumption of 3·5 amperes.

The successful application of this method presents a distinct improvement in the art of mercury-vapour lighting, as it is entirely automatic, and is the only method by which the tube as a whole remains perfectly stationary during the starting. An 800-c.p. lamp, employing this method, consists of a straight one-inch tube of 50 in. (light-giving) length, suspended in a holder from a compact round housing in which all the auxiliary apparatus is contained. The lamp consumes 3·5 amps at 110 volts direct current, or approximately 0·5 watts per candle. The light emitted is highly diffused on account of the great length of tube, and the light source itself is made least offensive to the eyes by a relatively low intrinsic brilliancy.

THE ELECTRICAL INSTALLATION AT THE NEW PUBLIC OFFICES, WHITEHALL

THE large new block of public offices at the southern end of Whitehall, which will be the home of the Local Government Board and the Board of Education, and later of the Board of Trade, is now practically complete, and a description of the lighting installation, which includes over 6,000 lamps, may be of interest. The building is supplied jointly by the Westminster and London Electric Supply Corporations; the former supplies current for power and lighting, and the latter for lighting only. At present about three-fifths of the whole building is built, and this portion is supplied chiefly from the London Electric Supply Company's mains, but when the remaining two-fifths of the building are finished, the lighting load will be about equally divided between the two companies. The scheme provides for two pairs of service cables from each company's mains, at different parts of the building, and there will be four separate main switchboards at these intake points. The Westminster supply is three-wire direct-current, 400 volts across the outers; and each main switchboard is divided into two halves, the 200-volt lighting circuits being balanced on either side of the three-wire system. The London Company's supply is alternating. Two feeders supply two sets, each of three 40 kw. single-phase transformers in parallel, the two sets, as mentioned above, being in different parts of the building. These transformers transform down from the mains pressure of 2,500 volts to the lighting pressure of 200 volts. The transformers are in a fire-proof chamber adjoining the room containing the main switchboard, but the handle of the high-tension oil-break switch projects through a slot in the wall, and so the transformers can be isolated from the high-tension mains or changed over from one pair of cables to the other without entering the transformer chamber. The transformer chambers and main switchboards are situated in the basement proper, and from the four main boards 1,000-ampere flexible rubber cables lead down through openings in the floor to the sub-basement. From the point where the cables leave the main switchboard room, they are carried in 6 in. by 2½ in. iron troughing, built up of sections a few feet in length and covered with a loose iron cover. This troughing is hung from the ceiling of the sub-basement by half-inch iron rods hinged to hooks which are attached to the girders. The troughing is continuous throughout, and the curved portions were cast specially for the work. The cables are lead-covered, paper-insulated, and the joints between these and the short lengths of rubber cable leading down to the sub-basement are enclosed in specially designed sealing boxes, one for each of the two cables, which can easily be disconnected if required. Each sealing box consists of a brass cylinder (iron was not permissible for the alternating-current cables), at each end of which a brass cap is screwed on. One cap is sweated on to the lead-covering of the paper cable, and the other cap contains a gland which makes an oil-tight joint round the rubber cable. The ends of the cores are sweated into lugs, and these are screwed together with a sheet of copper gauze covered with tinfoil between the machined surfaces, and the cylinder is filled with oil. From the 1,000-ampere cables smaller (250-ampere) cables run up to the sub-main boards in the basement. The iron troughing widens out where the cables enter a junction box, to the sides of which the troughing is bolted, the whole forming a continuous conduit. There are about a dozen of these sub-main boards, each containing a double-pole switch, and eight double-pole porcelain enclosed fuses. These boards are let right into the 18 in. wall, and the backs of the boards are accessible from the other side of the wall. From this point onwards the wiring is entirely in ¾ in. galvanised steel seamless conduit. In the basement and sub-basement the wiring is on the surface, but everywhere else it is in special ducts and under the plaster. Where the leads from the sub-main boards enter the conduit, the insulation is protected from the edge of the conduit by "Crystalate" bushes. The main and sub-main boards were supplied by Messrs. Drake & Gorham. The distribution boards, 132 in all, were supplied by the Electric Ordnance Accessories Co., and are 5-ampere way, but only 3 amperes per way is used.

The fittings in the corridors and rooms are all hung on gimbals from the ceiling. The ornamental electroliers in the Council Chamber and in other important rooms were made by the Bromsgrove Guild, but all the other fittings were supplied by Messrs. Verity. Ceiling rose blocks are arranged in the centre of the rooms so that either a single electrolier can be suspended or five separate flexible leads can be brought through ceiling eyes to separate counter-weight lamps. All rooms are well provided with wall-plug sockets, which are flush with the skirting and are not screwed on to the wood blocks sunk in the wall, but are sprung into brass rings attached to the blocks. This gives a much neater appearance. Four handsome standards by the Bromsgrove Guild, supported on marble pillars, serve to illuminate the Grand Staircase leading to the Council Chamber. The lamps are all 200-volt carbon filament lamps, mostly 16 candle-power, a few 8 candle-power lamps being used in the corridors. There are in all over 6,500 lamps; 4,000 of these are counter-weight lights, and there are over 1,000 wall plugs for table lights, &c.

The telephone arrangements, which are being carried

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out entirely by the Post Office, are not yet complete. There will be two exchange rooms in the building, and at night the telephones in several rooms on each floor will admit of direct communication to the hall-porter, so that in case of fire, anyone in any part of the building can inform the hall-porter, who in turn communicates with the fire station and no time is wasted. Of twelve lifts installed, all supplied by Messrs. Waygood, six passenger and goods lifts are hydraulic, as well as an ash lift provided by the Eastern Lift Co. The paper lifts are, however, electrically driven. These lifts, which have push button control, can hoist 1 cwt. at the rate of 120 ft. per minute. Five of the lifts have a rise of 82 ft., and the remaining lift 69 ft. The one horse-power motors are operated off the 200-volt direct-current supply.

All the wiring was designed and carried out by the electrical department of the Office of Works. The lead-covered cables were supplied by Messrs. Siemens Brothers & Co., the smaller cable by the Liverpool Cable Company. The whole of the engineering work of the building has been under the direction of Mr. E. G. Rivers, chief engineer to the Office of Works.

ELECTRICAL SCIENCE

British and American

Directive Wireless Telegraphy.—At the Physical Society meeting on Friday last, E. Bellini and A. Tosi described their system of directive wireless telegraphy and gave some details of a

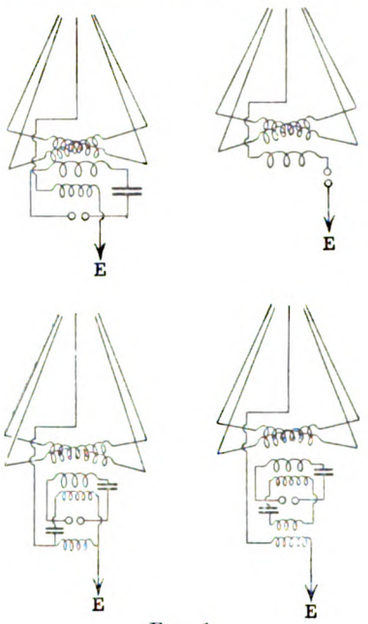


FIG. 1.

further development of their system. The principal methods and apparatus have already been fully detailed in ELECTRICAL ENGINEERING, p. 748, Vol. 2, and p. 348, Vol. 3. They employ two closed radiators, fixed in vertical planes at right angles to one another, and, by means of an apparatus called a radiogonometer, they adjust the phases of the waves emitted by the two closed radiators so that the energy is transmitted principally in one plane. The closed radiators are usually of the convenient form of wire triangles supported from the same mast. In the Physical Society Paper an important improvement on the above-sketched apparatus is recorded. The improvement consists of means for transmitting principally in one direction, and not merely in one plane—that is, the radiated energy is despatched practically wholly towards one side of the sending station, as well as principally in one plane. This improvement is effected by adding a plain vertical aerial wire to the sending aerial system, and by exciting this added aerial just so strongly, and with the right phase relation, as to annul the radiation sent to the one hand by the closed-circuit aerials, and to add to the radiation sent to the other hand by the closed-circuit aerials. The authors have accomplished this by exciting the aerial inductively from the moving coil of the radio-goniometer described in our articles quoted above. This secures the simultaneous excitation of the closed oscillatory circuits and of the vertical antenna, and ensures perfectly uniform excitation of the latter, however the moving coil of the radio-goniometer be rotated. Various arrangements which have been employed are diagrammatically depicted in Fig. 1. In the first of these arrangements the excitations of the two systems are in phase; in the other three cases they are in quadrature. Fig. 2 shows one of many diagrams picturing the distribution of the radiated energy. This diagram was obtained by using the thermo-galvanometer to measure the radiation from the second arrangement shown in the above diagrams. The very small backward radiation here shown may be taken as experimental proof that there is a phase-difference of 90° or thereabouts between the emissions from the closed-circuit and the open-circuit systems. Not only unilateral transmission, but unilateral reception also has been accomplished by the authors in the principles laid down above. In fact, the process of reception is exactly the inverse of the above-described process of transmission. The incoming waves excite oscillations in the closed-circuit aerials and in the vertical aerial simultaneously. By a modified receiving radio-goniometer, these oscillations act on the detector. If the waves come from one side, the effects are added; if from the other, the effects of the two systems are subtracted. It is found necessary to obtain quadrature between the action of the vertical system and that of the closed-circuit system on the detector. This is effected very well by means of the arrangement shown in the diagram of Fig. 3, where *R*, the detector, is in a tuned circuit linked through one inductive coupling with the vertical antenna, and through two inductive couplings with the closed-circuit aerial system.

Self-Induction in an Iron Cylinder Traversed by Alternating Currents.—In the May *Proceedings* of the Royal Society, E. Wilson gives an account of his further experiments on the effects of self-induction in an iron cylinder. The previous experiments (*Roy. Soc. Proc.*, 1906) related to the effects of reversing a continuous current flowing through the cylinder. In the present experiments slowly alternating currents are passed through the cylinder in the direction of its length. The currents were made to alternate in the following manner. A continuous-current dynamo, capable of giving up to 2,000 amperes or more, was weakly excited and its brushes were short-circuited by the cylinder to be experimented on. The brushes were moved by hand round the commutator by aid of a worm and a worm-wheel from the position of maximum to that of zero current, when the field was reversed and the brushes moved back to their initial position. By continuing these operations an alternating current was caused to flow through the cylinder, and its periodic time was controlled by the operator listening to a seconds clock. The current was led into and from the cylinder by massive gun-metal castings. The cylinder was of mild steel 10 in. in diameter and 10 in. long. It was provided with pairs of holes drilled in a plane containing its axis of

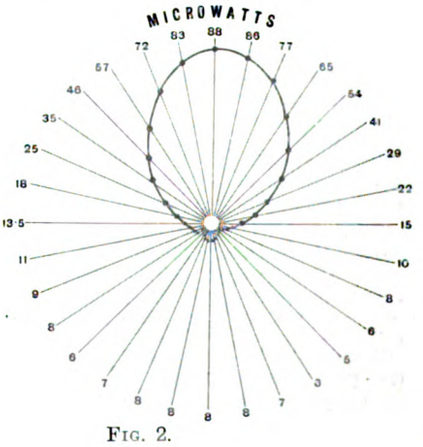


FIG. 2.

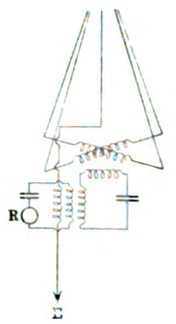


FIG. 3.

figure in such a manner that exploring coils could be threaded to enclose certain portions of that plane. The depths of the holes reckoned radially were 1, 2, and 4 in. The three coils were connected to dead-beat galvanometers. The galvanometer deflections allow the magnitude, the wave form, and the phase-displacement, and the energy dissipated in the cylinder, to be studied. The period of alternation of the current varied from

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six minutes to three-quarters of a minute. One result well brought out is that for a maximum total current of 1,000 amperes the percentage diminution of maximum flux of induction, as the periodic time is varied from 6 to 0·75 minutes, is much greater than in the case of maximum total currents of 500 and 2,000 amperes. For the periodic time 0·75 minute, the shielding effect for maximum total currents of 1,000 amperes is much greater than for currents of 2,000 amperes, an effect which is ultimately connected with the higher average permeability of the iron at the 1,000 amperes maximum. Further, for a given total current, the maximum of the induced E.M.F. occurs later as the frequency is increased. The wave-forms of the E.M.F.'s are very much more peaked for the higher currents and for the longer periodic times. The peaks of the E.M.F. curves cease to be prominent at the high frequencies, but they are retained more with the large total currents than with the small ones. The watts lost in resistance and in hysteresis were separately estimated by the author by methods fully explained in the Paper. It is interesting to note that for a given total current the ratio of the resistance loss to the hysteresis loss diminishes as the frequency increases; the increase in the hysteresis watts due to increased frequency much more than counterbalances the decrease owing to the greater skin effect.

Continental

X-ray Test for Death.—The effectiveness of the Roentgen ray test for death is seriously questioned by M. Ménard in the *Comptes Rendus* for May 25th. Vaillant has maintained that the radiographic aspect of the intestines is decisive for or against death, but some radiographs taken by the author show that the aspect is the same 80 minutes after death as it is 5 minutes after the cessation of respiration, except that some of the convolutions are discernible. The convolutions are all traceable 20 hours after death, but by that time other physical signs usually relied upon have set in. The visibility of the walls of the intestine is not a matter of structure, but simply of thickness. An intestine distended by gas becomes invisible on radiographs because the walls become thinner. This was proved by direct experiments with the intestine after removal from the body. The invisibility of the intestine cannot be attributed to phosphorescence, as that would have no power of penetrating the other tissues.

Parallel Working of Alternators.—M. Dumoulin gives some results of experiments in the parallel working of self-excited alternators in the *Comptes Rendus* for June 1st. Most such alternators are excited by rectified currents, and the exciting E.M.F. depends upon the mean value of the p.d. between the brushes, within limits depending upon the commutation. This mean value varies with the phase, and a displacement of phase produces the effect of a shifting of the brushes, and *vice-versa*. If a self-exciting alternator whose brushes have been shifted, in the sense of the rotation, in advance of the position for maximum E.M.F., is subjected to some kind of perturbation, oscillations will be set up. The alternating p.d. at the brushes will present an increasing retardation of phase with respect to the commutation. This retardation will act practically as a diminution of the forward displacement of the brushes, and will increase the mean rectified E.M.F. The final effect will be diminution of the resisting couple. In the opposite oscillation there will be an increase in the resisting couple, and the oscillations will increase and finally prevent the alternator from working in parallel at all. If, on the other hand, the brushes are shifted in the direction contrary to that of motion, a similar reasoning shows that this condition is particularly favourable to parallel working, since an advance will increase the resisting couple, and a retardation will diminish it. The author gives the equation governing the oscillatory movement described. The energy corresponding to the damping in the second case above considered is absorbed by the network, so that no energy is actually lost. The process described has been successfully tested at the Anzun Mines.

The Iron Arc.—H. Buisson and C. Fabry have found that two distinct types of arc are possible between iron electrodes, and that these two types differ by the aspect of the arc and its electric conditions. Particulars are given in the *Comptes Rendus* for June 1st. In the more usual form, there is a brilliant point on the drop of molten iron on each of the electrodes, and these points emit the "spark" lines. The flame which joins the two points is brightest over the negative pole, and it is this part of the flame which alone shows the lines due to the rarer elements contained in the iron as impurities. The flame as a whole shows the "arc" lines, and none of the "spark" lines. On increasing the resistance in the circuit, but leaving the length of arc and the E.M.F. unchanged, another form appears abruptly. The point over the positive pole disappears, while that over the negative pole remains constant. For the same current strength, the E.M.F. has to be higher in the second form. Thus, for a current strength of one ampere, the E.M.F. is 92 volts for the first form and 117 volts for the second. It is one more evidence of the superior importance of the cathode in arc phenomena. An arc can be obtained between a solid terminal and an electrolyte, but only if the latter is the anode.

SINGLE-PHASE TRACTION MOTORS

Commutation and the Effect of Variations in Voltage

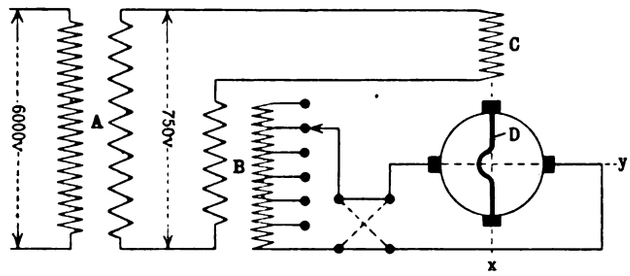
IN an article in a recent issue of *Elektrische Kraftbetriebe und Bahnen*, Dr. W. Reichel discusses the properties of single-phase traction motors particularly with regard to the commutation and to the effect of variations in the line pressure. In enumerating the requirements of a traction motor, the author emphasises the importance of a series characteristic, moderate temperature rise, substantial mechanical construction, freedom of the commutator from damage due to sparking, and low sensitiveness to variations in pressure, especially at starting. Although as regards most of these properties the single-phase commutator motor can be considered as equivalent to the continuous-current motor, there are two respects, however, in which the continuous-current motor is superior to the single-phase commutator motor, that is, with regard to commutation and sensitiveness to variations of pressure. The commutators of good continuous-current traction motors require practically no attention when good carbon brushes are employed, and do not require to be turned or ground until the car on which they are fixed has run some 20,000 to 25,000 miles; indeed, many motors will do even better than this. On the contrary, the commutators of single-phase motors need constant attention, and not only are the costs of supervision thus increased, but the commutators themselves have to be changed much more frequently than is the case with continuous-current motors. It is, therefore, very necessary to improve the commutation of the former type of motor, especially during the starting period. Compensating windings, interpoles, and resistance leads between armature winding and commutator have been successfully used for this purpose. Yet another means of improving the commutation lies in the employment of a lower frequency than is at present usual, say, for example, a frequency of 15 cycles per second. An increase in the capacity of the motor for a given weight and a better power-factor are also obtained, and the latter improvement renders the use of a larger air-gap possible between rotor and stator. Above all, the inductive drop in the transmission line and the extra resistance (due to the skin-effect) of the rails are very considerably reduced. In the face of these advantages, the influence of a reduction of the frequency on the generators and transformers does not seem to be so important. As the main lines operated on the single-phase system will require large amounts of power, the generating units will have a capacity of at least 2,500 h.p. each, and if these are driven by water turbines, the design of 15-cycle alternators will present no difficulty. The turbines would probably run at a speed of between 150 and 300 r.p.m., and a 15-cycle alternator at this speed would require from 12 to 6 poles. Alternators driven at a slower speed by large gas engines would be even easier to design for 15 cycles. If the prime movers are steam turbines, two-pole, 900 r.p.m. generators of from 1,500 to 3,000 kw., or four-pole, 450 r.p.m. generators of from 3,000 to 5,000 kw. would be employed. In cases where the capacity per unit would be less than 2,500 h.p., piston engines running at from 75 to 100 r.p.m., and coupled to 24- to 18-pole generators, could well be used. Where small units are desirable, as, for example, for the power supply to branch or local lines not operated in conjunction with the main lines, the continuous-current system may be preferable. Instances of such cases are the Cologne-Bonn (2,000 volt), and the Düsseldorf-Crefeld continuous-current railways.

The transformers both in the generating and sub-stations and on the trains would be heavier and more costly than those for a 25-cycle system, but not in the ratio of 25 to 15, as the iron could be worked at a much higher density than that allowed at 25 cycles. On the whole, the advantages obtained by the use of a lower frequency for that most vital part of the system, the motors, and also for the transmission, seem of greater importance than the disadvantage of the increase in weight and cost of the generators and transformers. Maintenance of commutators and reduced brush wear are factors of the highest importance in main-line traction, and the question of the employment of a lower frequency deserves more attention on the Continent than is at present devoted to it.

The other property in which the continuous-current motor is superior to the single-phase motor is the less sensitiveness to

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variations in pressure. Thus, if, due to the concentration of the traffic on a portion of the system far removed from the power station, the contact-line pressure were to be reduced to half the normal value, a single-phase motor under certain conditions, for instance, on an incline or on a curve, would not even start. The vector sum of the ohmic and inductive drops in the leads,



A. Main Transformer. *C.* Stator Winding.
B. Series Transformer. *D.* Short-circuited Brushes.

FIG. 1.—DIAGRAM OF CONNECTIONS FOR WINTER-EICHBERG MOTOR.

contacts, transformer, and motor windings would be equal to the applied voltage, and the current would not be sufficient to start the train. A continuous-current motor, on the other hand, with only one-fifth of the normal terminal voltage, would develop a large torque and start the train easily. All single-phase commutator motors have this failing to a greater or less degree. The effect of a drop in line pressure is even more pronounced with three-phase motors. This failing is, however, not so very

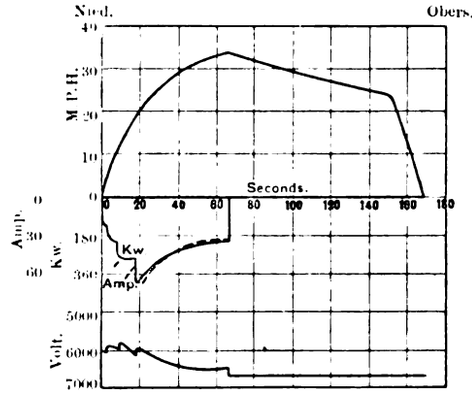


FIG. 2.—SPEED-TIME, KILOWATT-INPUT, CURRENT AND VOLTAGE CURVES ON A TEST RUN BETWEEN NIEDERSCHÖNEWEIDE AND OBERSPREE. LINE PRESSURE, 6,700 VOLTS.

important, as such a large drop as 50 per cent. could hardly occur, especially on a 15-cycle system with over-compounded generators. If such a drop were to occur it would mean that the section of conductor and the number of feeding points had been reduced below the economical limit.

When, as in the case of the A.E.G. Winter-Eichberg motor, a series transformer is also included in the motor circuit, as shown

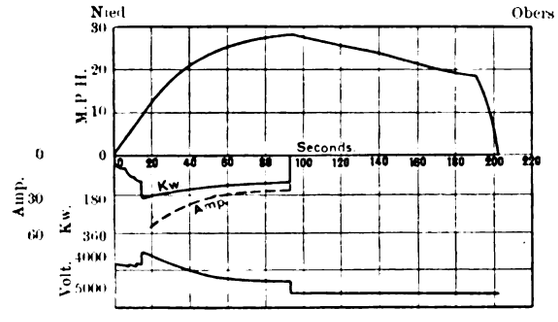


FIG. 3.—SPEED-TIME, KILOWATT-INPUT, CURRENT AND VOLTAGE CURVES ON A TEST RUN BETWEEN NIEDERSCHÖNEWEIDE AND OBERSPREE. LINE PRESSURE, 5,100 VOLTS.

in Fig. 1, one would imagine that the impedance of the transformer winding would further increase the sensitiveness to pressure variation. Actual measurements show, however, that the series transformer has practically no influence, and that the Winter-Eichberg motor suffers no more in this respect than a compensated series or any other type of commutator motor. Fig. 2 shows the result of a test run on a double car equipped with three W.E. 115-h.p. motors, the total weight of the loaded car being 80 tons. This test was made on the Niederschoneweide-Spindlersfeld experimental line, and the double car was similar to those now in use on the Blankenese-Ohlsdorf-Hamburg Railway. The speed-time diagram shown is for the run from Niederschöneweide to Oberspree, where a 20 second stop was made before going on to Spindlersfeld. The car attained a schedule speed of 21 miles per hour over the two and a half mile track, with the one 20-second stop in the middle. Curves showing the power input to the car (as measured at the feeding point at one end of the track), and the amperes input, are

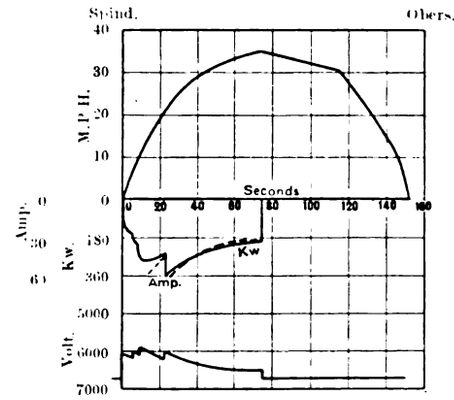


FIG. 4.—SPEED-TIME, KILOWATT-INPUT, CURRENT AND VOLTAGE CURVES ON A TEST RUN BETWEEN SPINDLERSFELD AND OBERSPREE. LINE PRESSURE, 6,700 VOLTS.

given. The lower full line curve shows the line pressure as measured at the feeding point. It will be noticed that at starting the line pressure fell from 6,700 volts to 5,800 volts, or 13·5 per cent. Fig. 3 shows the result of a test made on the same portion of the track, in the same direction and with the same car. The line pressure was only 5,100 volts, and fell at starting to 4,000 volts, or 21·5 per cent. The total fall in pressure, *i.e.*, from 6,700 to 4,000 volts, was over 40 per cent., and yet the run was accomplished at this reduced pressure. The times taken to complete the run being 169 and 202 seconds respectively. Fig. 4 shows similar test results for a run on that portion of the track between Spindlersfeld and Oberspree, at the line pressure of 6,700 volts. The same run at the lower pressure of 5,100 volts is shown in Fig. 5. The times taken to complete the run were 151 and 180 seconds respectively. With regard to the effect of the pressure drop on the starting torque, the following figures are of interest:—With

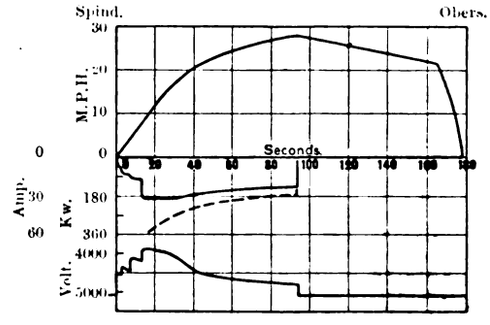


FIG. 5.—SPEED-TIME, KILOWATT-INPUT, CURRENT AND VOLTAGE CURVES ON A TEST RUN BETWEEN SPINDERSFELD AND OBERSPREE. LINE PRESSURE, 5,100 VOLTS.

the full pressure of 6,000 volts, a total draw-bar pull of 5,750 kg. for the test car was obtained on the second stop of the controller at starting. With the same car and a line pressure of 4,000 volts, or 34 per cent. below the normal, a starting draw-bar pull of 5,600 kg. was obtained on the fourth stop of the controller, or a pull of 70 kg. per ton for an 80-ton car. The upper limit of the pressure during the tests was about 6,700 volts, so a drop in voltage of nearly 40 per cent. can apparently be permitted without seriously affecting the operation of the motors. Thus, concludes Dr. Reichel, in respect of sensitiveness to variations of pressure, the single-phase motor may be considered to be practically as satisfactory as the continuous-current motor.

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ELECTRIC TRACTION ON THE MIDLAND RAILWAY

Single-phase Equipment of the Heysham, Morecambe, and Lancaster Lines

Rolling Stock

As mentioned in our last issue, the electrically equipped rolling stock at present consists of three trains, two with equipments of Messrs. Siemens Brothers Dynamo Works, Ltd., and one equipped by the British Westinghouse Co. There are three motor coaches and four special trailers provided with driving gear at both ends, but the train can, of course, be made up to any length by means of the company's ordinary passenger stock.

The motor cars are of the open central corridor type, and have a total length over end panels of 60 ft., and an extreme width of 9 ft.; there are three compartments with a total seating capacity of 72 passengers, the vestibule compartment at each end being reserved for the accommodation of driver and guard. Of the passenger compartments, the middle one with a length of 25 ft. has the seats arranged transversely, while the other two compartments, each 13 ft. 5 in. long, have longitudinal seats to allow of trap doors in the floor for easy access to the motors, &c.; hand straps have been provided throughout all the vehicles for safety and support of passengers whilst standing, and when entering or leaving. Efficient ventilation is provided by means of drop lights in the upper part of the side windows, and "torpedo" air extractors in the roof. The rolling stock has been built by the Midland Railway Company in their carriage and wagon shops at Derby, to the designs of Mr. D. Bain. The lighting of the cars is from the power current throughout; the motor cars are also electrically heated from the same source, but the trailers have not yet been fitted with heaters, as their extensive use during the winter months is not anticipated. The interior finishing and decorating has been carried out with regard to facility in keeping the cars clean; the roof is covered with millboard and painted white; the cabinet work is of polished oak, and the seats are covered with perforated sycamore. The underframe is constructed of Z and channel section steel, with angle knees and gusset plates, and well supported with truss rods to sustain the electrical equipment. The trailing bogie is of the Midland Railway Company's standard type, composed of pressed steel members. The wheel base is 8 ft., and the wheels are 3 ft. 7½ in. diameter on tread. All the cars are fitted with both hand and power brakes, under easy control of the driver, who can work at either end of the vehicle, of both motor cars and trailers; the power brake is of the vacuum type obtained by pumps driven from independent motors, and each trailing bogie wheel is braked on both sides.

The trailer cars have a length over end panels of 43 ft., and extreme width of 9 ft.; they consist of one long compartment with a driver's vestibule at each end. The seats are placed transversely throughout, and will accommodate 56 passengers. The interior finish, ventilation, and lighting is similar to that of the motor cars. The underframing is of light construction, as it has no electrical equipment to sustain; but the two bogies are interchangeable with the trailing bogie of the motor car, with the exception of the springs, which are of lighter construction.

The motor bogies were constructed by the Company's Locomotive Department, and owing to the small number required have been specially built up of rolled sections and plates. The axles are of forged steel 6¼ in. diameter parallel between the wheels and reduced to 4¾ in. in the axle bearing, the length of the journal being 9 in. The wheel base is 8 ft. 6 in., and the driving wheels are 3 ft. 7½ in. diameter on the tread when new. As only a few cast steel wheels were required an existing tender wheel pattern was made use of for the wheel centre, and consequently the wheels are considerably heavier than is really necessary. The centres are of cast steel, and the tyres of mild steel ordinary rolled tyre section; in fact, the wheels are practically standard tender wheels. The tyres are 5¼ in. wide, and are shrunk on the centre and held by screws through its rim. The steel side frames are of rolled joist section 14 in. by 6 in., the end frame being 10 in. by 4 in. channels, and the transom, or centre cross frame, being built up of plates and angles. It is of box section, the bolster lying inside between the webs. The top plate and gussets on both sides of the centre pin are in this case in one complete piece slotted out of the solid. The bottom plates are as usual in two pieces, one each side of the centre, the gusset plate being combined with the cross flange in this case also.

Owing to the necessary length of bolster being too great to get in between the flanges of the side frames, a certain amount had to be cut from the inside of the top flanges of these, and as this necessitated doubling plates on the top of these flanges and their combination with the top flanges of the centre cross-frame, the making of the top plate in one piece as above described followed naturally; incidentally this construction gives a very stiff and rigid backbone to the bogie. The swinging bolster is of pressed steel, and is similar to that of the trailing bogie, except for the heavier springs.

The axle-boxes are of a special pattern built for these bogies, though they are very similar to the standard carriage axle-boxes suitably altered to act as driving boxes. The brasses, which are white-metalled, subtend a slightly larger angle than the usual carriage brass, being about the same angle as locomotive brasses. Lubrication is effected entirely from a pad at the bottom supplied from the usual oil well, the brasses being well chamfered away at each side so as to ensure an ample feed of oil into the journal and its formation into a proper lubricating film. The top of the box casting forms a seating for the ordinary laminated steel bearing springs. The horn blocks are cast steel, bolted with the usual fitted bolts to the framing. The brakes, as is usual in electric motor trucks, act only on one side of the wheels, lack of space making it impossible to adopt the standard railway practice of two brake blocks per wheel. The blocks are hung from brackets on the bogie end frames, and are actuated by levers connected to bars running lengthwise under the inside top flange of the side frames. An arc-shaped cross bar connects these bars together, and is coupled to the brake pull rod through a shackle and roller arrangement, which allows for the swivelling of the bogie on curves without affecting the brake gear adjustment. The weight of the whole bogie is 6½ tons, the extra weight of the wheels, however, accounting for about 1 ton of this.

Before going on to deal with the actual driving equipment of the cars the other accessory apparatus, which may be of interest, may be shortly described. Each motor car has two brake cylinders, that for the motor bogie having special levers giving the cylinder greater purchase than usual. The trailer cars have only a single brake cylinder, operating brakes on both bogies. The vacuum is obtained from a Gresham & Craven vacuum pump supplied through the electrical equipment contractors, by the Vacuum Brake Com-

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pany. The pump is motor driven with a worm speed reduction running in an oil bath. A single brake pump is used on each motor car.

The control gear for the pumps is arranged so as to give a high speed and a low speed, the latter being a quarter of the higher. The pump runs at the low speed throughout the operation of the train, and whether the brakes are being applied or not, excepting when put on to the high speed in order to take off the brakes rapidly. The action thus corresponds exactly with the operation of the large and small ejectors on a locomotive.

The pump control gear has been specially arranged with a view to making it practically impossible for a train to be moved without proper vacuum having first

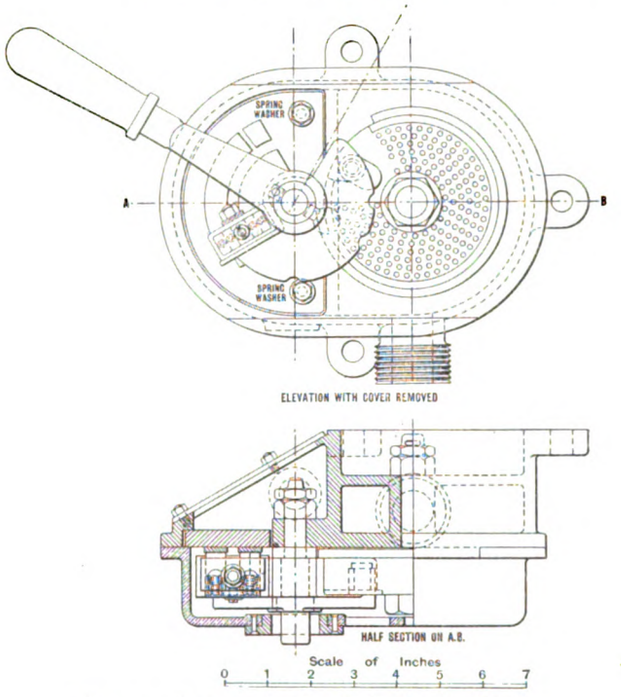


FIG. 1.—DETAILS OF DRIVER'S BRAKE VALVE.

been obtained, as follows:—The driver's brake valve is of special construction, as shown in Fig. 1, and is combined with a switch which operates the contactors controlling the pump. Current is fed up to this switch through one contact of a three-way plug, of which one of the remaining contacts is the feed wire from the auxiliary transformer, and the third goes to the master controller; it is, therefore, impossible to move the car by means of any of the controllers unless this plug is inserted, and its insertion automatically operates one of the pump contactors and starts it working at either the high or the low speed; most probably the former, as the driver's brake valve handle is removable but can only be removed in full pump speed position. The use of this plug also ensures that only one controller throughout the train can be used at a time. There is, of course, a driver's brake valve in every driving compartment, but it will be clear that only the valve and switch in that compartment which is being used for driving and in which the driving feed plug is inserted is operative for starting and varying the speed of the pump, but the brake can be *applied* by the guard or other authorised person who is in possession of a handle at either end of every coach. There is also fitted to each motor car an additional switch controlled by the vacuum which will trip the main circuit breaker in the event of the vacuum falling below about 15 in., this being decided upon principally in connection with emergency applications of the brake by a guard, who will thus be given full control over the train, an advantage, seeing that there is only one motor man. This switch also ensures that motor men cannot start the train before taking off their brakes.

A horn, which takes the place of a locomotive steam whistle, is carried on each end of each motor car, and is electrically operated, the sound being produced by the vibration of a diaphragm by means of apparatus similar, but of greater power and more substantial construction, to the ordinary trembling bell, a surprisingly loud and clear note being obtained in this way. The sound is multiplied considerably by use of properly designed trumpets obtained from Messrs. Boosey & Co., and a very satisfactory sound is produced at an expenditure of far less power and much less complication than would be the case with a vacuum operated horn; in fact, the electric horn compares well with a horn operated by compressed air, which was not available on these cars. The vibrators were supplied by Messrs. Marples, Leach & Co., and are operated by a small 12-volt set of secondary batteries, the train wire for operating them being carried through the train in the ordinary train cable and through the jumpers.

The lighting is carried out by groups of six 24-volt lamps in series from the 150-volt auxiliary transformer control main. The two side tail lights, however, which are electric, are each direct on the 150-volt mains, the lamps being carried inside ordinary tail lamp lanterns, which are detachable and carry an ordinary watertight plug, the socket being fixed on the end of the coach, just above the lamp-iron. Lamp-irons, plugs, and plug sockets are provided at each end of each coach. The lamp in the driver's compartment is specially shaded so as to throw only a narrow beam of light on the vacuum gauge and ammeter, thus allowing the driver to get a good view of the road outside, his compartment being practically dark. The shade is arranged so as to be opened when occupied as a guard's and luggage compartment, or as an entrance vestibule.

The window on the left or near side of the train is that through which the driver views the road and, in order to clear the outside of this window from snow and rain, a special scraper has been arranged with a handle inside the compartment so that by throwing this handle up and down the window is cleared. The scraper consists of a squeegee made of flat rubber on edge.

The specification of the driving equipments called for two motors per car, both to be carried on one bogie, as it was considered both the more economical and the more mechanical arrangement to concentrate the motor power and reduce the number of parts as much as possible, while with single-phase traction and voltage step control there is, of course, no necessity to consider series paralleling. The normal train was specified to consist of a motor car and two trailers, the weight of these being, without any of the electric apparatus or the mountings for the same, 25 tons for the motor car, and 17½ tons for each of the trailers. The motor car seats 72 passengers and the trailers 54, the respective standing capacity being 58 and 36, giving a total maximum capacity without encroaching on the vestibules of 310, with a total of 180 seats.

It was specified to the contractors that they would be permitted to run at 25 miles per hour round the speed-restricted curves, and on this basis the trains were to be capable of working a 20-minute service from either end as between Heysham and Morecambe with a single train, and a 15-minute service as between Morecambe and Lancaster under similar conditions. The capacity of the motor car was to be such as to enable it to take on occasions two additional main line coaches weighing 26 tons each, and it was also to be capable of climbing with its train the gradient from Lancaster Green Ayre to Lancaster Castle occasionally.

The specification also called upon the contractors, should the order for the coaches be divided, to make

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their equipments capable of being worked from the same master controllers, and though considerable difficulty had to be got over in order to meet this condition it was found possible to work the Siemens all-electric equipments in conjunction with the Westinghouse

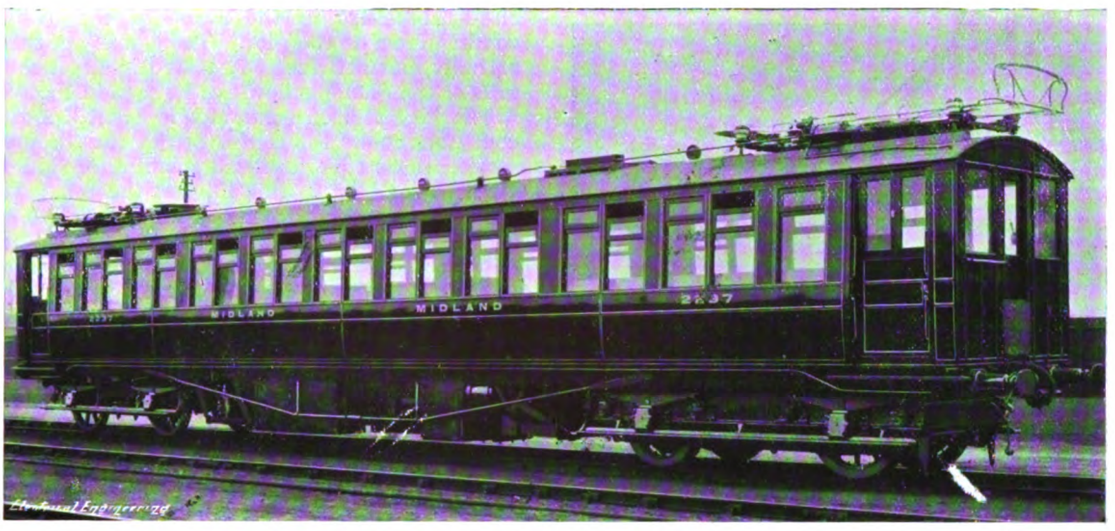


FIG. 2.—SIEMENS CAR COMPLETE.

electro-pneumatic equipment in this way. It was considered by the railway company that two 150 h.p. motors per motor coach would satisfactorily carry out the work, and the respective contractors supplied motors of their nearest standard sizes to this, the Siemens motors being nominally of 180 h.p., and the Westinghouse motors of 150 h.p. The specification called for the motors being capable of delivering, when tested on the stand with single-phase alternating current

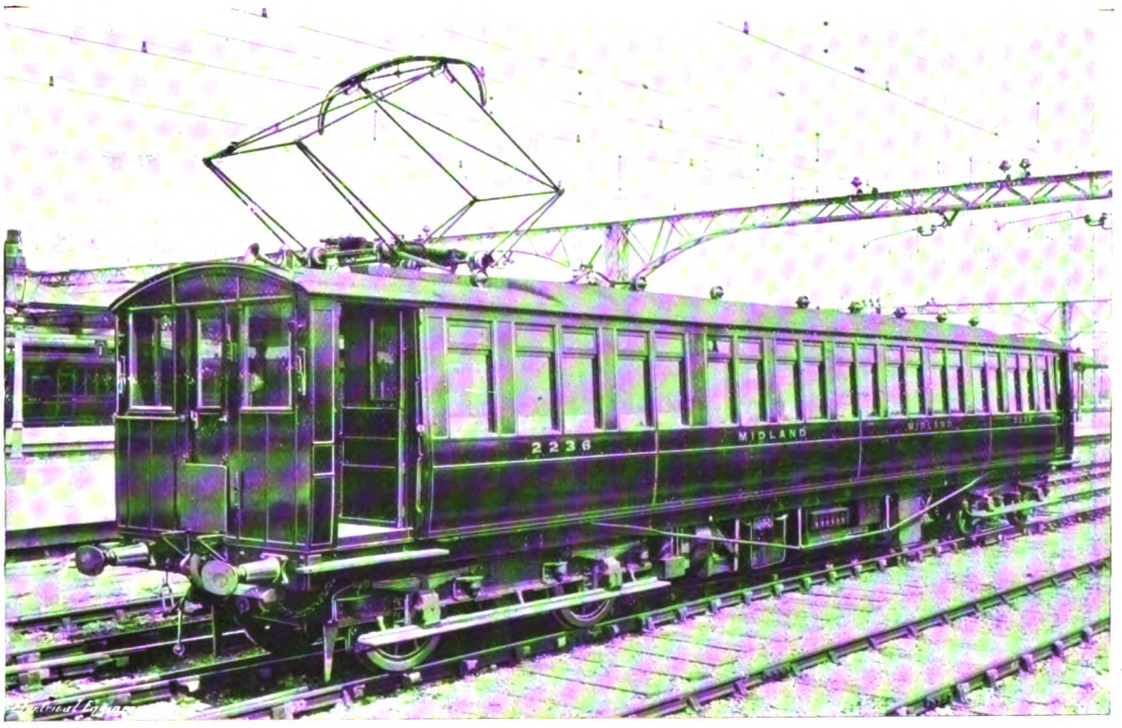


FIG. 3.—WESTINGHOUSE CAR COMPLETE.

of the proper periodicity, their declared output for one hour with a temperature rise not exceeding 135° F., and they were also required to have a temperature rise not exceeding 90° F. on any portion after having run the three-coach train for six double trips as per the schedule above mentioned from Heysham to Morecambe, Morecambe to Lancaster, and return. Overload and other similar tests were also specified.

The control gear was specified to be preferably all-electric multiple unit type. The Westinghouse car has, however, been accepted, with their standard electro-pneumatic control modified as necessary to enable it to work with the Siemens car which is all-electric. Stringent guarantees of efficiency, energy consumption in watt hours per ton mile, and general performance were required to be given. The main transformer was required to conform to the same test conditions for heating as the motors, an auxiliary transformer being specified to provide for the supply of current for lighting, heating, and working the control apparatus and brake pump, this transformer having a three-hour test specified, it being subject to continuous working. A view of one of the Siemens cars is given in Fig. 2, and of the Westinghouse car in Fig. 3.

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The Siemens cars are provided with two collector bows, it being considered by the firm best to ensure continuous contact as far as possible. It was found impossible to get the firm's standard inverted pantagraph bow into the restricted space at disposal between

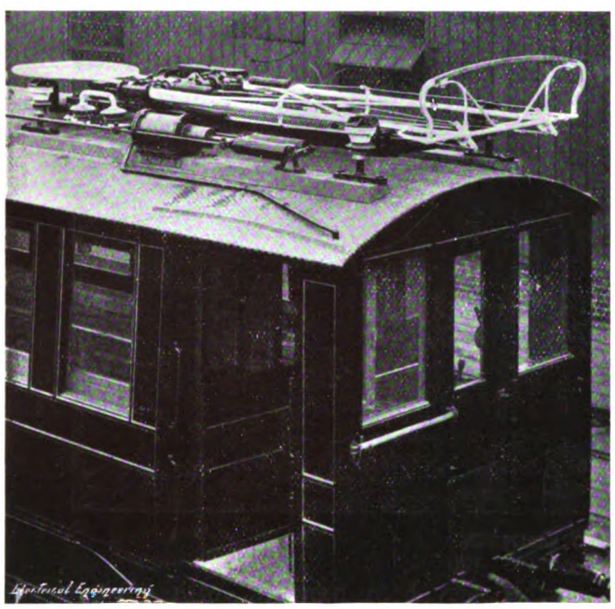


FIG. 4.—END OF SIEMENS CAR, SHOWING COLLECTOR AND WIRE NETTING ON ROOF.

the coach roof and over-bridges, and a type of bow has been adopted somewhat similar to the Continental tramway type of bow, but having a small auxiliary bow at the end controlled by parallel motion. This bow, while appearing somewhat simpler than the standard bow, and requiring less room, has the disadvantage that it requires balancing by a wind screen. Both makers' bows are purely spring controlled so far as their working is concerned; the Siemens bow, however, is lowered by a master spring which can be thrown out of action by a vacuum cylinder. The two Siemens bows can be raised or lowered separately, and the vacuum for holding them up is obtained from the train pipe through a ball valve, so that when the brakes are operated the vacuum remains on the bows. All the "live" portions of the collector gear in each case are carried on porcelain insulators. It may be mentioned in connection with the collector gear that the roofs of all the coaches have been covered with an "earthed" wire netting, so as to throw out the station circuit breakers in the event of the overhead wire coming down on the roof. The efficacy of this has been actually and satisfactorily tested in practice. The details of the Siemens bow can be seen in Fig. 4.

The high-tension conductor is carried down from the collectors about the centre of the car through a heavy section brass tube, the lead covering of the cable being sweated solid on to this tube at the top. The further high-tension wiring to the two transformers on this car is also in lead-covered cable, which again in its turn is protected in metal tubing. These cables are rubber insulated. Except for the short length down through the coach the high-tension wiring on the Siemens car is, from the bow down through the high-tension chamber to the main transformer, all bare wire, being carried on porcelain insulators on the coach roof and underneath the coach. The vertical tube through the coach itself is of brass, and in this case made removable, being practically part of the wiring. The cable is paper insulated, lead-covered, terminating above and below in bitumen sealing chambers with porcelain insulator terminations. There is about 3-16ths of an inch air space between the lead covering and the inside of the tube. Both lead covering and tube are heavily "earthed."

On the Siemens cars the high-tension wire proceeds into the high-tension chamber, shown in Fig. 5 the door of which is mechanically interlocked with the bows so that it cannot be opened unless the bows are down.

The low-tension wiring does not call for much description. Longitudinally it is carried between the two girders forming the centre members of the under-

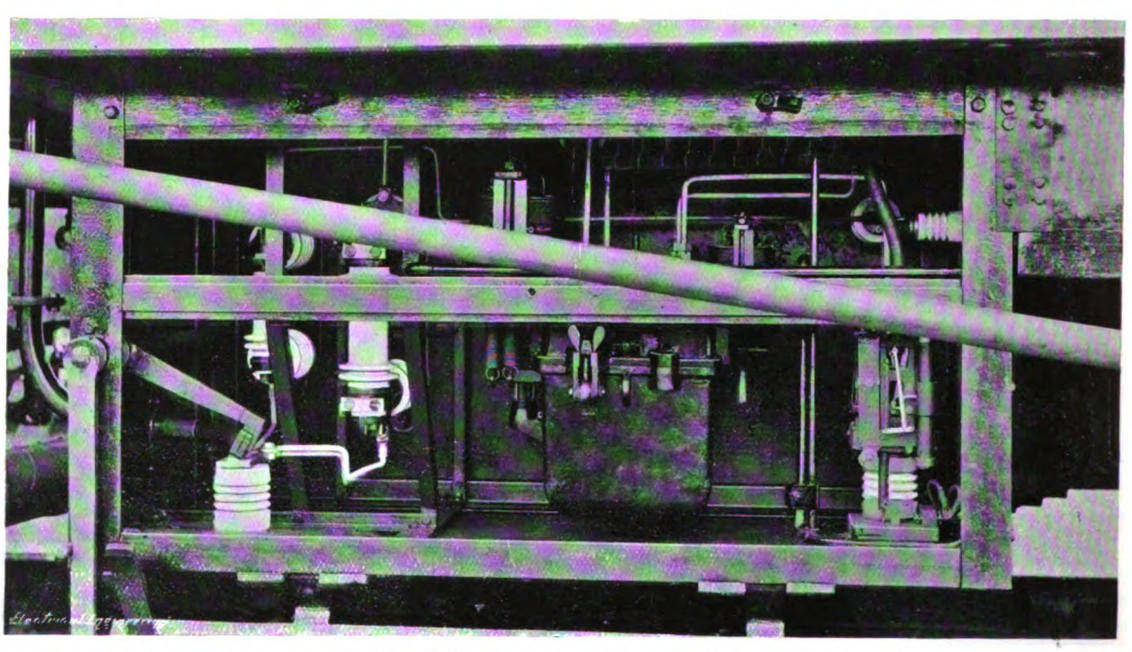


FIG. 5.—H.-T. CHAMBER ON SIEMENS CAR, OPEN.

frame, and it is supported between these two members in wooden frames spaced about 18 inches apart. The low-tension cables themselves are not carried in metal tubing, as probably eddy current troubles would arise if they were, but they are substantially surrounded with metal, and the coach body and its frames are all covered with sheet iron and asbestos wherever cables are run underneath. Where these cables require to go crosswise they are carried between the tops of the girders

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and the floor and spread out fanwise. The train cable is carried along the outside of the coach alongside the sole-bar in a metal tube, being carried round the bends in flexible metallic tubing. The train cable, couplers, and master controllers, for the whole of the motor cars, and trailers, as well as all the pump motors and their control gear have been supplied by Messrs. Siemens. The high-tension apparatus and contactors are contained in sheet-iron cases, which have been made by the railway company. The supporting of these and of the transformers, auxiliary transformer, preventive coil, and other apparatus has involved the provision of a good deal of special girder work on the underframe, which has added considerably to the weight of the latter, and which, as the coach had to be proceeded with before the final details of the electric equipments could be decided upon, could be considerably lightened in a future case.

The Siemens equipment consists of the two motors, the main transformer, the auxiliary transformer, preventive coil, and commutating transformer, high-tension circuit breaker and fuse in the main transformer circuit, high-tension fuse in the auxiliary transformer circuit, contactors, motor fuses which also act as motor cut-outs, and low-tension fuses in the circuit feeding the control, and also a low-tension fuse in the circuit feeding the fan.

There is intentionally no fuse placed in the brake pump main circuits, the cables for which are carried in special heavy section tubing, so that if anything goes wrong on the pumps the main high-tension fuse will be blown, and it will be impossible to work the car.

A full description of the working of the Siemens single-phase traction motor was given in ELECTRICAL ENGINEERING, Vol. II., page 367, and details of the construction of the motors actually employed on the Midland Railway are given in Fig. 6.

The apparatus was very stringently tested at the makers' works. At 180 h.p., and with forced draught, the motors were very much under their guaranteed temperature rise, and did not exceed this temperature rise when tested at this h.p., with natural ventilation on the stand. With forced draught, and with only 300 volts on their terminals (the full voltage being 340), they tested under the specified temperature rise at 200 h.p., corresponding at full voltage to fully 225 h.p. They were also tested for continuous operation giving at 250 volts, which was chosen as being a mean operating voltage, 105 h.p., for five hours with a temperature rise of only 115° F., so that at full voltage, allowing nothing for the improved ventilation at the higher speed, the machine can give continuously nearly 150 h.p. The sparking tests were equally satisfactory, there being no objectionable sparking at a current of 1,100 amps., at 300 volts, which corresponds at full voltage to 350 h.p., and a torque of fully 2½ times that at the rated h.p. of 180. The commutating transformer, while apparently an additional complication, probably pays its way in effectiveness, as we understand that the sparking of these Siemens' motors, both on test and during actual running on the line, has proved to be quite as good as that of any, and better than that of many D.C. traction motors; in fact, during the testing on the line, currents of over 1,000 amps. per motor have been of frequent application without any demonstration at the commutators, even just at starting, the brushes on the latter portion of the acceleration, and during free running, being absolutely dark.

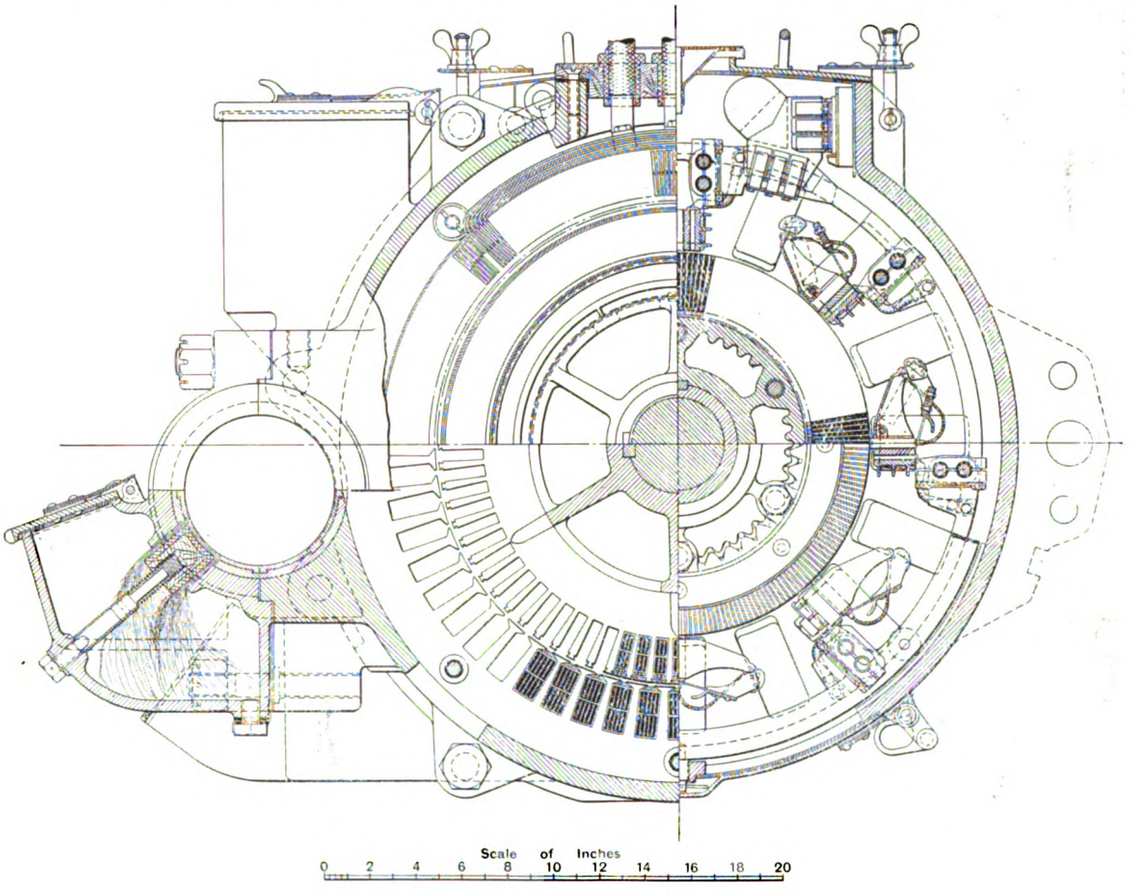


FIG. 6.—SECTION OF SIEMENS MOTOR.

The position of the various items of the control equipment under the car is shown in Fig. 7. On the left is the high-tension chamber, and the transformers are seen in corrugated cases between this and the case containing the contactors. The high-tension transformer windings are of copper wire, and the low

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voltage windings of copper strip wound on edge. All the windings are divided into a number of parts, mounted alternately, in order to reduce the stray field. The various taps on the secondary coil are connected to the contactors. Space is left between the core and the windings for the free circulation of the cooling oil

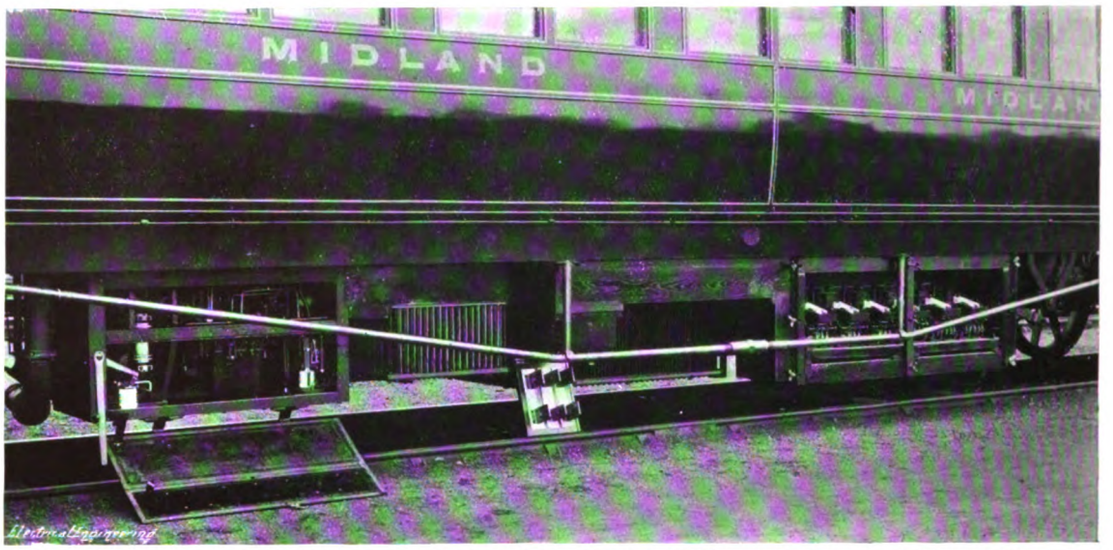


FIG. 7.—APPARATUS ON UNDERFRAME OF SIEMENS CAR, SHOWING H.-T. AND CONTACTOR CHAMBERS OPEN.

contained in the high-tension chamber. The main switch consists of an electrically worked oil-switch. It has four contact fingers mounted on a spindle, two of the fingers being longer than the other two; the circuit is made and broken therefore in two steps. The first step closes the circuit through a damping resistance which prevents a sudden rush of current into the transformer. The second step short-circuits this resistance. It is not necessary to pause on the first step; the arrangement works satisfactorily however quickly the switch is closed. The switch is held in its closed position against the action of a spring by means of an electro-magnet which loses its current when the master controller is moved to the "off" position.

The master controller consists of two barrels, one for controlling the speed, the other for reversing. The contact fingers pressing on the barrels are connected to the contactors and to the secondary windings of the auxiliary transformer. The main controller barrel is moved against a spiral spring and held in any working position by means of a catch on the driver's handle, which is depressed into a notch by the weight of the driver's hand. The main barrel is divided into two parts, the lower part being rigidly connected to the driver's handle and the upper part being carried with it by means of a projecting catch. The relative motion of the two parts opens a switch in the control circuit. The high voltage main switch can only be closed in the first position. The main barrel and the reversing barrel are interlocked in the usual manner.

The contactors are operated by electro-magnets. The magnet core consists of laminated plates. Part of one of the magnet poles is surrounded by a short-circuit winding producing an auxiliary field which prevents vibration. The switch has several contacts arranged side by side, only one of which is used for actually breaking the circuit; this contact has a magnetic blow out. In order to maintain a good electrical contact, the switch is so designed that the contact pieces, after meeting, have a rubbing motion.

The contactors are mechanically interlocked so as to prevent the possibility of wrong connections. The



FIG. 8.—APPARATUS ON UNDERFRAME OF WESTINGHOUSE CAR SHOWING TRANSFORMERS, CONTACTORS, &C.

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interlocking levers have the further advantage that if any contactor should accidentally remain closed, the closing of the next contactor will open it. These con-

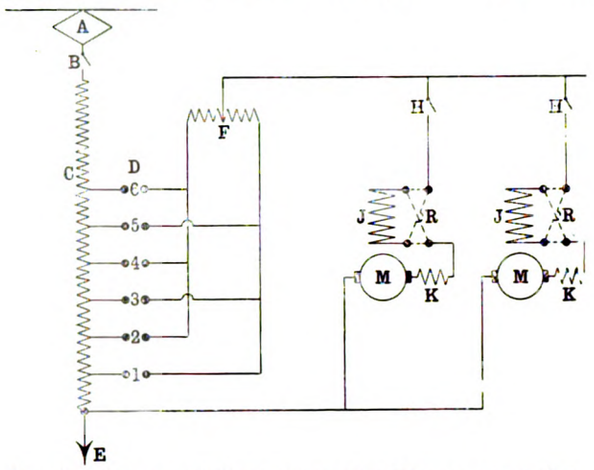


FIG. 9.—DIAGRAM OF CONNECTIONS FOR WESTINGHOUSE CAR.

tactors differ from others in having no auxiliary contacts.

We are informed that the working of the contactors has proved quite satisfactory, and gives none of the trouble that has been prophesied in various quarters for single-phase contactors in the direction of humming and chattering, excessive size, &c., though they are more liberally designed than will probably be adhered to as standard practice.

It will be noticed that the feature of the master controllers is the fly-back or dead-man handle type, being somewhat different from the usual design, inasmuch as the release of forward pressure on the handle by the driver trips the whole of the contactors at once, no matter on what stop the driver may be working at the moment, and without his allowing the handle to come back to the "off" position. This practically ensures the obtaining of the maximum amount of safety that can be obtained from a handle of this type, though the occasional sudden throwing off of heavy loads in this way is a somewhat severe tax on the regulating properties of the power station.

The electrical equipment of the Westinghouse car consists of two 150 h.p. motors, a main transformer, an auxiliary transformer for the lighting and control circuit, collector, circuit-breaker, compressor, contactors, and control gear. The pantagraph bow collector is of the standard Westinghouse pattern. The collecting surface is held up against the overhead wire by spring pressure acting on the supporting frame, and is lowered by an air cylinder at the base of the apparatus. A small hand pump is supplied for raising the bow when first starting out in the morning, or at similar times when no compressed air or vacuum is available. From the collector, the current is carried to the main circuit-breaker through a lead-covered rubber insulated cable, which is further protected by being led through a heavy brass conduit. The circuit-breaker, which can be seen on the extreme right of Fig. 8, is electro-pneumatically operated, and breaks contact under oil. It opens automatically on overload, and is closed again from the driver's cabin by moving the master controller to the first notch. The current then passes to the high-tension end of the oil-insulated self-cooling auto-transformer, the other end of the winding of the transformer being earthed. This transformer, the corrugated case of which is shown in Fig. 8, has a continuous capacity of about 150 k.v.a. The oil tank can be readily lowered away from the transformer, when it is necessary to inspect the latter.

The contactor group, shown in the middle of Fig. 8, measures only 43¼ in. by 24½ in. by 23 in., and weighs 845 lb. The switches are provided with electric interlocks, which ensure their closing in the proper sequence. From the electro-pneumatic switch group the current passes to the two terminals of the preventive coil, from the centre point of which the lead to the reverser is taken. The reverser is of the drum type, and is electro-pneumatically operated. The magnet valves on the reverser are interlocked with those on the main switch group, so that it is impossible to close any of the switches in the latter until the reverser is set in the right position. Cut-out switches are fitted in the reverser case, so that either of the two motors may be disconnected if desired. A diagram of connections for the two-motor equipment is shown in Fig. 9. In this diagram *A* is the pantagraph collector, *B* the circuit-breaker, and *C* the main auto-transformer. The six tappings on the transformer are connected to the corresponding six contactor switches *D*, which are also connected to the preventive coil *F*. This coil, which bridges across the sections of the transformer winding, is highly inductive, and consequently only small wattless currents flow in the local circuits. The load current is taken off from the centre of the coil, and thus, as this current flows in opposite directions in the two halves, the resultant inductive effect is zero. With the aid of this coil, the voltage across the motors is gradually increased without either breaking the circuit or shorting any section of the transformer. In the motor circuits, *H* represents the isolating switch, *J* the main field winding, *R* the reversing drum, *K* the compensating winding, and *M* the motor armature. The usual practice of the Westinghouse Company is to have only one transformer, from which tappings are taken off for the lighting and control circuits as well as for

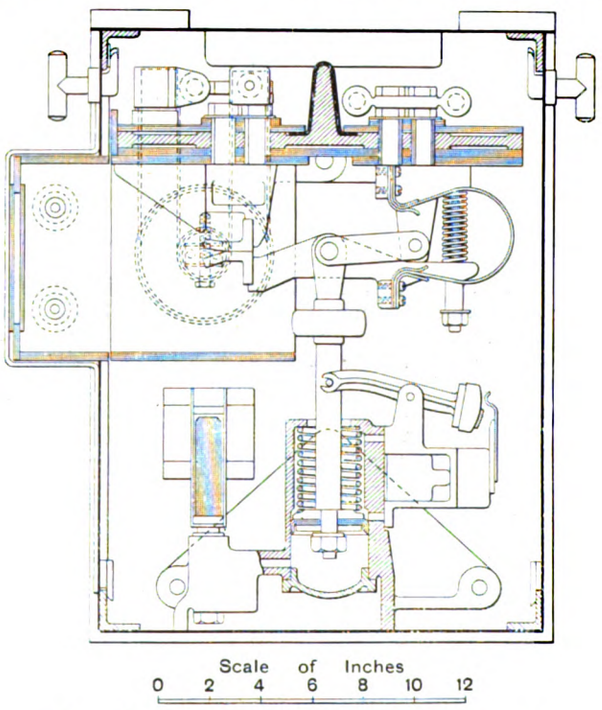


FIG. 10.—SECTION OF WESTINGHOUSE CONTACTOR.

the motor circuit. In the equipment under consideration, however, a separate auxiliary transformer is used for the former purposes. This transformer, which can be seen to the right of the contactors in Fig. 8, supplies the lighting circuit and the control circuit at 150 volts. The Westinghouse system of electro-pneumatic control was fully described in ELECTRICAL ENGINEERING, Vol. I., page 593, and both the continuous-current and single-phase systems were dealt with. The diagram of connections for the single-phase systems given on page 596 of that description repre-

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sents the connections employed for the present equipment with the exception that the latter is a two and not a four motor equipment, and the lighting and control circuits are shown in that diagram as being supplied from the main transformer, whereas they are supplied from the auxiliary transformer in the present case. Fig. 10 shows a cross-section of one of the unit

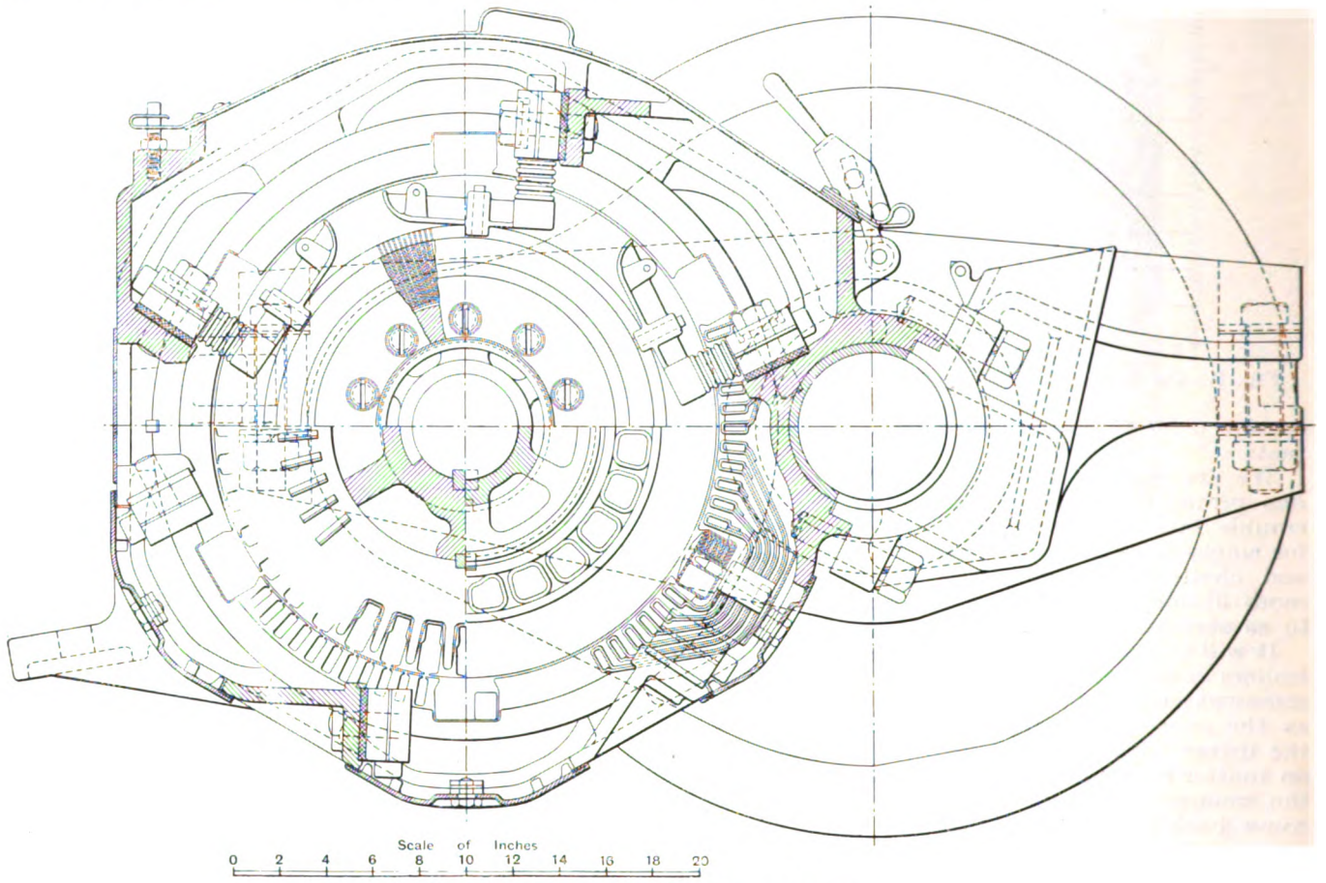


FIG. 11.—SECTION OF WESTINGHOUSE MOTOR.

switches or contactors forming the group illustrated in Fig. 8. It will be seen from the former figure that each switch-arm makes and breaks contact in a powerful magnetic field. Air is admitted to and released from the air cylinder by a small pin valve actuated by an electro-magnet. In order that the Westinghouse car should be capable of being worked in combination with the Siemens cars, it was necessary to operate the Westinghouse electro-pneumatic control circuit at the same pressure as the Siemens solenoid control circuit, viz., 150 volts instead of 50 volts; and furthermore, as the Siemens solenoids take a large current in comparison to the solenoid valves used in the Westinghouse system, the master controllers installed on the Westinghouse car had to be somewhat larger than usual.

The motors are of the Westinghouse Company's standard series compensated type arranged for forced ventilation. A cross section is given in Fig. 11, from which it will be seen that the motor has six poles and six sets of brushes. The field core is made up of laminations having six inwardly projecting poles, and is enclosed in a cast steel shell. Each pole is surrounded by a former wound field coil, which can be readily removed if required. Semi-closed slots in the pole faces are provided for carrying the compensating winding which is connected in series with the armature. Air is admitted to the motor for forced ventilation at openings over the pinion end and passes through the motor and out through the perforated commutator cover. This method of cooling the motors, which was first introduced by the Westinghouse Company on the Metropolitan Railway, has proved very effective in service, and materially increases the capacity of the machine. With the construction adopted by the Westinghouse Company it is not necessary to have any complicated system of forced lubrication; both the armatures and axle bearings on this motor are equipped with simple oil and pad lubrication.

The above equipment was designed for operating in regular service a train weighing 82 tons, including passengers, but has shown itself capable of dealing with much heavier trains than this. A train made up of seven ordinary vehicles and this motor car, giving a total weight of 161 tons, has been run between Lan-

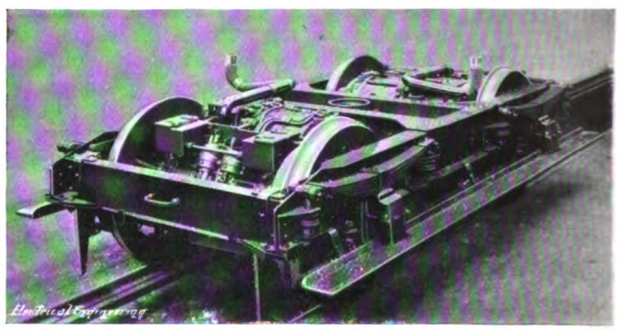


FIG. 12.—COMPLETE MOTOR BOGIE.

caster and Morecambe. On starting with this load each motor takes about 1,050 amps., and this current is commutated quite satisfactorily without the motor showing any signs of distress. The train accelerated rapidly and smoothly, reaching a maximum speed of about 50 miles an hour. A view of one of the motor bogies, which are similar in appearance in both makes of car, is given in Fig. 12.

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The respective weights of the two motor coaches are as follows:—

	Siemens.			Westinghouse.		
	Tons.	Cwts.	Qrs.	Tons.	Cwts.	Qrs.
Carriage body work	13	5	0	13	5	0
Carriage bogie	4	10	0	4	10	0
Special supports	1	6	0		17	0
Motors with gear and gear case	6	5	0	5	11	0
Main transformer	2	14	2	2	11	0
Aux. com. transformer and preventive coil		19	2		9	2
Pumps and compressors ...		9	2		16	0
Contactors and chambers	1	2	2		9	3
Other sundries, including bows, blowers, controllers, &c. ...	3	7	0	2	9	3
Motor bogie...	6	11	0	6	11	0
	40	10	0	37	10	0

The forced ventilation for the motors of both sets of cars has been fairly simple to arrange. For the Siemens car the suction duct has been carried inside the car under one of the seats, the whole of the air coming in this case from the inside of the car. The Westinghouse car has a similar duct inside, but as more air is required for their motors they have also a suction duct with a filter taking air from the outside of the car. In both cases this duct comes direct into the suction eye of the fan, and the delivery duct after leaving the fan splits into two pipes, one of which crosses to the other side of the coach and comes up under the longitudinal seat on that side, thus getting across the cross-member of the under-frame, and coming down again above the motor, to which the air then proceeds through a rubber concertina pipe. The other half of the duct proceeds direct up under the longitudinal seat on its own side, coming down in a similar way to the other motor.

The auxiliary transformer was adopted chiefly at the instance of Messrs. Siemens with a view partly to suiting their control gear better, and partly to obviating any possibility of the lights in the coaches being put out by the coming cut of the overload circuit-breaker in the high-tension circuit, or by any other accident which would cut off supply from the main transformer. Also, during a great portion of the year the cars will be lying in the stations for long intervals between running, and an appreciable saving of energy will be effected by doing away during such stoppages with the magnetisation losses of the large transformer. On the Westinghouse car, however, at the instance of that company, the main transformer is kept continuously energised except when the main circuit breaker comes out on overload. The auxiliary transformer might be dispensed with in cases where the cars are in continuous service, and this would also save some amount of high-tension apparatus.

On the Westinghouse car there is no interlocking of the high-tension chamber with the bow, the high-tension circuit-breaker and fuse being put in lockfast cases, the keys of which are kept at headquarters, so that the train staff are not permitted access to these chambers at all.

The Engineers to the Midland Railway state that the performance of the motors of these three cars both on the test bed and on the line suffices to disprove the assertion made against single-phase motors of excessive and injurious sparking. They also mention that in a test with a two-car train weighing approximately 58 tons, made incidentally in the course of ordinary running, one of the Siemens cars attained speeds of 30 miles per hour in 41 seconds, and 48 miles per hour in 80 seconds, and the free running speed of 60 miles per hour in 160 seconds, starting, and running for 440 yards after starting, on an up grade of 1 in 200, there being, however, thereafter about 100 yards of level, and then a down grade of 1 in 500 for 1¼ miles; this portion of the line is also very considerably curved, with curves of 30 and 40 chains radius. These tests are not the most favourable that could be obtained, as the motors were not being worked to their utmost capacity. If analysed, bearing in mind that the machines are geared for "free running" at 60 miles per hour, and remembering the high train resistance at this speed, this test shows the accelerating power of the equipments to be very satisfactory.

The general scheme for the electrification, the equipment of the power station, and the driving equipments of the rolling stock, were originated and planned by Mr. R. M. Deeley, Locomotive Superintendent of the Midland Railway Company, and his assistant, Mr. J. Dalziel. The carriages are, as has already been mentioned, to the designs of Mr. D. Bain, Carriage and Wagon Superintendent of the Midland Railway Company, who has been assisted by Mr. P. Ellis, Carriage and Wagon Department chief draughtsman. We wish to express our thanks to these gentlemen and to Mr. W. B. Worthington, Chief Engineer to the line, under whose direction the designs of Mr. J. Sayers relating to the overhead equipment were prepared, as well as to Messrs. Siemens Brothers Dynamo Works, Ltd., and the British Westinghouse Company, for descriptive particulars, drawings, and photographs, from which these two articles have been prepared.

Electrical Equipment of the London, Brighton & South Coast Railway Co.'s Suburban Line.—The first train for this service, consisting of two motor coaches and one trailer, was completed at the Metropolitan Amalgamated Railway Carriage & Wagon Co.'s works last week, and it is expected that the whole of the trains will be delivered to the Brighton Co. by August. The first train was inspected last week by the Chairman of the company, Lord Berborough, who expressed himself highly delighted with what he saw. The experimental running of the trains will probably begin in the autumn of this year, and, as soon as the repair shops at Peckham Rye have been completed, running for public traffic should be commenced. This will probably be by about the end of this year, when it is hoped that the whole 25 miles of single track which is being electrically equipped, will be in regular operation.

The Journal.—The June number of the Journal of the Institution of Electrical Engineers (No. 189, Vol. 40) contains the proceedings of the meetings in London, where the following Papers were discussed, together with the corresponding provincial discussions:—"Standard Performances of Electrical Machinery," by Dr. R. Goldschmidt; "Protective Devices for High-Tension Transmission Circuits," by Mr. J. S. Peck; and the following Papers, discussed only by Local Sections:—"The Reluctance of the Air-gap in Dynamo Machines," by Mr. T. F. Wall; "Experimental Determination of the Losses in Pole-shoes due to Armature Teeth," by Messrs. T. F. Wall and E. P. Smith; "The Heat Conductivity of Iron Stampings," by Mr. T. M. Barlow; and "Direct-current Generators," by Mr. W. Hoult.

The Kearney High-Speed Railway.—A Press demonstration of a working model of this railway system was given by Mr. E. W. C. Kearney at Aldwych, Strand, on Saturday afternoon. The system is a "mono-rail" with guide-rail, the former being the bearing-rail beneath the car and the latter being above the car, two pairs of wheels fixed on the roof of the car, underrun the guide-rail. On straight portions of the track the guide-rail is exactly vertical above the bearing-rail, but on curves it has a shorter radius of curvature than the bearing-rail, so that the car leans inwards to the proper degree. It is stated that derailment is physically impossible, so long as the rails do not break, and that much higher speeds can be permitted on sharp curves and steep gradients than were possible with the ordinary twin-rail system. Thus it is proposed to construct tube railways with the stations at the surface, but the intermediate level stretches 90 ft. below the surface. The train would descend out of the station on a gradient of 1 in 7, attain within 20 seconds from starting a maximum speed of 50 miles per hour, and then, after completing the level stretch at this speed, would run up a gradient of 1 in 7 into the next station. It is proposed that long-distance railways on this principle should follow the contour of the country, and that speeds of 120 miles per hour should be attained on long runs. A company is to be floated for exploiting the invention.

Recent Developments in Electric Lighting.—A course of three lectures on "Recent Developments in Electric Lighting" was commenced on Monday at the East London Technical College by Prof. J. T. Morris. The second and third lectures will be given on June 22nd and 29th respectively.

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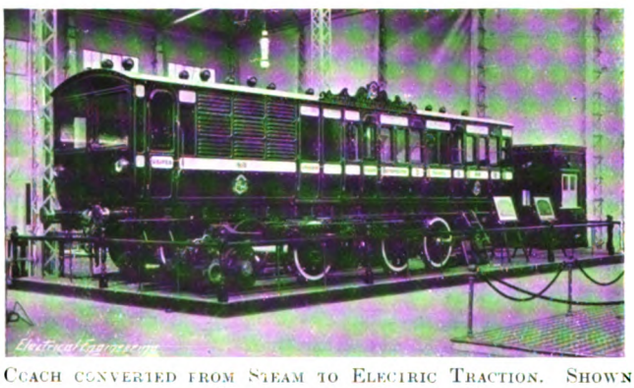
ELECTRICAL ENGINEERING AT THE FRANCO-BRITISH EXHIBITION

IN our issue of May 7th (page 687), we described in some detail the arrangements for the supply and distribution of electricity for lighting and power purposes in the Franco-British Exhibition, in itself an electrical engineering undertaking of some magnitude. Since that time a great deal has been done to remedy the state of unpreparedness which obtained at the time of the opening, and a very fair proportion of the exhibitors' stands in the various buildings are more or less complete. The chief portions of the exhibition to present objects of technical interest to the electrical engineer, apart from the applications of electric power for driving machinery of every description throughout the grounds, and the lighting arrangements already alluded to, are found among the exhibits in the British and French sections of the Machinery Hall and the Science section. The general impression obtained in glancing round is that, although a few electrical firms have striking displays, the heavier branches of electrical engineering are not well represented. Lighting, heating, and other domestic uses of electricity will be effectively demonstrated on the completion of the collection of stands which has been the outcome of the combined energies of the electric lighting companies, but at present a good deal remains to be added to this interesting display.

Electric Traction, &c.

The large hall which runs across and joins the western ends of the French and English Machinery Halls proper is devoted chiefly to iron and steel manufacture and transportation, including both shipping and railways, and here are to be found some fine exhibits by the leading steel makers of the country, and a magnificent collection of ship models.

One of the two exhibits of actual railway rolling stock is that of the METROPOLITAN RAILWAY CO., who show a complete compartment coach which they have converted at their Neasden Works into an electric motor coach with multiple unit control. This forms a part of a series of trains which at the time of the conversion of the line to electric traction had only recently been built. Two or three of these trains were put into service in



COACH CONVERTED FROM STEAM TO ELECTRIC TRACTION. SHOWN BY THE METROPOLITAN RAILWAY CO.

their converted form in July, 1906, and the equipment of the remainder has proceeded since. The conversion consisted in the case of the motor coaches of a certain strengthening of the underframes, the provision of new motor bogies, and the addition of the control equipment. The particular coach exhibited is shown in the accompanying figure. It differs somewhat from some of the first to be converted, and is fitted with a Westinghouse two-moter equipment with the usual electro-pneumatic multiple unit control (see ELECTRICAL ENGINEERING, Vol. I., page 593). The main differences from the standard equipment, as fitted to the ordinary Metropolitan rolling stock specially constructed for electric traction, lie in the arrangement of the whole of the control apparatus, including contactors resistances, &c., above the frame in the driver's compartment, and the provision of more complete arrangements on switch panels near the driver for isolating parts of the circuit and cutting out single motors if required. Another difference from the earlier Westinghouse equipment is the provision of a motor generator instead of a battery for the supply of current to the control circuit. The only part of the equipment below the frame is the motor-driven air compressor, but the automatic switch by which this is controlled is placed inside the car. In these later connected coaches a corridor is provided by which the guard can obtain access to the driver's compartment. In addition to this complete coach, a sample bogie without motor is shown, and also a G.E. 69 motor by the British Thomson-Houston Co., such as is used on some of the other Metropolitan trains.

In this part of the building is a show-case forming the exhibit of MESSRS. HANS RENOLD, LTD., of Manchester, and demonstrating their well-known system of chain driving. This includes patent silent chains; bush roller chains; block, stud, balance, textile, pipe wrench, and other special chains. In several cases the parts of the chains are displayed separately, so as to show the construction. The complete chain drives shown include sizes for powers ranging from 3 to 40 h.p., and speeds from 400 to 1,300 ft. per minute. In the silent chain drive is included a spring wheel, part of the cover of which is cut away to expose one of the springs. This special form of wheel is used for drives where the load is impulsive, as in pumps, compressors, forging machines, &c.

French Electrical Engineering.

Before the exhibition was opened, it was rumoured that the French electrical section was to be particularly complete, but on visiting the wing of the Machinery Hall occupied by our Continental friends, we confess to some disappointment. The variety of industries represented is very considerable, but many of the exhibits finding prominent places in the building are only most remotely connected with machinery and engineering, and, indeed, what may be described as heavy French electrical engineering is only represented on one or two stands.

Of the French electrical engineering stands, one of the most striking is that near the entrance of the MAISON SAUTTER HARLÉ & CIE., of Paris. One of the most interesting exhibits is a direct-coupled generating set driven by a four-cylinder 225 h.p. Diesel high-speed enclosed engine of what may practically be described as the marine type. This engine is very much more compact than the form of long-stroke slow-running Diesel engine which has usually been seen in this country, and a fine example of which is to be found in the *Daily Mail* Pavilion, particularly as regards over-all height. There are differences in the mechanical arrangement of the valves and fuel-injection pumps, but the main principle of working with a sufficiently high compression to produce self-ignition and the maintenance of a supply of compressed air for starting and injection of the fuel into the cylinders is, of course, the same. A description of the working of the earlier form of Diesel engine was given in ELECTRICAL ENGINEERING, Vol. I., page 559. The engine is direct-coupled to a four-pole generator provided with commutating poles, and designed for an output of 1,180 amperes at 120 volts, and to run at 450 r.p.m. It is to be regretted, however, that it has not been found convenient to show this interesting set running. A most imposing exhibit on the stand is a huge searchlight projector, which claims to be the largest projector in the world, having a mirror two metres (nearly 6 ft. 7 in.) across. This is provided with an automatic lamp taking 250 amperes, with a positive carbon 50 mm. in diameter and a 35 mm. negative carbon. The carbons are horizontal, and the starting and feeding are entirely automatic; a hand adjustment is, however, provided, by which each carbon can be centred independently. A special feature is the mirror, which is entirely of metal manufactured by a patent process, and is gilt to produce a beam of greater penetrative power than the ordinary silver surface. A complete set of apparatus, lenses, &c., for a lighthouse lamp is also shown. Another object of interest on the stand is a vertical shaft sinking pump for mining work, direct-driven by an enclosed water-cooled continuous-current motor of special design, taking seven amperes at 1,000 volts and running at 2,900 r.p.m. The pump is of the Mégy centrifugal type. A horizontal electrically-driven high-lift multistage centrifugal pump is also shown.

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The adjoining stand is occupied by the SOCIÉTÉ GRAMME, of Paris (whose London agents are Messrs. T. L. Scott and Co., of 28 Martin's Lane, Cannon Street, E.C.) One of the most interesting exhibits shown by this well-known firm is a small complete generating set for isolated plants, consisting of a standard four-pole Gramme continuous-current dynamo for an output of 70 amperes at 110 volts, direct-coupled to and driven by a 10 h.p. two-cylinder vertical Tabord gas engine, supplied with gas from a specially constructed suction gas generator made by E. Bardot, of Paris, capable of using wood, charcoal, or even refuse as a fuel. The actual set is not shown running, but we understand that a similar set can be seen running in London on application to Messrs. Scott. Sets of this nature should prove of considerable use where coke or anthracite such as is required by the ordinary suction plant is not available. A representative group of continuous-current motors of various sizes is shown, and some examples of switchgear, including some motor starters and a series of automatic cut-outs of the laminated edgewise switchboard type, with auxiliary copper and carbon breaks. Smaller apparatus on the stand includes electric fans, and ignition apparatus and accumulators for motor-cars.

The firm of J. A. GENTEUR, of Paris, have a small stand near by, on which is a fine example of a marble switchboard. Among the smaller electrical apparatus in this part of the building is a display of small accumulators and motor-car ignition apparatus by A. DININ, of Puteaux.

Large accumulators are represented by a stand of the SOCIÉTÉ ANONYME DES TRAVAILS ÉLECTRIQUE DES MÉTAUX, who show plates and complete cells of their "T.E.M." accumulator, including a large 6,000 ampere-hour central-station cell.

A fine, well-arranged exhibit has been provided by the FRENCH POSTAL TELEGRAPH DEPARTMENT, comprising typical sets of apparatus for the various systems employed, including several forms of Hughes printing telegraph Morse and other instruments.

One of the finest of the machine-tool stands in the French section is that of the SOCIÉTÉ DES ANCIENS ETABLISSEMENTS PANHARD ET LEVASSOR, better known now perhaps for their motor-car work than for the branch of engineering which they originally practised. The most prominent feature is the wood-working machinery. On the same stand MESSRS. JACQUOT & TAVERDON, of Paris, are showing a very convenient form of hand-worked shaping machine, which should be useful for small work of a non-standard nature. Wood-working machinery is also shown by Messrs. GUILLOT FILS & CIE.

Among the larger exhibits, attention should be drawn to a full-sized water-tube boiler of the land type exhibited by Messrs. J. & A. NICLAUSSE, of Paris. This is of the firm's well-known model, with fire-box cut away to show the arrangement of the grate and the tubes. In the boiler exhibited there is a single steam and water drum, and a collection of straight inclined tubes, with their upper ends towards the boiler front, and arranged so that not only can they be readily cleaned, but any one tube can be quickly removed and renewed without disturbing the others in a few minutes.

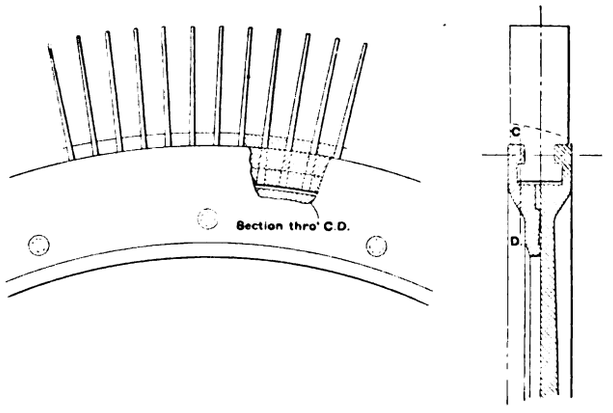
Carbon brushes, dry batteries, carbons for microphones, &c., are exhibited on an effectively arranged stand by LE CARBONE, of Levallois Perret (London office, 17 Water Lane, Great Tower Street, E.C.), who claim to be the pioneers of carbon brushes in Europe, having exhibited them as long ago as the Crystal Palace Exhibition of 1892. The collection shown comprises carbon brushes, carbon switch contacts, microphone discs, shot and powder, welding carbons, primary cells of different descriptions, and the firm's patented connection for brushes fitted with pigtails. In addition to the well-known "X," "Z." and "S" grade carbon brushes, the company have during the last few years introduced several high-conductivity types, such as the "K.K.," "C.C.1.V.2," "L.F.C." (low-friction coefficient). It is claimed for the "K.K." brushes that they take a load of 100 to 120 amperes per square inch of contact area; they are recommended for slip-rings of alternating-current machines and induction motors, and for switch contacts which have to deal with a high-current density. The "C.C.1.V.2" brushes can be loaded up to 125 to 150 amperes per square inch, and are recommended for slip-rings of alternating-current machines and induction motors, and also for low-voltage direct-current machines designed for plating and electrolysis, while the L.F.C. grades, which can be worked up to about 65 amperes per square inch are specially intended for turbo-generators. Special types of brushes are also shown for dealing with commutation difficulties, and others which possess the property of attrition.

Several firms have closed glass cases containing examples of apparatus in which they specialise, but in the absence in many cases of attendants and the presence of armies of workmen engaged in the fitting up of adjoining stands, it is a little difficult sometimes to obtain information as to the special points of the apparatus exhibited. Among these show cases may be mentioned that of CHARBONNEAUX & CIE., of Reims, containing examples of their special "Isorex" insulator for overhead lines constructed of a dark coloured glass; a case containing induction coil, wireless telegraph, and Roentgen-ray apparatus shown by E. DUCRETET, of Paris; a display of bells, indicators, and telephones, by CH. MILDÉ FILS & CIE., of Paris; and a show case containing a collection of "NILMELIOR" ignition apparatus. An effective show of telephone apparatus has been sent over by the SOCIÉTÉ INDUSTRIELLE DES TÉLÉPHONES, of Paris. Dry batteries are also shown by P. DELAPON, of Paris.

British Electrical Engineering.

The stands in the English wing of the Machinery Hall present a rather different appearance to those in the French wing, as they are not partitioned off from one another to the same extent as the French stands. Although perhaps the same degree of artistic taste is not exhibited in the arrangement of the stands, it is possible to obtain a much more imposing general view of the exhibits, and the large machinery is certainly displayed much more effectively.

Entering the hall from the eastern end, the first examples of British engineering which meet the eye are those on the large stand of MESSRS. MATHER & PLATT, of Manchester. In the centre of this well-arranged display is a large twin cylinder two-cycle gas engine of the Körting type, capable of developing 800 B.H.P. continuously at 107 r.p.m. with a gas supply of about 140 B.Th.U. per cu. ft. This engine has mounted on its shaft between the cranks a massive fly-wheel, forming the



SECTIONS SHOWING ATTACHMENT OF BLADING OF ZOELLY TURBINE. (MESSRS. MATHER & PLATT.)

rotor of a three-phase alternator designed for an output of 170 amperes at 2,200 volts 25 cycles, which, at a power factor of 0·8, is equivalent to 520 kw. This set is absolutely complete, although it has not been found convenient to connect it up with a gas supply for running, and is one of two which will run in parallel together built to the order of Messrs. Cory Bros. Another object of interest is a small Zoelly turbine; this, however, does not form part of a generating set, but is coupled to a patent high-lift turbine pump. This set is designed to run at 3,000 revolutions per minute, and the turbine will develop 210 b.h.p. when supplied with steam at a pressure of 160 lb. per square inch, and condensing. The pump will lift 1,200 gallons per minute against a total head of 400 ft. The construction of this type of turbine is better seen from a single wheel complete with vanes forming part of a much larger turbine, which is shown separately. These wheels are forged in one piece with the boss from Siemens-Martin steel, and are polished all over. The blades, of nickel steel, are much fewer in number per wheel than in the reaction type, are secured by a patent special device to the periphery of the wheel, and are separated by accurately-cut distance pieces, the whole being backed by a grooved ring of forged steel riveted to the wheel, as shown in the accompanying figure. The cross-section of the blades decreases from the point of attachment towards the tip, with the result that they are well adapted to resist the strains set up by the high peripheral speed at which they run. The blades,

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like the wheels themselves, are highly polished in order to minimise friction losses, while the nickel steel of which they are constructed enables them to retain their polished surfaces and clean-cut edges over lengthened periods of continuous operation. Another exhibit is a pair of patent high-lift turbine pumps direct-coupled to a direct-driven steel-clad motor, placed between the two pumps. The motor runs at 1,060 revolutions per minute, and is capable of giving out 150 b.h.p. The two pumps, which have each six successive chambers, through which the water passes, are connected in series, and are capable of pumping 400 gallons per minute against a total head of 720 ft., that is, each of the twelve chambers in series furnishes pressure sufficient to overcome 60 ft. This is at 1,060 revolutions per minute; at 1,450 revolutions the output would be 500 gallons per minute against 1,300 ft., and at 1,850 revolutions 600 gallons per minute against 2,000 ft. head. In addition to this plant the firm also show a large tank constructed of standard-sized cast-iron plates, with accurately-machined external or internal flanges, and several steam-driven pumps. An example of Messrs. Mather & Platt's "armoured" fire-resisting door for factories, &c., is also shown. In connection with the exhibition the firm have issued a series of five most attractive pamphlets, with artistic embossed covers, containing descriptions of the products of various departments of the firm, including engines and dynamos, textile machinery, hydraulic machinery, water-purification plant, and fire appliances.

MESSRS. CROSSLEY BROTHERS, LTD., have a large stand also at the end of the Hall on which is shown a fine example of an entirely new type of engine for direct coupling to electrical generators. This is of the vertical single-acting four-cycle pattern, and runs at a rather higher speed than has hitherto been characteristic of Messrs. Crossley's practice. The engine exhibited has four cylinders, each 14 in. bore and 16 in. stroke, and is rated at 215 b.h.p. on town gas and 180 b.h.p. on producer gas at 250 r.p.m. It is coupled to a 125 kw. 220-volt multipolar dynamo, built by the General Electric Co. at their Witton works, and is shown running off a standard No. 8 Crossley suction gas producer, burning anthracite. The principal features of the engine are the arrangement of the admission and exhaust valves side by side right in the cylinder heads, worked by vertical tappet rods from a camshaft inside the crank chamber, and the improved design of the throttle, which acts both on the gas and air inlets, and secures very even running on low charges. The ignition is on the high-tension system, with four separate trembler coils supplied by accumulators, and a specially designed contact maker is used in which the timing of each cylinder can be adjusted separately. A small dynamo is belted to the engine for charging one set of ignition accumulators while the other is in use. A compressed air starter is provided. As a contrast to this set, a small single-cylinder vertical engine is shown, running off town gas, and driving a dynamo for an output of 32 amperes at 100 volts at a speed of 700 r.p.m. This design of engine, which has also the valves arranged at the top, is such that it can be arranged for petrol or paraffin as well as gas. Some examples of the familiar horizontal single-cylinder engine are also shown, as well as a 40 h.p. automobile petrol engine of the firm's manufacture.

A large horizontal gas engine is being erected on an adjoining stand by the NATIONAL GAS ENGINE CO., but is not as yet quite complete, and a description must be deferred to a later date.

Reference has already been made to the large gas engine at the other end of the British wing of the Machinery Hall, which has been provided by the BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO. to assist in the lighting of the Exhibition. This is an example of the latest type of vertical tandem six-cylinder three-crank Westinghouse gas engine, generally similar to the engine described in another column of this issue in connection with the Midland Railway. The engine is rated at 750 h.p. on producer gas, and is direct coupled to a 500 kw. 500-volt Westinghouse multipolar generator. When complete the set will run in parallel with the Parsons steam turbo-generator referred to below. The engine works with gas supplied from a Mond gas producer, provided by the POWER GAS CORPORATION. The cooling tower for the water in connection with this plant was supplied by Messrs. Jarvis Bros., Middlesbrough.

In addition to this generating plant, to which we hope to make further reference when it is more complete, the British Westinghouse Co. have supplied certain plant in other parts of the Exhibition, as well as a large number of motors in use on various stands. For generating electricity for use in their pavilion, the Canadian Government have erected two gas-engine generating sets, each of 150 kw. capacity. These engines are of the same type as those supplied for the Machinery Hall, and each is direct connected to a 130-kw D.C. generator. The engines are run on ordinary illuminating gas. The Canadian Government have also installed in their pavilion some 48 D.C. and A.C. Westinghouse standard pattern flame arc lamps. The Australian Pavilion will be lighted, and the machinery therein operated, from two gas-engine generating sets, one of 100 kw. and the other of 130 kw. capacity. The former engine is a single-crank two-cylinder, and the latter a three-crank six-cylinder engine, both being of the new vertical tandem type, and both being adjusted for operating on ordinary illuminating gas.

In the same part of the Machinery Hall is the 1,800 kw. continuous-current tandem turbo-generator of MESSRS. C. A. PARSONS & CO., of Newcastle-on-Tyne, which forms the most powerful generating set in the Exhibition, and which, when complete, will take part together with the Westinghouse set in the supply of current to the exhibition for power and lighting purposes. The set consists of a standard Parsons steam turbine running at 1,800 r.p.m., coupled to two continuous-current compound-wound generators, each capable of an output of 900 kw. at 460 to 550 volts, and overloads of 25 per cent. for two hours, or 50 per cent. momentarily. These generators are of Messrs. Parsons' standard two-pole type, with compensating windings, but without commutating poles. The overall length of the set is about 46 ft. Alongside the set is a glass case containing a model of a 10,000-kw. turbo alternator and a turbine-driven blower.

The set exhausts into an ejector condenser by MESSRS. KÖRTING BROTHERS, LTD., placed outside the main hall.

Steam is supplied to the Parsons generating set from a set of three boilers erected just outside the Machinery Hall, supplied by MESSRS. BABCOCK & WILCOX, LTD., and of their standard land-water-tube type. In order to exhibit the different ways of mounting these, they are arranged two in a battery and one independently. They are fitted with the usual mountings and the latest form of superheater and automatic chain grate stoker. Each has 3,140 square feet of heating surface, and can evaporate 10,000 lb. of water per hour. A short iron chimney is provided, working with induced draught supplied by two fans, one electrically driven and the other steam driven. Messrs. Babcock & Wilcox have also a stand in the body of the hall, upon which a coal conveyor of the gravity bucket type is shown, together with a small marine boiler, a model Lassen and Hjorth water softener, and other exhibits.

On the stand of MESSRS. W. H. ALLEN, SON & CO., of Bedford, near the west end of the British Machinery Hall, are examples of this firm's well-known high-speed compound vertical enclosed engines, one of 450 h.p. and one of 220 h.p. These engines are, however, not under steam. A good exhibit of condensing plant is also shown, and several electrically driven pumps. An interesting novelty is a small generating set driven by a vertical two-cylinder 6 b.h.p. paraffin engine of the firm's own manufacture, which runs at 800 r.p.m. The vapouriser requires to be heated by a lamp at starting, but afterwards the necessary heat is maintained by the working of the engine. Low-tension magneto ignition is fitted.

The Combined Exhibit Promoted by the Electric Supply Companies.

Electrical interest naturally centres largely round the combined exhibit of the applications of electricity which has been organised by a joint committee of the electric lighting companies of London. Owing, however, to an unfortunate chain of circumstances upon which it is unnecessary to dwell here, the scheme for the display only took final shape a very short time before the opening of the exhibition, and although the work has been pushed forward with great rapidity, it is not yet in a sufficiently advanced state to be done justice to at present by a complete description. We will, therefore, reserve the full particulars of the exhibits to a later date, and content ourselves at present with a brief indication of the range covered by some of the principal exhibits.

A good deal of attention will be attracted by the complete miniature flat furnished by Messrs. Warings, which is fitted up to demonstrate the various domestic applications of electricity. This is the most complete part of the display, and, when the descriptive literature which will doubtless be prepared is ready, will prove an interesting object-lesson to consumers, but we are inclined to think that its usefulness in this direction would be enhanced by a greater number of attendants to call attention to and explain the utility of the many accessories which might easily pass unnoticed. The visitor enters a tasteful hall, and

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wanders successively through a series of miniature rooms forming dining-room, drawing-room, bedroom, nursery, and kitchen. All are lighted electrically in suitable style, provided with radiators for heating and fans for cooling, and a thousand and one small electrical accessories for adding to one's domestic comfort, particularly so in the luxurious bedroom, containing electric footwarmers, warming pans, curling-iron heaters, water boilers, &c. Attention should also be drawn to the very effective and reposeful lighting of the drawing-room by concealed lamps below the frieze. The feature of the house, however, is the kitchen, completely fitted with every variety of cooking appliance by Messrs. RASHLEIGH PHIPPS & Co., and demonstrated by a lady attendant.

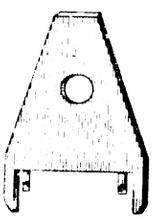
More or less surrounding the "Home" is a group of some twenty stands tenanted by well-known electrical firms, but with one or two notable exceptions, these are far from complete. We give below, however, the names of some of the firms whose exhibits are complete or approaching completion, together with an indication of the nature of their principal exhibits :—

Barlow's Patent Lift Co.—Model of patent electric lift similar to that shown at Machines Exhibition at Olympia (see ELECTRICAL ENGINEERING, Vol. II., page 524). *British Thomson-Houston Co.*—Domestic heating appliances. *Berry, Skinner & Co.*—Non-clad switches, &c., similar to those used throughout the Exhibition. *H. Cox & Co.*—Induction coils, and high-frequency electro-medial apparatus. *Dowsing Radiant Heat Co.*—Electro-medical appliances, including radiant heat baths, &c. *Edison & Swan United Electric Lighting Co.*—Artistic fittings, lamps, distribution boards, &c. *Electromotors, Ltd.*—Motor-driven pumps, fans, drills, &c. *O. C. Hawkes, Ltd.*—Convection type electric heaters. *Imperial Lighting Co.*—"Fairyland" strip, such as used for the exterior decorative lighting of the Exhibition. *Linolite Co.*—Component parts of their "Tubolite" lighting system. *F. W. Reynolds & Co.*—Wood-working machinery. *A. Reyrolle & Co.*—Distribution boards, plugs, switches, controllers, &c. *R. Waygood & Co.*—Complete working model electric lift. *Westminster Engineering Co.*—Flame and other arc lamps.

There are also several stands of interest to electrical engineers in the Machinery Hall other than those included in the combined exhibit and those containing heavy plant already mentioned. Among these are the following :—

W. GIEPEL & Co. have an effective exhibit of the new non-hygroscopic insulating material known as "Liconite," the properties of which were recently described in ELECTRICAL ENGINEERING (May 28th, page 803) in connection with a demonstration of leadless cables insulated with this compound at the works of Messrs. Johnson & Philips. Arrangements are made on the stand for showing lengths of cable under continuous test at a pressure of 50,000 volts alternating. Examples of the Giepel well-known "Rapidity" steam trap are shown on the same stand.

Several interesting articles are to be seen on the stand of J. DUGDILL & Co., of Failsworth, Manchester, whose convenient flexible fittings we have more than once had occasion to refer to. The principal feature of most of these fittings is the special self-sustaining elbow joint, fully described in ELECTRICAL ENGINEERING (Vol. II., page 525), but this is now applied to a greater variety of fittings and in larger sizes than formerly. Among the new designs shown we noticed a fitting in the form of a tree, with a number of branches suitable for shop window lighting, and a convenient double-arm table fitting. Attention should also be drawn to the large size jointed brackets of very strong construction for workshop use, the largest of which has a swing of six feet, and can be raised or lowered for bench or floor work of any description more conveniently than a pendant on a cord. Messrs. DUGDILL have also brought out one or two useful small tools for wiremen, which are worthy of notice. One of these is a simple punch, illustrated herewith, for making holes in the correct position for screws in wooden casing cover, which not only secures improved accuracy in the position of the holes, but results in a great saving of time. Another novelty is a tool for removing shade rings from lamp holders when the shades are too narrow to admit the hand. This is double ended, and can be used either for ordinary or miniature holders.



TOOL FOR MAKING SCREW HOLES IN WOODEN CASING COVER. EXHIBITED BY J. DUGDILL & CO.

Among the exhibits on the stand of Messrs. THOMAS BROADBENT & SONS, of Huddersfield, are several electrically-driven hydro-extractors, in which the direct driving vertical spindle meter forms an integral part of the apparatus, and is connected to the body of the extractor by an automatic centrifugal friction clutch. As an example of electric crane work, a 10-ton crab is shown, as used in the firm's standard 3-motor workshop travelling cranes. An electric capstan with several interesting features is also shown.

Messrs. JOHN BARKER & Co., of Kensington, show examples of Kennedy's patent pipe-bending machine for all sizes of tube from light conduit to heavy piping. This apparatus was described in ELECTRICAL ENGINEERING in connection with the Machinery Exhibition at Olympia (Vol. II., page 485).

One of the earliest of the small stands to be completed was that of Messrs. SMITH & PARKES, LTD., of Manchester. Examples are shown of this firm's "Roko" belting of camels' hair yarn, with a specially woven patent "pile" surface, which takes all the wear and is impregnated with a special waterproof compound, samples of "Karmal" fibrous packing, and also a special form of flexible non-metallic protected hose with a damp resisting textile cover suitable for water or steam.

Perhaps one of the most striking features of the British section of the Machinery Hall is the collection of machine tools displayed on several large stands. We will not, however, attempt to describe them in detail at present.

One of the largest of these stands is that of Messrs. SELIG, SONNENTHAL & Co., and some fine examples of automatic machinery are to be found on the stand of Messrs. ALFRED HERBERT, LTD., of Coventry. A number of recent improved designs, particularly as regards lathes, boring, and milling machines specially made for individual electric drive, are shown by Messrs. JOHN HETHERINGTON & SONS, of Manchester. Messrs. JOHN STIRK & Co., of Halifax, show a number of lathes and other machine tools for electric driving, and a special design of electrically-driven planing machine is shown in action on the stand of Messrs. JOSHUA BUCKTON & Co., of Leeds.

The Science Section.

The Science Section of the Exhibition is very complete, and contains a large number of most interesting exhibits amongst the fine series of scientific apparatus and products which have been brought together. A brief description of this section, owing to the great variety of subjects dealt with, forming, as they do, a summary of the whole realms of science, is difficult to prepare without describing practically everything which is present. We will, however, endeavour to confine ourselves in the main to the electrical exhibits, but even these we will not attempt to take in chronological order.

An historical exhibit of great interest, and which appeals not only to scientific workers, but perhaps even more to commercial men, is that of Sir Joseph Swan, in which the earliest incandescent lamp ever shown in public is included, together with objects exemplifying the gradual development which has led up to the metal filament lamp of the present day. The older filaments, such as those of parchment, with enlarged ends, are shown, and also the cellulose squirted filaments, both before and after carbonisation. In the next case are exhibited the original Leyden jars, which were the property of, and were also used by, Cavendish in his electrical experiments in the eighteenth century. There is also a very comprehensive exhibit by the Cambridge Scientific Instrument Company, such as Ayrton-Mather-D'Arsonval and other galvanometers, standard cadmium cells and various apparatus designed by Duddell, amongst which must be noticed the latest forms of oscillograph designed for use on high-tension circuits, and by the use of which circuits of high potential up to 30,000 volts may be safely studied. In this instrument the magnetic field

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is produced by means of a strong permanent magnet, so that the only connections to the oscillograph are those from the vibrating systems to the circuit to be investigated. The insulation, which is thus easy to effect, is provided by placing the oscillograph on a tall corrugated porcelain insulator; it has also a porcelain cover, while brush discharge is provided against by a large porcelain plate between the instrument and the case. Behind the oscillograph there is a large high-tension insulator for supporting the leads to the oscillograph. All the working parts are in a strong metal case, with iron pole pieces let into the side to concentrate the magnetic field. This case is filled with the damping oil, and is provided with an oil-tight lid. The two vibrating systems are each distinct from one another, and can be removed independently for repair. As each vibrating system is made as simple as possible, no special skill is required to repair it, any reasonably skilled experimenter being able to re-suspend it in about a couple of hours. A special non-inductive resistance to put in series with one pair of strips to obtain the P.D. wave can be supplied with the instrument. A somewhat similar form of the same instrument, fitted with a powerful electro-magnet, has been most successfully employed in the investigation of telephone currents. A frame of various oscillograms is exhibited.

Among the exhibits relating to magnetism and electricity from the Wheatstone Laboratory, King's College, London, we notice the original Daniells batteries and original Wheatstone Bridge, also Clerk-Maxwell's dynamical model, to illustrate the primary and secondary circuit; Wheatstone's 4-needle Instrument (1837), and his original resistance box. There is also a large Russian lodestone in ancient mounting, used by Faraday to show the induction of currents by a natural magnet, and Faraday's coil employed with it. There are some extremely interesting photographs of electrical discharges of extra high tension and frequency by K. J. Tarrant.

Marconi's Wireless Telegraph Co., Ltd., have an interesting exhibit representative of modern wireless telegraphy, in which they show types of coherers from 1895 to the present time. Early and modern coherer and magnetic receivers, old multiple and enclosed spark gaps, also the revolving discharger formerly used at Poldhu, and a variety of other early and present day apparatus employed in wireless telegraphy.

The National Physical Laboratory has an exceptionally fine exhibit, and one obtains an idea from this how varied is the work which is carried out in their laboratories. There is a model showing the construction of an apparatus used at the laboratory for testing radiation pyrometers over the lower ranges up to 1,400° C. The electric furnace on which the pyrometers are tested gives nearly perfect "black body" radiation up to 1,400° C. The temperature of the radiator is determined by means of the thermo-couple and potentiometer. The pyrometers shown under test have been devised by Prof. Féry, and are supplied by the Cambridge Scientific Instrument Company. In one of these, the Féry radiation pyrometer, the radiation from the object whose temperature is to be determined is concentrated upon a minute thermo-couple at the focus of a concave gilt mirror. There is also on exhibit an apparatus for comparison of mercury thermometers with standards. This apparatus consists of an electrically-heated bath suitable for water or oil. In the latter medium comparisons can be made up to a little over 200° C. The exhibit shows a set of mercury thermometers, which are being standardised by comparison with a platinum resistance thermometer, whose readings are taken by a Callander Griffiths bridge. The Campbell type of mutual inductance standard is also shown. This is a secondary fixed standard, in which exact adjustment is easily made by altering the number of turns on a small coil concentric with the large primary and secondary coils. By stranding the wires several ranges are obtained with one adjustment (*e.g.*, 0·1, 0·2, 1·0, and 2·0 millihenries).

The National Physical form of resistance bridge is also shown. The bridge is arranged for the evaluation of a tenth-ohm in terms of a unit coil, balance being obtained by shunting one of the ratio coils; at the same time, the ratio of the two coils which shunt the small resistance connecting the tenth-ohm to the unit coil is made equal to the ratio of the proportional arms. The arrangement is that of the Kelvin double bridge, but special observations are made for determining the resistance of the current leads and contacts, since for comparisons of high precision no assumption as to constancy of contact resistances is admissible. Resistances from 0·0001 ohm to 1,000,000 ohms can be compared in the same bath. Standard cadmium cells are also exhibited, the form shown being the H style.

Under Metallography there are two interesting electric resistance furnaces, one arranged for carbon combustion and the other one for quenching metals. The metal is heated up in a quartz tube under vacuum to the required temperature, and when this is reached it is immediately quenched by opening a tap, the end of which dips under water; water rushes into the tube, cools the metal, and at the same time drives it out of the tube.

Messrs. Reynolds & Branson show various Leyden jars of different capacity in the Astronomical Section. There are also in this section Apps' Patent Induction Coils, one giving a 20-inch and the other a 14-inch spark.

In the Chemical Section there is shown Lord Rayleigh's apparatus, in which, by means of a special form of discharge, he ultimately separated argon from the air. Dr. Sand shows electrodes which can be rapidly rotated and used for the quick deposition of metals electrolytically. There are also a very fine display of pieces of electrolytic apparatus shown by Dr. F. M. Perkin, and also a number of specimens of various chemical products which have been prepared by electro-chemical means, and are shown to illustrate what it is possible to do by means of electro-chemistry.

An Australian Submarine Cable Guarantee.—We read in the *Australian Mining Standard* that a writ has been issued by the Eastern Extension Telegraph Co. against the Commonwealth Post and Telegraph Department, in connection with the Government guarantee on the submarine cable between Tasmania and the mainland. In pre-federation days the Eastern Extension Co. made an agreement with the Tasmanian Government, under which the company was not only subsidised, but received a "receipts guarantee," and the company was indemnified against loss through business dropping below a certain specified point. This agreement was continued by the Commonwealth when the postal department was transferred. In 1906 the Federal Parliament passed an Act abolishing the rate of ½d. per word, which, it is contended, was really the point guaranteed, and the Government has since declined to pay anything beyond the subsidy. The original contract, however, is still in force, and the company claims that if the Government elects to reduce the charge of telegrams to the public it must be at Government expense, and not at the company's. The company, therefore, claims damages to the extent of £605, namely, the difference between the bare guarantee and the guarantee plus the charge of ½d. per word, which had been discontinued.

Bournemouth Tramway Disaster.—The Board of Trade inquiry into the circumstances attending the accident on the Corporation tramways on May 1st was concluded on June 10th, before Major Pringle. Wilton, the driver of the car, said that he did not observe anything wrong with the car when he took it over. He had no difficulty in removing the handle from the rear controller when he changed over at the Poole terminus. At Poole Hill he applied the hand brakes before the car started, and then later tried to put on the magnetic brake, but found there was no effect. Realising that the magnetic brakes were not working he pulled the reversing lever over and worked the power notches, but this, instead of retarding the car, accelerated it. The speed was then between 20 and 25 miles per hour. The car then rushed the curve and went over into the glen. No instructions as to the trying of the magnetic brakes before going down hill were issued until after the accident. After some further evidence from previous witnesses, the inquiry was concluded. The report of Major Pringle, the Board of Trade Inspector, will be issued in due course.

As announced on page 869 of our issue of June 4th, the inquest was resumed on June 11th. Wilton said that he could have taken the car down the hill on the hand brake, and would have applied it earlier had he known that the magnetic brake circuit was out of order. Other drivers gave evidence as to the condition of the brakes and controller of the wrecked car previous to the accident. The jury returned a verdict of accidental death, the accident having been caused by the car getting out of control, owing to a defective controller. The driver was exonerated from all blame, but the jury recommended that more supervision should be exercised over repairs.

Electric Traction on the Prussian State Railways.—The following further details relating to the electrification of the main lines in the district of Magdeburg are taken from an American consular report (see also ELECTRICAL ENGINEERING, April 30th, p. 668, and June 11th, p. 893). At first short sections Güsten-Stassfurt and Güsten-Bernburg-Köthen will be electrically equipped, and then later on the lines Magdeburg-Leipzig and Halle-Leipzig. There are some large deposits of bituminous coal between Halle and Leipzig. This coal (Braunkohle), though not suitable for locomotives, will be used at the central power station, which will be built in the coal district, and which will provide power for both lines. The ordinary passenger traffic will consist of light trains at frequent intervals, but the express and freight trains will be hauled by electric locomotives. The single-phase system will be employed with a contact wire pressure of 10,000 volts. It is estimated that the change over of the two main lines mentioned above (amounting to 102½ miles of line) from steam to electric traction will take two years.

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"ELECTRICAL ENGINEERING" PATENT RECORD

(This Patent Record is compiled by our own Editorial Staff and is Strictly Copyright.)

Specifications Published June 11th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.

Names in brackets indicate communicators of inventions from abroad.

1907 Patents

11,288, V. A. FYNN. This invention relates to single-phase commutator motors of the type in which the field winding is partly on the rotor, and in which two rotor circuits, the axes of which do not coincide, are connected in series either directly or through a transformer. Such motors have a true series characteristic, similar to that of a continuous-current series motor, and their no-load or light-load speed greatly exceeds their full-load speed. According to this invention, a negative torque is produced after a determined speed has been reached, and so the light-load speed is reduced. Thus the machine has only a true series characteristic at starting. The negative torque is produced by reaction between the rotor exciting current and the transformer field. Although such a machine will start with a powerful torque, it will not race at no load. Eight claims, eleven figures.

11,471, S. O. COWPER-COLES. A method for the electro-deposition of metals in a smooth homogeneous form at a rapid rate. The electrolyte is caused to travel over the surface of the metal at a speed of about 500 ft. per minute, the circulation being obtained by means of air jets placed around the metal surface. One claim.

15,412, L. H. WALTER. A self-restoring receiver for wireless telegraphy, consisting of a fine tantalum wire in contact with mercury. Good results have been obtained with a tantalum wire 0·05 mm. in diameter, taken from an ordinary tantalum lamp, and supported in a glass sheath from which the point projected about 1/16 in. The potential difference applied may be anything from 0·1 volt upwards, but a pressure of 0·2 to 0·3 volt has been found very suitable. The property of not giving a good electrical contact with mercury seems peculiar to tantalum, as platinum, tungsten, vanadium, and even iron in contact with mercury give a good electrical connection. The above coherer is not so sensitive to atmospheric changes as the carbon-mercury coherer, and has a longer life. Four claims, two figures.

21,860, SIEMENS BROS. DYNAMO WORKS (*Siemens Schuckertwerke Ges.*). A method of reducing the necessary thickness of insulation between the windings and the iron core of high-tension transformers. If the potential gradient through the dielectric is made uniform, a smaller amount of insulation is required than when some layers of the dielectric are subject to higher stresses than others. To obtain this uniform fall of potential through the dielectric, layers of good conducting material are inserted in the dielectric at suitable intervals, and connected to suitable points of either the high-pressure winding itself, or a resistance fed from that winding. Two claims, two figures.

23,585, W. FAIRWEATHER (*Glühlampenwerk Anker Ges.*). It has been noticed that when raw filaments are reduced by heating by the electric current in an atmosphere of some inert gas, the reaction between the current-carrying filament and the earth's magnetic field, or any other magnetic field that may be present, causes the filament to become distorted. This is particularly noticeable when continuous current is used. According to the present invention, the filament is supplied with a continuous current which, with the aid of a commutator, is repeatedly reversed. At the same time the applied voltage is gradually reduced. The filament oscillates with the current reversals, but as the current dies down the amplitude of swing is reduced, and the final metal filament sets perfectly straight. One claim.

23,778, C. A. DAY (*Fabrik Elektrischer Zünder Ges.*). Resistance bodies are manufactured by mixing together metallic particles with particles of semi- or non-conducting material and a suitable binding agent. While the mixture is setting or solidifying, it is put under the influence of Hertzian waves, and a coherer action takes place. The resistance can be adjusted to any desired degree by this means, and the solidification of the mixture renders the condition permanent. One claim.

24,074, V. ARCIONI. A direct-reading, recording, or integrating wattmeter for measuring power on unsymmetrically loaded three-phase circuits without a neutral conductor. The instrument is an electrodynamometer, consisting of two stationary coils and one movable coil. The movable coil is fed by a current proportional to the line pressure (across phases), and one of the stationary coils is fed with the current of one phase. The second stationary coil is fed with a current equal to the current of the second phase, but leading in phase by 60°. The fields due to the stationary coils are superimposed, and react on the field produced by the pressure coil, giving a deflection proportional to the load on the system. To obtain the leading current mentioned above, a current transformer, with a magnetic circuit of high reluctance, and a secondary circuit of high resistance, is used. Three claims, seven figures.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.

Summaries of the more important of these patents will appear in our next issue.

1907 Patents

4,713, FESSENDEN. Transmission of energy by electromagnetic waves.
9,397, DE PONT. Compositions for insulation.
12,239, BÉKÉSY. Portable signalling apparatus.
12,369, BRZESKI & STRAUSS-COLLIN. Arc lamps.
12,436, SCIPLE. Cross arms for telegraph, telephone, or other posts.
12,443, RAWORTH & RAWORTH. Control of electric motors.
12,902, QUINT. Enclosed arc lamps.
13,285, ELLISON. Circuit breakers for the protection of induction motors.
13,596, JAHR. Wireless telegraphy.
15,012, ROSS. Magnet or solenoid coils.
15,050, YATES. Electric fire and burglar alarm.
15,878, SIEMENS BROS. & Co. & GRIMSTON. Electrically controlled selective switch and a transmitter of current impulses.
16,092, ALLGEMEINE ELEKTRICITÄTS GES. Alternating current commutator machines.
17,796, FRICKER. Electric sign apparatus.
18,245, RANSFORD (*Compagnie Parisienne des Voitures Electriques procédés Krieger*). Electrically-driven vehicles.
19,891, BOURDIL. Safety device for overhead lines.
19,907, HAY, COUPER, & LINDSAY. Portable electric vulcanising apparatus.
20,006, SCHWARZLOSE. Automatic fire-arms.
20,510, SIMPSON. Brakes for railway vehicles.
21,535, MAICHE. Transformers.
23,529, FELTEN & GUILLEAUME-LAHMEYERWERKE AKT.-GES. Electric valve.
23,386, KITSEE. Relays.
25,123, ARCIONI. Electric meters.
25,444, BARRETO. Electrical ignition devices for internal-combustion engines.
25,830, LOEBL & THE BRITISH EVER READY ELECTRICAL CO. Electric switches.
27,073, SIEMENS-SCHUCKERTWERKE-GES. Systems for driving machinery subject to variable loads.

1908 Patents

66, LITTLE. Arc lamp electrodes.
665, STROHMENGER. Material for separating plates of secondary batteries.
878, SIEMENS BROS. DYNAMO WORKS (*Elektrizitäts-Akt.-Ges. vorm. Schuckert & Co.*). Arrangement on electricity meters for determining the maximum consumption.
1,615, BELIN. Electrical apparatus for reproducing pictures at a distance.
4,112, SIEMENS BROS. DYNAMO WORKS, LTD. (*Siemens Schuckertwerke Ges*). Section insulating arrangements for the overhead construction of electric railways.
4,432, MASCHINENFABRIK OERLIKON. Single-phase commutator motors.
4,464, SIEMENS BROS. & Co. (*Siemens & Halske Akt.-Ges.*). Manufacture of coils of large section for electromagnetic apparatus.
7,219, ADAMIAN. Electrically-controlled apparatus for seeing at a distance.

Complete Specifications open to Public Inspection before Acceptance.

1908 Patents

10,317, MERSHON. Insulating supports for high-tension conductors.
11,068, ROUTIN. Regulators for electric generators and furnaces.
11,128, HANKIN. Electric heating apparatus.

Expiring Patent

The following patent expires during the current week after a life of fourteen years :—

No. 12,221 of 23rd June, 1894. P. M. JUSTICE (*Edward G. Acheson*). An electric furnace especially adapted for the production of carborundum. A core of some refractory material, of higher conductivity than the mass to be treated, is provided, and this forms a direct path for the current. The mass to be treated is packed round this core. Also a mixture for the production of carborundum, consisting of 29 parts sand, 20 parts coal, coke, or other form of carbon, 5 parts common salt, and about 2 parts sawdust or cork.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. * = Interim. 1906	DIVIDEND PAID. * = Interim. 1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£	%			
Bournemouth & Poole E. S. Co. Ltd.	10	7	7%	10½—11	
Do. 4½% Cum. Pref.	10	4½	4½%	9⅞—10⅜	
Do. 6% Cum. Second Pref.	10	6	6%	10½—11	
Do. 4½% Debenture, Red.	Stock	4½	4½%	102—105	
Bromley (Kent) E.L.& Power Co., Ltd.	5	5½	5½%	4½—5	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	94—97	
Brompton & Kensington E. S. Co., Ltd.	5	10	10%	6¾—7¼	+¼
Do. 7% Cum. Pref.	5	7	7%	6¾—7¼	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%	98—101	
Ch. Cross. W. E. & City E. S. Co.	5	5	5%	3⅞—4⅛	+⅛
Do. 4½% Cum. Pref.	5	4½	2½%	4⅛—4⅜	
Do. 4% Deb. Red	Stock	4	4%	95—98 xd	−1
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	3⅜—4⅜	+⅛
Chelsea Electric Supply Co., Ltd.	5	4½	4½%	3—3⅜	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9½—10½	+¼
Do. 6% Cum. Pref.	10	6	6%	12—13	
Do. 5% Deb. Red	Stock	5	5%	124—127	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	102—105	
City of Durham E. P. Dis. Co.	5	4	2%	2½—3	
Do. 5% Pref.	5	5	5%	3¾—4¼	
County of London Elect. Sup. Co. Ltd.	10	5	5%	7⅞—8½	
Do. 6% Cum. Pref.	10	6	6%	10½—11	+⅛
Do. 4½% Deb. Red	Stock	4½	4½%	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	98—101	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	+⅛
Do. 6% Cum. Pref.	5	3½	—	½—1	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	63—73	
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4¾—5¼	
Do. 5% Cum. Pref.	5	5	5%	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½%	6—6½	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	90—93	
Kensington & Knightsbridge E.L.Co.	5	10	10%	7—8	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N'tng Hill E.L. Cos. Db. Rd.	Stock	4	4%	97—101	
London Electric Supply Corporation	3	4	2½%	⅞—1⅛	
Do. 6% Pref.	5	6	6%	4½—4¾	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	83—92 xd	−1
Metropolitan Elec. Supply Co., Ltd.	5	8	6½%	⅜—5	
Do. 4½% Cum. Pref.	5	4½	4½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. Db.	100 & 500	4½	4½%	96—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	7¾—8¼	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	5	8%	5½—6	
Do. £2 Pm.	5	8	8%	5½—6	
Do. 5% Pref. (fully paid)	5	5	5%	5¼—5½	
Do. 10/- Pm.	5	5	5%	5¼—5½	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11¼—12½	
Oxford Electric Co., Ltd.	5	7	7%	5¾—6¼	
Do. 4% Deb. Red	Stock	4	4%	94—98	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7¼—8¼	
Do. 7% Non-Cum. Pref.	5	7	7%	6¾—7¼	
Do. 3½% Deb. Red	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	¼—⅜	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4%	2¼—2½	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅝—⅞	
Do. 7% Cum. Pref.	1	7	7%	1⅛—1⅛	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99 –102	
Urban Elec. Supply Co., Ltd.	5	5	5%	1—2	
Do. 5% Cum. Pref.	5	5	5%	1⅞—2⅛	+¼
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7¼—8	
Do. 4½% Cum. Pref.	5	4½	4½%	4⅞—5⅜	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	90—92	+2
Central London	Stock	4	3%	80—83	−1
Do. 4% Preferred	Stock	4	4%	91—92	
Do. Deferred	Stock	4	2%	61—64	−3
Do. 4% Debentures	Stock	4	4%	100—103	
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	82— 5	+1
City and South London Cons.	Stock	2⅜	4¼%	39—41	−1
Do. 4% Perp. Deb.	Stock	4	4%	100—103	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1895	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11s.d.	¾—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4%	6—7	
Do. 4% Perp. Deb.	Stock	4	4%	89—92	
Mersey Cons.	Stock	nil	—	1—3	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	½%	41½—42½	−½
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	75—78	
Do. 3½% Convertible Pref.	Stock	3½	3½%	73—76	
Metropolitan District	Stock	nil	—	13—14	−1
Do. 6% Perp. Deb.	Stock	6	6%	120—125	
Do. 4% Deb.	Stock	4	4%	73—78	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	23—28	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	39—43	
Whitechapel and Bow 4% Deb.	Stock	4	4%	103—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅛—⅜	−⅛
Do. 5% Cum. Pref.	1	5	5%	⅛—⅜	
Do. 4½% Deb. Red.	Stock	4½	4½%	85—90	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93 96	
British Electric Traction Co., Ltd.	10	—	—	1¼—1⅜	+⅛
Do. 6% Cum. Pref.	10	6	6%*	4⅛—4⅜	+⅛
Do. 5% Perp. Deb.	Stock	5	5%	92—97	+1
Do. 4½% 2nd Deb.	Stock	4½	4½%	74—78	+2
City of Birmingham Trs. Co., Cm. Pf.	5	5	5%	4¼—4⅜	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	97—100	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. * = Interim. 1906	DIVIDEND PAID. * = Interim. 1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%			
Dublin United Trams Co.	10	6	6%*	12¼—13¼	
Do. 6% Pref.	10	6	6%	12½—13½	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	93—96	−1
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅞—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	⅝—⅞	
London United Trs., Ld., Cm. Pf.	10	5	5%	7⅛—8¼	+½
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—86	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅜—⅝	
Do. 5% Cum. Pref.	1	5	5%	¼—½	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	95—98	+1
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—⅝	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	¼—⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	½—⅝	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	4%	¼—½	
Do. 5% Cum. Pref.	1	5	5%	¼—½	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	+2
Provincial Tramways Co. Ltd.	10	3½	4%	4½—5½	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6%	¾—1	
Do. 4% Deb. Red.	Stock	—	4%	77—81	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	76—81	+3
Yorkshire (West Riding) Elec. Trams	5	nil	—	⅜—⅝	+⅛
Do. 6% Cum. Pref.	5	nil	—	3⅛—3⅜	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	59—62	
Do. 6% Pref. Ord.	Stock	6	30/-*	103—105	
Do. Def. Ord.	Stock	1⅜	1%	16½—17	
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3—3½	
Do. 10% Cum. Pref.	5	10	10%	8—9	
Do. 4½% Debs.	50	4½	4½%	100—103	
Direct United States Cable Co. Ltd.	20	4¼	4/-*	13½—14	
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	100½—102½	+½
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	100½—102½	+½
Do. do. (Mauritius Sub.)	25	4	4%	99½—101½	+½
Eastern Ext. Australasia & China	10	7	7/6	12⅜—13¼	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	100½—102½	
Eastern Telegraph Co.	Stock	5¾	7%	131—136	+1
Do. 3½% Pref.	Stock	3½	3½%	84½—86½	+1
Do. 4% Mort. Deb.	Stock	4	4%	100½—102½	
G. N. Tel. Co. (Copenhagen)	10	20	20%	28—31	+1
Indo-European Telegraph Co. Ltd.	25	13	65/-	52½—55½	+½
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅛—⅜	
National Telephone Co., Ltd., Pref.	Stock	6	6%	108½—110½	+½
Do. Deferred	Stock	5½	6%	113—115	+3
Do. 6% Cum. 1st Pref.	10	6	6%	10½—12½	
Do. 6% Cum. 2nd Pref.	10	6	6%	10½—12½	
Do. 5% 3rd Pref.	5	5	5%	5¼—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	99½—101½	+½
Do. 4% Deb. Red.	Stock	4	4%	102½—104½	+½
Western Telegraph Co., Ltd.	10	7	7%	13⅜—13⅝	
Do. 4% Deb.	Stock	4	4%	100½—102½	
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	6%	⅝—¾	
Babcock & Wilcox, Ord.	1	20	1/7½*	3¾—4	+⅛
Do. 6% Pref.	1	6	7½d	1⅞—1⅞	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	5⅜—6½	
Do. 6% Cum. Pref.	5	6	6%	5⅜—6½	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	93—98	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅞—1⅛	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—½	
Do. 6% Pref.	2	nil	—	⅝—⅞	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	70—75	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	55—60	
Callender's Cable and Const. Co., Ld.	5	15	15/-	9¾—10¾	
Do. 5% Cum. Pref.	5	5	5%	5½—5¾	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	107—109	
Consolidated Electrical Co., Ltd.	1	3	3½%	⅜—½	
Crompton & Co., Ltd.	3	5	5%	1⅝—1⅞	+⅛
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1⅞—1⅞	
Do. 6% Cum. Pref.	1	6	6%	1—1⅛	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
Edison & Swan United "A." £3 paid	5	4½	2/6	2¾—3	
Do. do. (fully paid)	5	4½	4/2	1⅝—2½	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	½—¾	
Do. 7% Cum. Pref.	2	7	—	1½—1⅝	
Do. 4% 1st Mort. Deb.	Stock	4	4%	63—67	−1
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8¼	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10¾—11⅛	
Do. 4½% Cum. Pref.	5	4½	4½%	5—5¼	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	104—106	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	30—32	+1
Do. 4% Deb. Bds. Red	100	4	4%	102—104	+½
Willans & Robinson, Ord. Shres	1	nil	5%	⅜—1¼	
Do. 6% Cum. Pref.	5	nil	6%	3⅛—3⅜	−¼
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	70—74 xd	

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ELECTROCHEMISTRY AND ELECTROMETALLURGY

AT the recent meeting of the American Electrochemical Society, Dr. H. L. Bronson described a method for measuring the resistances of the order of 100,000 megohms. There are many difficulties in measurements of such high resistances. Resistances of the magnitude of 10^{11} ohms can be measured by means of fine carbon lines on ebonite or ground glass, but as the resistance is probably merely due to bad contact it is very uncertain. So, also, are liquid resistances, such as xylolylol or amyl alcohol, contained in capillary tubes. Dr. Bronson makes use of the resistance of an ionic gas, the process being based on the law that the ionisation current through a gas subjected to a constant source of ionisation is practically proportional to the potential difference between the plates when this potential is small. The resistor vessels are of ebonite, the inside measurements being $2{\cdot}5 \times 1{\cdot}5$ c.m., with aluminium electrodes, the active material consisting of radium bromide, about 1_{10} milligram. Usually it is possible to adjust the distance between the plates so that a linear relation exists for a considerable range of potential. It is, however, necessary to obtain a calibration curve for each vessel. From the results given in the paper it would appear possible to make standard vessels of this type, and keep them as standard high resistor standards. They should remain constant over a long period of time, and would have a much higher resistance than the usual standards.

The firm of Le Gallais Metz and Co., in Luxemburg, are building a large electrolytic steel works, in which they will install an improved form of Kjellin induction furnace. Not only will the furnaces be employed for the manufacture of high-class steels, but it is intended also to manufacture ordinary cast steel. It is hoped that the works will be in operation by the early autumn.

In the American Patent, 886,857 (1908), E. F. Price and W. S. Horry describe a method for obtaining metallic calcium electrolytically. The bath employed is of calcium chloride or calcium fluoride, and it is said to be advantageous to also have present corresponding salts of strontium and ammonium in order to lower the melting point. A composite anode of calcium carbide and a binder is employed, iron forming a suitable cathode. As electrolysis proceeds the anode gradually dissolves, the calcium of the calcium carbide combining with the liberated halogen, the bath thus being kept replenished. The carbon of the calcium carbide may float on the surface and be consumed by coming into contact with atmospheric oxygen, or calcium oxide may be added to the bath. In this case the oxygen ion is liberated at the anode, and unites with carbon, consuming it there, the calcium ion of the oxide being deposited at the cathode.

From *Electrochemical and Metallurgical Industry* of June we notice that Dr. E. F. Kern contributed a Paper upon the "Electrolytic Refining of Iron" to the recent meeting of the American Electro-Chemical Society. He describes the experiment carried out with different electrolytes. The solutions employed were various:—Ferrous sulphate, sodium sulphate, ferrous chloride with sodium chloride, and ferrous fluosilicate. With the last-named solution it was found that the metal deposited was of a grey colour, and was very brittle, due to contamination with silica. The E.M.F. when from 10-20 amperes per square foot of current was employed was 0·9 to 1·2 volt, the temperature being 20°. At 60° the E.M.F. dropped to 0·55 to 0·7 volt. Satisfactory deposits were obtained by electrolysing ferrous sulphate solutions containing 6 per cent. iron and 3 per cent. sodium in the form of sulphates, or 8 per cent. iron and 4 per cent. sodium as chlorides. The E.M.F. with a current density of 10 to 20 amperes per square foot was 1·15 to 1·4 volts at 20° and 0·8 to 0·98 at 50°. When the electrolysis was started in solutions of sulphates and chlorides, the iron deposited at the cathode commenced to peel off; this was due to the presence of ferric salts in the solution. After the electrolysis had been conducted for from 3 to 4 hours, however, regular and smooth deposits were obtained. If the solutions were boiled previous to electrolysis, less pitted deposits were produced, and it was always found that smoother iron was obtained when the electrolysis was conducted at from 40 to 60°. The deposits produced in neutral chloride electrolytes containing sodium chloride were of finer grain and more flexible than those formed in neutral sulphate solutions. Deposits of iron obtained from neutral sulphate or chloride electrolytes readily became malleable when they were heated to redness, *i.e.*, provided no ammonium salts were present. In presence of ammonium salts they were harder and more brittle and less rapidly oxidised. It was suggested that perhaps this was caused by iron deposits obtained from ammonium solutions containing nitrogen. In the discussion which followed the Paper, Dr. Richards suggested that the time had now come for attempts to be made as to commercial possibilities of iron depositions from aqueous solutions. Readers of this column will remember that the Thames Iron Works have already produced iron on a commercial scale by electrolysis of aqueous solutions. ELECTRICAL ENGINEERING, Vol. I., p. 444. In the same number of the *Electrochemical and Metallurgical Industry*, Dr. H. Goldschmidt contributes a note upon "The Use of Calcium Silicide for the Purification of Metals, particularly of Steel." Many metals and alloys have been used for a number of years in the purification of liquid steel, the best known being manganese and ferro-silicon. Aluminium also possesses in a high degree the property of ridding liquid steel of the last traces of oxygen. In the case of aluminium, the oxide, owing to its infusibility, remains in small quantities in the steel. Titanium likewise has similar properties, but in this case it is mainly owing to the fact that the metal combines with nitrogen forming a cyano-nitride. Aluminium is unable to unite with sulphur, and in this respect calcium silicide has a great advantage in that the calcium can remove sulphur, and probably the nitrogen, whereas the silicon removes the oxygen; it therefore represents a new and very effective purification agent. The product employed contains about 30 per cent. calcium, the remainder being silicon. Calcium silicide is also useful for the refining of nickel copper or bronze castings.

LONDON ELECTRIC POWER BILLS

LORD CROMER'S Committee of the House of Lords resumed consideration of the London Electric Power Bills, after the Whitsun recess, on Tuesday. At the time of the adjournment, the whole of the opposition to the London and District Electric Power Bill had been heard, and it had been arranged that Mr. Fitzgerald's reply should be deferred until he opposed the second Bill. Consequently, on the resumption, Mr. Balfour Browne, K.C., opened the Bill for the eight electric lighting companies of London. We gave the full details of the Bill in ELECTRICAL ENGINEERING, Vol. II., p. 1007, the objects of which, briefly, are as follows:—The creation of a Joint Committee, the undertakings of the companies or local authorities forming which would come under the control of that body, and be worked as one undertaking. So far, only eight companies have agreed to be represented on the Joint Committee, but an area has been scheduled somewhat smaller than that in the previous Bill, all the authorised distributors in which will have the option of joining the Joint Committee.

Authorised distributors will be supplied in bulk at prices not exceeding £5 per annum per kw. of maximum demand *plus* 0·35d. per unit, on a contract for not less than seven years. Incidentally, it may be pointed out that the Bill proposes to revise the schedule of prices attached to the Provisional Orders of the London companies, so that from January 1st, 1909, the maximum charge for electrical energy for power purposes shall be £4 10s. per annum per kw. of maximum demand and 0·5d. per unit, a price which may be revised by the Board of Trade after seven years on the application of 20 consumers, or the London County Council, the Joint Committee, or the individual companies themselves. The Joint Committee takes powers to supply electrical energy throughout the area for canal haulage, or traction, &c., but the "bulk supply" areas of the following companies are exempted from the provisions of the Bill:—North Metropolitan Electric Power Supply Co., Kent Electric Power Co., Metropolitan Electric Supply Co., Charing Cross, West End & City Electricity Supply Co., South Metropolitan Electric Light & Power Co.

The financial clauses of the Bill provide that stock may be created called "The London Electric Supply Joint Committee Guaranteed Stock" to the extent of £1,000,000 at interest not exceeding 5 per cent. per annum, and it may be redeemed at not less than 110 on the purchase of the undertaking of the Joint Committee in 1932, or at par if not purchased until 1952. The following companies will guarantee the interest upon this stock:—Charing Cross, West End & City

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Electricity Supply Co., City of London Electric Lighting Co., County of London Electric Supply Co., London Electric Supply Co., Metropolitan Electric Supply Co., South Metropolitan Electric Light & Power Co.

THE "EIGHT COMPANY" BILL.

Mr. BALFOUR BROWNE, K.C., who appears for the Bill, with Mr. C. A. Cripps, K.C., Mr. C. C. Hutchinson, and Mr. Tyldesley Jones, said that the scheme involved: (1) the concentration of the generation of electricity at six of the largest stations, belonging to the companies, four of which were upon the river, and two below bridges; (2) the ultimate purchase by the London County Council or some other Parliamentary authority of the whole unified system; (3) the building up of the new business upon the existing business, and utilising the existing plant; (4) the sharing of the benefits with the public, which was the modern principle of legislation given effect to in relation to gas, although there was not a sliding scale in the Bill. At present eight companies were joined in the scheme as follows:—Brompton & Kensington Co., Charing Cross Co., Chelsea Co., City of London Co., County of London Co., London Electric Supply Corporation, Metropolitan Co., South Metropolitan Power Co., but provision was made for other companies or local authorities to join the Joint Committee. Every member of the Joint Committee would have one vote, and an additional vote for every £10,000 guaranteed under the Bill. There was also a provision in the Bill by which the London County Council could become members of the Joint Committee, but he gathered that they did not desire to be so represented. By this Joint Committee, continued Mr. Balfour Browne, they would ensure a sort of public body regulating the supply of electricity, which seemed to be a far more likely thing than offering the public electrical energy as distributors. The Joint Committee constituted by the Bill would be under an obligation to supply electricity at a certain price to the various companies, but, of course, the price would depend upon various considerations. Provision had been made, however, for a temporary supply to the Joint Committee by the existing companies, because for a time the Joint Committee would not have any works themselves. The Bill also took powers to erect plant within five years which would be sufficient to supply 27,000 kw., which plant would be worked by the companies on behalf of the Joint Committee, and the companies would be paid for working it. Failing agreement as to terms, the matter would be determined by a standing arbitrator between the Joint Committee and the companies. At the present time two of the companies had already at the disposal of the Joint Committee land which would be sufficient to take plant up to 11,000 kw. The capital which it was proposed to raise for preliminary works and trunk mains was £1,000,000; this was guaranteed by six of the companies, and he believed there would be no difficulty in raising this money at 4 per cent., as all the guaranteeing companies were dividend paying concerns. The revenue of the Joint Committee was to be first of all applied in paying the interest on the guaranteed stock; secondly, towards a sinking fund and reserve, upon a basis of 42 years, and, before any profit went to the companies, 2 per cent. was to go to the guaranteeing companies. After that, any profit up to 6 per cent. was to be shared between the guaranteeing companies and the authorised distributors in the proportion that the guaranteeing companies took one-third and the authorised distributors, who took electricity from the Joint Committee, two-thirds. The object of the Bill was that the Joint Committee should merely supply the authorised distributors, and not in any way compete with them, and the bulk of their income would come from this source. It was believed that co-operation in this way would be a great advantage to the existing authorities. With regard to the prospects of the new concern, the existing companies supplied 46 per cent. of the total power installed in the area, and the whole of the remainder they calculated would be met by additional plant of 23,000 kw. With regard to railways, these required special plant, and if any railway wished to enter into a contract, then special plant would be provided. They had not much hope of getting contracts from tramways, because the three great systems in existence in the area, namely, the London County Council Tramways, the London United Tramways, and the Middlesex County Council Tramways, were already supplying themselves. Therefore the Joint Committee did not look for any business apart from the existing distributors. It was worthy of notice that the increase of load throughout the area during the past few years had been 9,799 kw., but this was decreasing at the present time. The problem was how best to provide for future demands at less capital cost than under existing restrictions, and at the same time to reduce the cost to the consumers by the most economical means of generation. The chief restrictions, which had been mentioned more than once, were the disadvantages of small self-contained districts, and the inability to associate amongst the various districts. As a matter of fact, this latter was now looked upon as a wrong principle, for the Board of Trade sought to remove it in the Electricity Supply Bill of 1905. By this means the Joint Committee would be enabled to use the smaller stations as peak load stations, just as the promoters under the other Bill proposed to do. Further, by allowing association between the companies, a very large amount of spare plant would be placed at the disposal of the Joint Committee, as at present each distributor had to have a larger amount of spare plant than would be necessary if they could fall back upon each other in emergency. It was calculated that the amount of spare plant thus made available would be 17,000 kw.

The six power houses which it was proposed to use as main generating stations were the Bow station of the Charing Cross Co., the Bankside station of the City of London Co., the Wandsworth station of the County of London Co., the Deptford station of the London Electric Supply Corporation, the Willesden station of the Metropolitan Electric Supply Co., and the Blackwall Point station of the South Metropolitan Power Co. The present capacity of these stations was 89,150 kilowatts; there was room for 34,500 kilowatts in the existing buildings, whilst of the total area of 34·15 acres there were 14½ acres unoccupied, on which buildings having a capacity of an additional 14,800 kilowatts could be erected. Similarly, the local authorities who would be able to come on to the Joint Committee had a large amount of surplus plant, totalling some 52,000 kilowatts, and if the Joint Committee could relieve them of the necessity of having large spares, or having duplicate plant, it must tend to great economy. It was also the contention of the promoters that very great savings would be made in the transmission losses by having the generating stations situated nearer the centre of supply. The promoters of the previous Bill had shown great savings by scrapping the existing stations, but his engineers argued that the saving would only be part of the local coal bill, some wages and oil, because the capital charges on the station scrapped remained exactly the same. Figures had also been got out showing that the works costs of 17 authorised distributors in London were 27·6 per cent. of the cost of supplying the consumer, and if the station were shut down, they would only effect some saving of this 27·6 per cent. The new plant which would be installed in the existing buildings by the proposed Joint Committee would be upon the three-phase system at 50 cycles and 10,000 volts pressure, and the amount of plant so provided would be sufficient for the next five or six years. In view of the slow growth, the companies did not think they ought to look any further ahead than this. Mr. Balfour Browne then handed in tables showing the comparative capital cost of plant and transmission mains for supplying a load of 25,000 kilowatts from steam-turbine plant worked on a station, say, at Barking, by a new company, and for the same output by the existing companies utilising their buildings and land. In the first case they took three sets of 12,000 kilowatts each, and taking land, buildings, and river work at £186,500, plant at £254,590, and transmission system at £521,350, making a total of £943,440, the existing companies could install the same amount of plant for £756,958. Adding the engineering and preliminary expenses, which in the case of a new company would necessarily be higher, they arrived at the figures of £1,137,630 in the case of a new company, as compared with £843,658 by the existing companies. The capital cost per kilowatt came out at £23·1 per kw. for 25,000 kilowatts, or £22·2 per kw. if the load were increased to 34,000 kilowatts, which was the capacity for additional plant of the present buildings and land. The figures for the new company, he said, were based upon the promoters' estimates for their 60,000 kilowatt station. Another table showed how the two schemes would work out so far as the consumer was concerned, and it estimated that the cost per unit delivered, for untransformed energy, was 0·486d. in the case of the new company against 0·441d. for the existing companies. Thus, for the 25,000 kilowatt load, which the existing companies thought was the extent to which they could look ahead, by utilising the existing resources they could generate cheaper. That it was exceedingly rash to look too far ahead in engineering matters, even the promoters themselves admitted in the evidence of Sir Hugh Bell, who looked forward to gas turbines, and at the present time suction-gas plant and oil engines were very serious competitors with steam turbines. The Charing Cross Co. were installing oil engines in one of their sub-stations, to the value of £30,000, and the total costs per unit were 0·39d., against 0·48d., which was the estimate of the promoters of the previous Bill.

An important feature of the Bill was the purchase clause, which proposed a modification of the existing legislation as it affects the companies. The clause in question provided for the London County Council or any public authority authorised by Parliament to purchase the undertaking of all the electric supply companies in London, either in 1932, the present date of purchase, or in 1952, i.e., 42 years from January 1st, 1910. The terms of purchase were to be the redemption of the Joint Committee guaranteed stock, minus the sinking fund, and if the 42 years were allowed they believed the sinking fund would probably be equal to, at any rate, the £1,000,000 sought under the Bill, so that should this be the case, the purchasing authority would get the £1,000,000 undertaking for nothing. The sinking fund was made absolutely compulsory upon the Joint Committee. If the purchase took place in 1932, the purchasing authority had to give compensation to the Joint Committee for the loss as between 1932 and 1952. The amount of compensation in the event of purchase in 1932 would be determined by arbitration. These terms, however, applied only to the Joint

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Committee's undertaking, leaving the undertakings of the Electric Lighting Companies purchasable under the terms of the Electric Lighting Acts. Another point in the purchase clause was that whereas certain parts of the undertakings of some of the existing companies were not purchasable, such as the Willesden Station of the Metropolitan Co., it was now proposed to make the whole of the undertakings of all the London companies purchasable. It should also be pointed out that any generating station transferred to the Joint Committee would cease to be the property of the electric lighting company. Powers were also taken in the Bill to supply electrical energy for use outside the area, and another clause revised the maximum price in all the electric lighting orders in London to persons requiring power. Probably some of the local authorities would object to this, but there was no Kitson clause in the Bill, as it was not applicable to the scheme, and it was thought that this would be a protection to the consumer. As he had already pointed out, the scheme aimed at utilising to the full capital already expended, and he asked that some consideration should be given to the company who had carried out pioneer work, if they were willing and in a position to do their duty to the public.

Mr. J. S. HIGHFIELD, Chief Engineer to the Metropolitan Electric Supply Co., and Joint Engineer with Mr. C. P. Sparks for the Bill, was called in support of the views expressed by Mr. Balfour Browne, and of the tables handed in. With regard to the decreasing rate of growth during recent years, he said that in 1907 the growth was 84·64 per cent. of the average of the previous three years. The falling off was mainly in light, but power users were steadily growing, and prices were steadily falling. Owing to the effects of metal filament lamps, a certain proportion of mains was thrown idle, and this would be taken up by the increasing power load. He did not think metal filament lamps had been used long enough to judge of their ultimate effects upon the supply business. A good deal, he said, had been made of the fact that London was behind in the matter of electric supply, but figures had been got out showing that the average size of the stations in London was larger than those in the provinces. The process which would be followed out by the Joint Committee would be first to utilise the existing spare plant; secondly, to erect additional plant in the existing buildings; and, thirdly, to erect new buildings and plant on the existing sites. This latter would give a capacity as stated by counsel, and beyond that he did not think it wise to go for the moment. The estimates, already given, so far as the existing companies were concerned, had been worked out after consultation with the engineers of the various companies. There was considerable doubt as to the type of plant that would be used in the future. Gas engines were now being largely used, and for the solid portion of the load these would show more economical working. On peak loads the cost of coal was not such an important item as at other times, and it was for the day load that gas engines would undoubtedly find a field. He illustrated the economy of gas engines by saying that whereas the lowest quantity of coal used was 2·5 lb. per unit generated, the equivalent in a gas engine was 1·7 lb., whilst there was a further saving in the value of the by-products, which he placed at 7s. 5d. per ton, so that, taking coal at 11s. per ton, the cost of the fuel would be reduced to 3s. 7d. per ton by the use of gas engines. As a matter of fact, in the estimates he had provided for 12,000 kilowatts of gas-driven plant, and the figures had been arrived at after consultation with the chief engineer of the Kastner Kellner Alkali Co., which company had replaced the whole of their extremely economical steam plant by gas engines.

Cross-examination was commenced by Mr. BLENNERHASSETT, K.C., on behalf of the Westminster City Council, in reply to whom Mr. Highfield agreed that the priniciple of giving a bulk supply was the same under this Bill as in the last Bill, although the companies had opposed it.

Mr. RIGG, K.C., for the City Corporation, asked what the object of the Bill really was, as the advisers to the City had not been able to make it out. He said that the case for the companies against the other Bill was that the public were quite satisfied now, and that the companies were doing the best that could possibly be done, yet the present proposal was to supply cheaper than at present. Was not the object of the Bill merely to keep out competition? Mr. Highfield replied that the object of the Bill was to give a cheaper supply, and, in reply to further questions, as to laying mains in the City, he stated that the plans which had been prepared of the routes for the mains showed that the City had been carefully avoided. Another question by Mr. Rigg was that there was no provision in the Bill for a reduction in the price to lighting consumers, but cross-examination on these points of policy was deferred for a later witness.

Mr. WILLIAMS, for the Stepney Borough Council, put it to Mr. Highfield that the companies had consistently opposed power Bills for the reason that competition should not be allowed, yet this Bill proposed to compete with existing authorities in the supply to docks, railways, &c. Was Mr. Highfield willing to make it quite clear that, so far as railways were concerned, the supply should only be for haulage and not for lighting stations. The Chairman, however, ruled that this question again came within the category of policy, and it was left over.

Mr. TALBOT, K.C., cross-examining on behalf of the promoters of the London and District Electric Power Bill, had some difficulty in getting Mr. Highfield to admit that both sides were agreed as to the necessity of giving a bulk supply to the authorised distributors, although the companies had argued to the contrary in their case against his Bill. After one or two members of the Committee, however, had expressed their opinion that this must be so, Mr. Highfield agreed that his Bill provided for a bulk supply to the authorised distributors, and to that extent the principle was the same, but the methods of carrying it out were entirely different. Mr. Talbot then asked Mr. Highfield if he had considered the machinery by which the scheme was to be put into operation, and suggested that as every member of the Joint Committee could refer every single matter to arbitration, it was not a very efficient scheme. Mr. Highfield did not agree, and stated that no difficulty would exist if a standing arbitrator were appointed. Another point brought out by Mr. Talbot was that although a considerable area outside the County of London had been scheduled in the Bill, the greater portion of it was in the areas of other bulk supply companies, and under the Bill the consent of these companies had to be obtained before any supply could be given. Consequently the scheme of the Bill practically dealt only with the County of London. Mr. Highfield replied that the promoters of this Bill did not believe in competition between bulk supply companies, and consequently the clause giving the other bulk companies the veto had been inserted. Mr. Talbot next dealt with the estimated costs referred to by Mr. Balfour Browne of giving a supply of 25,000 kw., and pointed out that if Mr. Highfield was correct, the London and District Company could never hope to compete with the existing companies. Mr. Highfield agreed that he believed a new power company would have no chance against the existing companies, whereupon Mr. Talbot asked why so much money and time had been spent opposing their Bill on the ground of competition? Mr. Talbot next dealt with the maximum prices in the Bill, and pointed out that there was a very large margin between the estimated costs under the Bill and the maximum prices.

The Committee adjourned.

In our account of the proceedings last week, Mr. Seale, Secretary of the Charing Cross, West End & City Electricity Supply Co., is reported to have said that since Mr. Merz introduced his first Bill in 1905, depreciation in the value of the companies' securities amounted to no less than £186,000. This is not quite accurate. What Mr. Seale actually stated was that the depreciation of £186,000 in the securities of the various London electric supply companies had occurred since the present Committee commenced their sittings this year. Previous to that there had actually been a depreciation of nearly £4,000,000 since the introduction of Mr. Merz's first Bill.

LOCAL NOTES

ABERDEEN: *New Telephone Exchange.*—Considerable progress is being made with the National Telephone Exchange in Aberdeen, which has been designed by Mr. Leonard Stokes, of Westminster. The main features of the façade are three large semi-circular arches forming the windows of the ground floor. The switch-room is on the second floor, the ground floor being partly occupied by the battery room. The switchroom is 47 ft. 6 in. by 36 ft., the lighting being by a large cupola above the flat roof, measuring 37ft. in length, and 18ft. in breadth. Adjoining the switch-room there will be an operator's instruction school. The basement will be used for the purpose of accommodating stores and the cable subway.

Electricity Works' Outing.—The staff of the electricity works had their annual outing last week to Ballater.

ARBROATH: *Electric Lighting.*—A commencement has been made with the laying of cables by the Arbroath Electric Light & Power Co., and it is anticipated that a supply will be given by the middle of next month.

AUSTRALIA: *Sydney—Electric Lighting.*—Final arrangements have now been made by the City Council for the taking over the business of the Stroud Electric Light & Power Co., and instructions have been given for the preparation of the agreement. The estimated annual business of the Strand Co., says the *Australian Mining Standard*, is 1,250,000 units, and the purchase money is fixed at £45,000. When this purchase is completed, the Council will have assumed control of virtually the whole of the electric light and power supply of the city, the Empire Co. having been already taken over. The business of the Arcadia Co. is also being acquired.

The Electric Lighting Committee are considering the installation of a storage battery at the Town Hall sub-station to help on the peak loads during the winter

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of 1909. The engineer's report for the year 1907 states that during that year, the third year of working, the Council sold over six million units, and that the average price per unit received during 1907 was 2·14 pence. A reduction in the present charges for current for lighting purposes is being considered. The Lighting Committee have recommended the Council to take over the business of the Oxford Street Electric Light Co., at a price of £13,500, exclusive of machinery, &c. (the annual output of this plant is about 350,000 units). The company, which originally offered the business to the Council for £17,570, have accepted the lower figure.

BATH: *Sale of Electrical Undertaking.*—In connection with the proposal to lease the Corporation's electrical undertaking to the Somerset and District Electric Power Co., an offer has also been received from the Bath Electric Tramways Co., by which the two undertakings would be worked in conjunction with each other.

BARROW-IN-FURNESS: *Electricity Accounts.*—In the annual report of the Electricity Committee, it is stated that the capital expenditure during the year was £2,027, making a total of £110,872. The revenue account increased by £745, but the costs have increased by £1,080, with the result that the gross profit has gone down from £6,437 to £5,988. The capital charges for the year were somewhat heavier than usual, and there is a loss of £791 compared with the profit last year of £33. The greater portion of the deficit is attributed to the increased cost of coal, whilst there has also been a smaller relative increase in the consumption, owing to the use of metal filament lamps. There has been a large increase during the year in the consumption for power and heating, the number of units having increased from 128,000 to 221,000.

BECKENHAM: *Street Lighting.*—It is announced that the Beckenham Council have decided, as the outcome of experiments with metal filament lamps for street lighting, to change over the whole of the street lighting from gas to electricity, and have given notice to the two gas companies supplying the district to that effect.

BEXLEY: *Tramways.*—The Urban District Council has sealed a conveyance and transfer of the tramway in High Street, Plumstead, to the London County Council. At the last meeting of the District Council, the Clerk explained that if there was no delay it should be possible to run the trams through the Beresford Square in the course of three weeks. Negotiations are progressing between the Council and the Erith authority upon the subject of the proposed inter-running of the tramway systems of the two bodies.

BRIGHTON: *Tramways.*—Messrs. Stephen Sellon & Partners, consulting engineers, of London, have placed a proposal before the Brighton Corporation for running a service of trams from Kemp Town through St. James's Street, North Street, and Western Road to Worthing. The Tramways Committee have considered the proposal, and recommend the Council to authorise them to negotiate with the promoters and to report further. The promoters are prepared to consider an arrangement by which the undertaking within Brighton should fall into the hands of the Corporation at the end of 35 or 42 years without consideration. A rental of £2,500 per annum is offered.

Tramway Accounts.—The report of the Manager of the Municipal Tramways, Mr. William Marsh, states that the total revenue for the year to March 31st, 1908, amounted to £47,200, as against £50,652 last year, showing a decrease of £3,452. The working expenses for the year amounted to £34,559, as against £34,499. The net result of the year's operation shows a loss of £969, against a profit of £2,410 last year. Although he regrets that the gross profit was not sufficient to meet all the statutory capital charges, the Manager points out that the average return on the whole capital invested amounted to £4 15s. 10d. per cent., a result only attained by a very few tramway companies as distinct from municipalities. The number of passengers carried during the year amounted to 9,945,574, a decrease of 813,736 on the previous year's total, but the average fare received has remained the same—namely, 1·09d. The report states that the permanent way continues to be a heavy drain on the financial resources of the undertaking, and there is no prospect of the load being lightened, but rather the reverse, the wood paving being the chief item. In the early part of the year the rail joints in Gloucester Place and Marlborough Place were welded by the "Thermit" process as an experiment. The result has been that the cars make considerably less noise than they did formerly, but, owing to the rails being in unbroken lengths, the earth tremors of a passing car are transmitted over a longer length of track than was the case before, causing the wood paving blocks to rise more than they did. This disadvantage will be provided against in all future work by anchoring the rails down every seven or eight feet. The cost of welding the joints with all the necessary work which it involves is so high that it cannot be carried out on an extensive scale on the old track, but it should receive serious consideration in connection with extensions. The overhead line and underground cables give less trouble than any other part of the system, the cost of maintaining the cables only amounting to a few shillings a year. With regard to the price paid for current, Mr. Marsh points out that the Tramways Committee are at present paying £1,638 per annum more than ought, in his opinion, to be paid. It is almost hopeless, he says, to try and make the tramways pay their way so long as this overcharge continues.

BRYNMAWR: *Provisional Order Revoked.*—The Board of Trade has revoked the Electric Lighting Provisional Order granted in 1904.

BUENOS AIRES: *Tramway Amalgamation.*—The municipality has consented to the incorporation by the Anglo-Argentine Tramways Co. of the other tramway undertakings in the town. The arrangement has already received the sanction of the shareholders.

Electric Lighting Statistics.—The German Electric Light Co., says the *Review of the River Plate*, have presented the Municipality with plans and descriptions of the various lands, machinery, cables, &c., the property of the company. There are four power stations, having a capacity of 29,490 kw.; 17 substations, 10 of which are installed at tramway company's buildings, the converters being capable of dealing with 13,600 kilowatts, whilst the existing six batteries have a capacity of 11,976 ampere hours. The length of the cables is 1,671.868 metres; distributing boxes number 1,696, and there are 19.964 meters. There are also 100 transformer stations, capable of dealing with 10,323 kw.

CARDIFF: *Electricity Supply.*—The Corporation have been granted permission to supply electrical energy on the Bute property, and one of the first customers is the Hills Dry Dock Co., whose demand, the Chairman of the Electricity Committee stated last week, will be anything from 800 to 2,000 h.p.

CARLISLE: *Station Superintendent.*—A station superintendent is to be appointed at a salary of £130 per annum.

COLCHESTER: *Vibration from Electricity Works.*—The Town Clerk has been served with a writ by Messrs. Hollington Bros., alleging vibration from the electricity works, and the Council is to defend the action. The Town Council has considered a special report by Messrs. Lacey, Sillar & Leigh with reference to the provision of a new generating station upon a site near the sewage outfall works. The Electricity Committee recommended that Messrs. Lacey, Sillar & Leigh be retained as consulting engineers for the proposed generating station, but when the matter came up for discussion in the Council, the opinion was expressed that other firms of consulting engineers should be considered in conjunction with Messrs. Lacey, Sillar and Leigh, and an amendment was moved referring the Committee's recommendation back.

COVENTRY: *Electricity Account.*—The Corporation electricity undertaking has yielded a net profit on the past year's trading, after paying capital charges, of £5,647 4s. 6d. It is proposed to hand over a thousand pounds in relief of the rates, and to carry the remainder to the reserve fund. Last year the profits were £5,114 14s. 1d., and in 1906 £2,339 11s. 6d., whilst in 1905 there was a loss of £228 13s. 2½d., but a profit in 1904 of £775 11s. 6½d. Up to the last-mentioned year there had been losses annually on the undertaking since its commencement in 1896.

CROMPTON: *Provisional Order Revoked.*—The Board of Trade has revoked the Electric Lighting Provisional Order granted in 1901.

CROYDON: *Telegraph Wires.*—An application has been received from the Postmaster-General for permission to attach telegraph wires to certain tramway poles, and the Tramways Committee recommend that an agreement be entered into upon the payment of a nominal rent, the agreement to obtain such clauses and conditions as the Town Clerk may consider necessary for safeguarding the interests of the Corporation.

DARWEN: *Tramwaymen's Holidays.*—The Amalgamated Association of Tramway and Vehicle Workers has communicated with the General Purposes Committee asking for a week's holiday a year, with pay, for drivers, conductors, and shed men, but the application is not to be entertained.

DUMBARTON: *New Tramways.*—The tramway system from Dalmuir to Balloch is complete, with the exception of a gap of about 100 yards at Old Kirkpatrick. The Board of Trade inspection was held yesterday. The whole new route is about eleven miles, and when complete it will be possible to travel all the way from Glasgow to Loch Lomond by tramcar.

DUNDEE: *University College.*—Plans for a new electrical engineering laboratory at the University College have been approved by the Corporation.

EALING: *Lighting and Tramways.*—At the meeting of the Town Council on June 11th, the Town Clerk was directed to take proceedings under the Gas Works Clauses Act, 1847 (with which the Electric Light Acts are incorporated), to recover penalties against a Mr. Gibbons in respect of the distribution by him to Messrs. Lipton, Ltd., of electricity supplied by the Corporation. The Commissioner of Police wrote with reference to the noise of the trams, that inspections were proceeding, and an account of them would be sent as soon as possible. So far the noise had been found to be due to the condition of the track rather than of the cars. The Town Clerk said he had forwarded to the Commissioner the numbers of certain cars which were particularly noisy. The Mayor, Town Clerk, and Borough Surveyor were requested to see Mr. Nield, M.P., with a view to his calling the attention of the House of Commons to the matter. Mr. W. Ottway gave notice that at the next meeting he would move that the centre tramway standards be removed. He said he knew it was rather a tall order.

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EASTBOURNE: *Electric Lighting Accounts.*—The report of the Borough Electrical Engineer, Mr. J. K. Brydges, for the year ended March 31st, 1908, states that the number of lamps, including 96 public arc lamps and six double-lamp metal filament lamps, and 99 motors connected to the mains, were the equivalent of 99,248 of 8 candle-power, and the number of consumers 1,285, the corresponding figures for last year being 90,506 and 1,175. The results are as follows:—Units sold for private lighting, 983,365, as against 904,029, an increase of 9 per cent.; and for power, 84,505, as against 72,172, an increase of 17 per cent., the increases for the previous year being 12 per cent. and 51 per cent. respectively. The increase in the number of units sold for lighting is slightly less than for last year, probably owing to the largely extended use of metal filament lamps. A total of 280 h.p. of motors is now connected to the mains, which may be considered a satisfactory motor load in a non-industrial seaside town. There are now 52 miles of feeder, distributor, and arc lamp cables laid. The report makes a reference to the proposed Home Office regulations, dealing with the supply of electricity. These regulations, however, it is not anticipated, will seriously affect the Eastbourne undertaking, though small alterations will probably have to be made to some of the sub-stations. The total income was £24,696, and the expenditure £12,109. Deducting capital charges, there is a net profit of £2,214, compared with £1,567 last year. It is recommended that the sum of £2,000 be allocated to depreciation, bringing this fund up to £9,150. The total costs for the year were 2·11d. per unit, compared with 1·98d. for the previous year, and the average revenue was 4·49d. per unit, against 4·55 in 1907. The maximum load was 1,056 kw., and the load factor 13·55 per cent., the corresponding figures for the previous year being 972 and 13·43 respectively. The Borough Accountant reports that he is now engaged on a report dealing with the depreciation of mains, plant, &c., which will show whether the depreciation and reserve fund of the undertaking is adequate or otherwise.

ECCLES: *Manchester Exhibition.*—At the meeting of the Town Council last week, some objection was taken to the subscription of £10 which has been made to the Manchester Electrical Exhibition, but as the resolution to subscribe was passed some time ago, it was ruled that the matter could not again be discussed.

EPSOM: *Electricity Statistics.*—A statement was presented at the last meeting of the Urban Council showing that the receipts for the half-year ended March 31st totalled £2,238, being £39 below the estimates. There was about £100 to be collected for private lighting. The expenditure for the period was £1,447, being £168 above the estimates. The explanation given for this excess was that there were 85 tons of coal in hand on March 31st, and £44 for new batteries and £26 for flues were items expended during the half-year which were not provided for in the estimates.

HANDSWORTH: *Tramways.*—The Tramways Committee have issued a report giving the results of the recent negotiations with the Birmingham and Midland Tramways Co., respecting the through running of cars. It had been agreed that the fare from Birmingham to Perry Bar should be 2½d., of which the City of Birmingham Tramways Committee should take 1d. and the Tramways Co. and the Handsworth Council should equally divide the remainder. A condition of the agreement was that the Handsworth Council should purchase the Villa Road lines at once, reconstruct them, and give the company running powers. When the draft agreement was submitted to the Tramways Co., however, certain alterations were made, to which the Committee felt it impossible to agree, and they therefore recommend the Council to decline to accede to the terms demanded by the company, which give the latter running powers over other lines not originally contemplated. The general result is that the suggested running powers will not now be granted.

HEMSWORTH: *Electric Lighting Order.*—The Board of Trade has notified the Urban District Council that they propose to revoke the Hemsworth Electric Lighting Order, as the company concerned cannot give the Board a satisfactory deposit.

HULL: *Telephone System.*—At a meeting of the Council of the Hull and District Chamber of Trades last week, it was resolved to forward to the Corporation a resolution of congratulation upon the results of the municipal telephone system, the accounts for which have just been published (ELECTRICAL ENGINEERING, June 11th, 1908, p. 878).

INDIA: *Delhi Tramways.*—The Delhi Electric Tramways and Lighting Co. has just opened its tramway service.

LANCASHIRE: *Coal Supplies.*—We understand that certain municipal Electricity Committees in central and south-east Lancashire are arranging for supplies of coal from Staffordshire and other Midland coalfields. It is said that the prices asked for Midland coal are lower than those asked by Lancashire colliery proprietors and merchants.

LIVERPOOL: *Tramways.*—The Tramways Committee has decided to experiment with running a service on the principal tramway routes for first-class passengers only. This change is the outcome of complaints that coal-heavers and other workmen travel in the ordinary cars.

LONDON: *London County Council—Forest Hill Tramways.*—A meeting was held last week by the four local associations who have been identified with the agitation for urging the County Council to construct tramways in the Honor Oak Park and Brockley district. It was pointed out that these trams were authorised four years ago, and an open-air demonstration is to be held next month with the object of inducing the County Council to include the lines in their programme of tramway construction next year.

Islington.—The Highways Committee of the London County Council has written to the Borough Council calling attention to the fact that the electric lighting mains beneath Seven Sisters Road and Caledonian Road have been laid at such a depth as to make it necessary to lower them when reconstructing the tramways. The Highways Committee remarked that the Borough Council, as electric lighting authority, did not appear to have given notice to the L.C.C., as required, of their intention to lay certain of these mains. A considerable expense had to be incurred in lowering the mains, and the Committee asked, in view of the correspondence on the subject in 1905, that in future the Borough Council would acquaint the central authority of electric lighting works proposed to be undertaken. The latter is under consideration by the Borough Electric Lighting Committee.

Lambeth: South London Supply Co.'s Accounts.—Messrs. Price, Waterhouse & Co., Board of Trade auditors, in their report upon the accounts of the South London Electric Supply Corporation, Ltd., for the year ended December 31st, 1907, point out that the directors' fees, amounting to £2,275, charged to capital in 1900, still remain to the debit of that account. The expenses of flotation, previously described by the official auditor as an unrealisable asset, continue in the balance sheet, as at December, 1906, at £29,289. This sum, together with the book value of discarded plant and the costs of the action against Lambeth Borough Council, will be extinguished in connection with the reduction of the company's capital by £65,000. After allowing for renewals charged to depreciation fund account during the year, that fund has been increased by £1,871 to £25,475, and the auditors do not feel justified in referring to the fund as inadequate. The capital expenditure during 1907 was £13,559, including siding to railway, £3,094, and mains, £6,580. The auditors do not object to a proportion of the salaries of the company's permanent officials, amounting to £941, being charged to capital account, in respect of time allotted to capital purposes.

Marylebone.—In compliance with a request from the authorities of the Middlesex Hospital the supply to that institution will be at the current rates as from the end of the present quarter, but the allowance of £60 per annum for transformer losses will be discontinued. A gratuity of £19 is to be distributed amongst certain members of the clerical staff who have been working overtime. The Works Department complain that a pipe was laid by the Electricity Department under the kerb in High Street, St. John's Wood, against the protest of the Acting Surveyor that it should be laid in the carriageway. The Electricity Supply Committee have been requested to instruct their officers to adhere to the regulations in this respect.

Wandsworth: Tramway Extensions.—Some pressure is being brought to bear upon the Borough Council by local influence in connection with the construction of tramways down the Wandsworth Road. It appears that some difference has arisen between the London County Council and the Borough Council with regard to street widenings, to the cost of which the latter have fixed the limit of their contribution at £3,500. The views of the inhabitants have been placed before the Mayor and the Borough Council, who will report to the Highways Committee of the Council.

St. Pancras.—During the quarter ended March, 383,939 units were sold for power purposes, as compared with 292,921 in the corresponding period of 1907. For lighting 1,768,137 units were sold for £19,573, against 1,597,750 and £18,225 respectively in the March quarter, 1907. The units supplied for public purposes were 663,454, producing £4,491. The total number of units supplied for all purposes was 2,431,591, against 2,220,247 in 1907, and the total value was £24,072, against £22,460 last year. The number of consumers at the end of the quarter was 2,934, an increase of 13 on the figures for the previous March. The maximum demand during the quarter was 6,478 i.h.p., against 6,136 i.h.p. last year. The bad and doubtful debts for year ended March 31st last amount to £165 6s. 1d., equivalent to 0·21 per cent. of the accounts rendered. The Electricity Committee has decided in favour of the Council's undertaking wiring and fitting of consumers' premises. With the new machinery in course of erection at King's Road generating station, the Committee point out that there will be a large margin of power available for utilisation, and by making arrangements whereby consumers' premises can be wired under the supervision of the Council, the full benefit of the plant and machinery may be obtained. The Committee wish to make it clear that they do not suggest that the Council should carry out the wiring by the staff of the electricity department, but that the work should be let out to contract, under competition, for stated periods, at an accepted schedule of prices. The following clause, which has never been enforced, is to be deleted from the conditions of contract with power consumers:—"Provided always that in consequence of the special price charged, viz., 1d. per unit, the Council are at liberty to discontinue the supply of current each day at any time upon notice being given to the consumer that the current is required by the Council's ordinary consumers for

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lighting purposes; for the carrying out of any necessary repairs to the mains, plant, and machinery; further, in the event of any unforeseen accident or interruption of the supply, the Council will not be liable for loss or damage occasioned thereby." The Electricity Committee state that in each of the Bills for a bulk supply in London during the last few years a point has been made to the disadvantage of the Council by the promoters, that no large power user would take a supply with such a condition imposed. A water-measuring apparatus, capable of recording on a chart the quantity of water passing from the turbines, is to be purchased at a cost of £49. The instrument will indicate the steam consumption at all loads, and enable undue consumption of steam to be checked.

Stealing Telephone Wire.—A labourer named George Harris was sentenced to four months' hard labour at the West London Police Court on Thursday for stealing telephone wire belonging to the National Telephone Co., to the value of £5.

LOWESTOFT: *Free Wiring.*—With reference to the application of the Corporation for sanction to borrow £1,000 for free wiring, the Local Government Board has asked for details of the expenditure of the previous loan of £940 sanctioned for similar purposes. It has been decided to insure the free-wiring installations of the Council in the Sun Fire Office at a premium of 5s. per cent. up to £2,000.

LUTON: *Tramway Extensions.*—The Leagrave Parish Council, in the neighbourhood of Luton, has decided to ask the Corporation to extend its tramway system to that district.

MANCHESTER: *Tramway Extensions.*—A new tramway route was opened last week to Ardwick Green.

MARGAM: *Provisional Order.*—A letter has been received from the Board of Trade stating that, after careful investigation, they have decided to revoke the Provisional Order.

MUSSELBURGH: *Street Lighting.*—The Town Council has agreed to pay the overdue quarter's bill for public electric lighting, in view of the offer by the Musselburgh Electric Lighting & Traction Co., to install twenty new lamps.

Condition of Tramway Track.—It has been decided to write a letter to the Tramway Co. "in the strongest terms possible," calling attention to the dangerous state of the tramway track, and threatening to report the matter to the Board of Trade if no improvement is made within a week. The Town Clerk has been instructed to ascertain whether, under the agreement with the company, the Council can make repairs at the company's cost.

NEWCASTLE: *Tramway Accounts.*—The accounts of the Corporation tramways for the year ended March 31st, 1908, show that the working expenditure increased by £9,533. The total traffic receipts were £205,322, or 11·17d. per car mile, against £205,261 in the previous year, an average of 11·56d. per car mile. The total receipts for the year, including revenue from public lighting, &c., was £211,318, an average of 11·50d. per car mile, against £209,891, an average of 11·81d. per car mile for the previous year. There is a gross profit of £96,884, against £105,643 last year, from which has to be deducted sinking fund, interest, reserve, and renewals fund, &c. No contribution is made to the relief of rates this year, but last year the sum of £12,000 was so allocated.

RATHDOWN (IRELAND): *Supply from Greystones.*—At the meeting of the Rathdown Rural District Council last week, a letter was received from the Wicklow County Council stating that, in consequence of certain conditions under which they had granted to the Greystones Lighting Co., Ltd., provisional leave to carry on operations not having been complied with, the permit would be now absolutely withdrawn. In the absence of Dr. Archer, who is taking a great deal of interest in the lighting scheme, no action was taken by the Rathdown Council until he can be communicated with. This unexpected hitch has caused considerable comment.

SHEFFIELD: *Corporation Loan.*—The Corporation has issued £1,500,000 3½ per cent. stock at 97, of which loan £1,000,000 will be applied in repayment of existing temporary loans, and the balance is to be expended upon extensions of the tramways, electric lighting, and other municipal undertakings of the city.

SOUTHAMPTON: *Tramways.*—Application is to be made to Parliament next session for considerable extensions of the tramways.

STALYBRIDGE, &c.: *Tramway and Electricity Board.*—At the last monthly meeting of the Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board it was stated that the loss on the electrical portion of the scheme for last year was £463, but on the tramway section the loss was £10,322 against £8,199. The net result was a loss on the whole undertaking of £10,700 against £13,600 for the previous year, and the amount required from each of the four Corporations would be £2,711, or £705 less than last year.

Tramway Insurance.—It has been decided that the Chairman and Deputy-Chairman of the Tramways Committee be appointed to attend the conference *re* mutual insurance.

STEYNING: *Charges for Electricity.*—The Brighton Corporation, which supplies in Steyning, has notified the Council that, in consequence of the revised tariff recently put into force, the charge for lighting will be 4½d. per unit, and 2d. per unit for power, heating, and cooking, this price being a halfpenny per unit above the rates in Brighton. Objection is taken by the Council to this increase, and the suggestion has been made that a Provisional Order should be applied for. A resolution has been passed calling upon the Brighton Corporation to supply at the same price as in the Borough of Brighton as provided for in Clause 3 of the agreement.

STOCKPORT: *Electric Clocks.*—The inauguration of the system of electric clocks on the Palmer system at the Town Hall took place on Tuesday. In addition to the clock in the tower with four dials 6 ft. in diameter, there are 70 clock dials in the interior of the building.

TAUNTON: *Electricity Accounts.*—The accounts for the year to March 31st, 1908, show a net profit of £281 after meeting interest and sinking fund. The sum of £265 has been transferred to the motor-purchase fund, and the Electricity Committee report that the whole of the motors purchased for hire purposes have now been paid for out of revenue.

TWICKENHAM: *Tramway Speeds.*—At the last meeting of the District Council a resolution was passed that on three evenings, between six o'clock and midnight, steps be taken to ascertain the speed of tramcars travelling along Hampton Road and the Green. Councillor Ayland, who moved the recommendation, said he supposed that if it was found that the cars travelled at a greater speed than ten miles an hour the Council would take proceedings against the tramway company. Councillor Anderson complained that the track was getting worn, as also was the machinery of the cars, which were exceptionally heavy.

WADEBRIDGE: *Electric Lighting.*—An offer has been made by a syndicate with reference to an electrical installation in the town on the condition that no rival scheme be sanctioned by the Council. The proposal is to carry out a non-statutory scheme. The matter has been postponed for a month.

WOLVERHAMPTON: *Tramways.*—It was stated at a meeting of the Town Council on Monday that the net profit for the tramway department during the past year had been £2,112, all of which had been set aside to cover the cost of improvements and to pay off the deficit.

TENDERS INVITED AND PROSPECTIVE BUSINESS

ACCRINGTON.—A Local Government Board inquiry will be Dukinfield Joint Tramways and Electricity Board, for sanction to borrow £7,500 for the electricity undertaking.

AUSTRALIA: *Sydney.*—The Electric Lighting Committee are considering the installation of a storage battery with the necessary boosters and switchgear at the Town Hall sub-station.

Melbourne.—The Council invite tenders for the supply of 5,060 yards insulated copper cables. Specifications, &c., from Messrs. McIlwraith, McEachern & Co. Proprietary, Ltd., agents for the Council, Billiter Square Building, London, E.C., to whom tenders by July 3rd.

DARWEN.—Application is to be made to the Local Government Board for sanction to borrow £4,300 for mains, &c.

EPSOM.—The Council have decided to apply to the Local Government Board for sanction for a loan of £1,500 for extensions of mains.

GOVAN.—An application is to be made to the Secretary of Scotland for increased borrowing powers of £23,000 for probable expenditure upon the electrical undertaking during the next four years.

GRAVESEND.—The Electricity Committee invite tenders for the supply and erection of yellow-flame arc lamps, columns, &c. Particulars from the Electrical Engineer (fee two guineas, returnable), and tenders to the Town Clerk by June 27th.

HANDSWORTH.—An inquiry was held by Mr. Shelford Bidwell into the application to the Local Government Board for sanction of a loan amounting to £22,300 for the Electricity Department to cover £18,200 already spent on the generating station, and £3,100 for additional plant to meet the increasing load for the ensuing winter. £1,000 is also required for a scheme of free wiring in private residences. Mr. E. Ward, Clerk to the Council, in giving particulars, stated that the application for £18,200 practically amounted to cancelling certain old powers and acquiring new ones.

HANLEY.—The sanction of the Local Government Board has been given to a loan of £20,643 out of the amount of £21,969 applied for the Electricity Department.

HULL.—Loans are to be taken up from the Hull Savings Bank for electric lighting purposes to the extent of about £3,500 in connection with the electrical undertaking.

LONDON: *London County Council.*—The Council invite tenders for the manufacture and delivery of high-tension main switchgear and low-tension auxiliary switchgear for the Greenwich generating station. Particulars from the Clerk, fee £2, returnable, and tenders by July 7th.

Fulham.—The Guardians invite tenders for a vertical high-speed engine and a 20-kw. dynamo, both British made. Full

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particulars from the Clerk, Guardians' Offices, 129 Fulham Palace Road, to whom tenders by July 2nd.

Islington.—Distributing mains are to be laid in three streets at an estimated cost of £320.

Stoke Newington.—The Electric Lighting Committee of the Borough Council has had under its notice a report by Messrs. Talbot & Stevenson, consulting engineers, advising the provision of a series booster in connection with the Palatine Road feeder, to remedy the present fluctuations of load on that feeder, and the consequent unsteadiness of the light in that neighbourhood during performances at the Stoke Newington Theatre. The estimated cost of the scheme is £410, and the committee has decided that tenders be obtained. An inquiry was held on Monday by Mr. H. R. Hooper, the Local Government Board Inspector, with reference to the proposed loan of £3,380 for erecting a generating station in connection with a dust destructor for the supply of electricity to the borough. Numerous objections were made on the ground of expense.

LOWESTOFT.—An inquiry was held last Friday by Mr. W. A. Ducat, of the Local Government Board, into a proposed loan of £1,661 for the electricity department, of which £1,000 is to be for free wiring, and the remainder for the provision of mechanical stokers to three of the boilers. There was no opposition to the application.

ROTHERHAM.—A Local Government Board inquiry has been held into the application for a loan of £300 for the purchase of a site upon which to erect a dust destructor station, and for £3,500 for extensions to the electricity undertaking.

STALYBRIDGE, &c., TRAMWAYS AND ELECTRICITY BOARD.—A Local Government Board inquiry has been held into an application by the Stalybridge, Hyde, Mossley, and Dukinfield Joint Tramways and Electricity Board, for sanction to borrow £25,223 for electric lighting purposes.

ST. ANNE'S-ON-SEA.—A feeder cable is required by the Council. Particulars from the Electrical Engineer (fee one guinea, returnable), and tenders to Town Clerk by June 27th.

SWEDEN.—H.M. Consul at Gothenburg (Mr. J. Duff) reports that tenders are invited for the supply of a 42-ton electric travelling crane, with the necessary bridge, required for the power-station of the "Kungliga Trollhatte Kanal och Vattenverk." Tenders, addressed to the "Kungliga Trollhatte Kanal och Vattenverk" by June 27th. A copy of the specification and drawings may be seen by British makers on application at the Commercial Intelligence Branch of the Board of Trade.

SWINDON.—At the last meeting of the Corporation, the Electrical Engineer drew attention to the fact that throughout last winter, and the same would occur again next winter, there was no reserve at the power station at times of heavy load. The Chairman of the Electricity Committee, in putting the matter before the Council, said that were he not Chairman, he would oppose the proposition to apply for sanction to borrow £8,000, and would recommend the Council to take the risk, whatever it was. Eventually the recommendation was referred back.

WALSALL.—A condenser and purifying plant is to be erected at the electricity works at a cost of £2,775.

WILLESDEN.—The Local Government Board has sanctioned the following loans for electricity purposes:—Additional plant, £2,931; meters, £1,166; services, £3,675; mains, £5,955.

WOLVERHAMPTON.—The Electricity Committee has submitted a scheme for the provision of two additional water-tube boilers, including draught and coal-conveying plant, at the electricity works, at an estimated cost of £6,000, and that applications be made to the Local Government Board for loan.

NEW PUBLICATIONS

"The Engineering Index Annual for 1907." Compiled from the Engineering Index published monthly in *The Engineering Magazine* during 1907. (London: The *Engineering Magazine*.) 10s.

"Transactions of the Mining Institute of Scotland." Part 4. Vol. XXX. (Newcastle: The Institution.)

"Proceedings of the American Institute of Electrical Engineers." June, 1908. (New York: The Institute.) 50c.

Journal of the Institution of Electrical Engineers. No. 189. Vol. 40. (London: E. & F. N. Spon.) 5s.

"Elektrotechnische Messkunde." By A. Königswerther. (Hannover: Max Jänecke.) M. 4.20.

"Great Eastern Railway Co.'s Tourist Guide to the Continent," edited by Percy Lindley. (London: 30 Fleet Street, and Continental Department, Liverpool Street Station.) 6d.

A 15,000 kw. Steam Generating Station in Japan.—A generating station is being built for supplying the town of Osaka, on the south coast of Nippon, with electric light and power. The town, which has over one million inhabitants, has up to the present been lighted exclusively with gas. The generating plant is to consist of five 3,000 kw. turbo-alternators running at 1,200 r.p.m., and generating three-phase current at 11,000 volts, 60 cycles. Five exciters, each of 38 kw. capacity, will be direct-coupled to the turbine sets.

TENDERS RECEIVED AND ACCEPTED

BELFAST.—At the weekly meeting of the Tramways and Electrical Committee Sir Robert Anderson, Lord Mayor, presiding, the manager was authorised to have automatic point controllers fixed wherever necessary. The offer of Messrs. Munro, Brecknell & Rodgers to supply the same was accepted.

DUNEDIN (NEW ZEALAND).—As a result of the successful performance of Westinghouse magnetic brakes on the Dunedin, Wellington (N.Z.), Sydney, Bendigo, Ballarat, Fremantle, and East Fremantle tramways, Australia, the municipal authorities of Adelaide have just placed an order with the British Westinghouse Electric & Manufacturing Co., Ltd., for 120 magnetic brake equipments of their latest improved type, similar to those in use on all the London County Council tramcars.

FOLESHILL.—The tender for the electrical installation at the Isolation Hospital has been placed with the Electrical Trades Supply, Ltd.

LONDON: *Bermondsey.*—The Borough Council has accepted the tender of Messrs. Crompton & Co. for the supply of an arc lamp column, with double carbon arc lamp and lowering gear, at £26 13s. 3d., less 2½ per cent. discount. The British Insulated & Helsby Cables, Ltd., has agreed to guarantee cables to be supplied by them for two years, instead of one year, at an increase of 1 per cent. above the contract price.

Lambeth.—The General Purposes Committee, having considered quotations from the Town Hall Superintendent and from various firms for the installation of telephonic communication between the various departments in the new offices, has decided to purchase from the General Electric Co. the necessary materials and instruments, and by its own Town Hall staff to execute the work of installation. The Council on June 11th sanctioned an expenditure of £45 on the installation, exclusive of the cost of materials.

Marylebone.—The Electric Supply Committee of Marylebone Borough Council received 25 tenders for the annual supply of coal to the generating station. The engineers having carried out tests (taking into account both price and efficiency), the tender of W. Cory & Son, Ltd., has been provisionally accepted at the following prices:—

	Price per ton.	Quantity available in tons.	Size of coal in. in.
Tibshelf small nuts	13/9	10 000	1¼ by ⅝
Shipley nuts	14/2	12,500	1¼ ,, ⅝
Mapperley nuts	14/3	10,000	1¼ ,, ⅝
Digby High Hazel small nuts	14/2	5,000	2 ,, 1¼
Pinxton small nuts	14/2	10,000	1¼ ,, ⅝
Kingsbury D/S nuts	14/0	10,000	1¼ ,, ⅝
Kingsbury beans...	13/0	10,000	⅝ ,, 5/16
Griff peas	12/2	12,000 (if desired)	⅝ ,, 5/16
Nuneaton D/S nuts	13/5	10,000	1¼ ,, ⅝
Cowdenbeath nuts	14/6	20,000	1 ,, ½
Cowdenbeath peas	12/3	20,000	½ ,, ¼
Hillhouserigg singles... ...	14/6	20,000	1 ,, ½
Edinburgh peas	12/6	20,000	½ ,, ¼
Methley nuts	16/3	10,000	¼ ,, 5/16
Ackton Hall nuts	16/3	10,000	1½ ,, ⅝

The Baths Committee of the same Council has placed an order with Maple & Co. for supplying and fixing 11 new battery wall telephones for £10 18s.

MANCHESTER.—The tender of Messrs. James Howden & Co., of Glasgow, for a 6,000 kw. alternator driven by a Zoelly steam turbine has been recommended for acceptance by the Electricity Committee. (We give some technical particulars on page 915 of this issue.)

RANDFONTEIN ESTATES.—The *Financial Times* states that the central power station at the Randfontein Estates is being equipped with Parson's turbines and B. & W. boilers. The first section of the plant is reported to be nearing completion. The estimated capacity of the plant to deal with this group of mines is intended to be 10,000 kw., and transmission will be by underground cables.

WESTON-SUPER-MARE.—A tender has been entered into with the Weston-Super-Mare Electric Supply Co. for lighting Walliscote Road for a period of five years, with option to continue for a further five years on similar terms.

£10,000 Counterclaim.—In the Brighton County Court on Friday the National Telephone Co. brought an action against Colonel G. E. Gouraud, of 109 Marine Parade, Brighton, for £5 5s. 5d., in respect of telephone charges due. The Colonel entered a counterclaim for the sum of £10,000 on the following grounds:—(*a*) neglect of duty, (*b*) breach of contract, (*c*) pecuniary loss, (*d*) injury to health, (*e*) prolonging an already long and critical illness, (*f*) increasing expense of doctors, (*g*) unwarrantable and illegal disconnection of exchange service, and (*h*) making statements prejudicial to the credit and honour of the defendant. The hearing has been adjourned until July 3rd owing to the illness of the defendant.

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COMPANIES' MEETINGS AND REPORTS

AFRICAN TRANSCONTINENTAL TELEGRAPH.—The annual general meeting was held in London on Monday, Mr. R. Maguire presiding. The Chairman stated that the prospects of direct telegraph communication between Cairo and the Cape appeared brighter at the present time than they had been. In view of the recent improvements in wireless telegraphy he thought it quite possible that the gap between the two sections of the line might be bridged by wireless telegraphy, in which event Cape Town and all the intervening stations would be directly connected with each other.

ALTRINCHAM ELECTRIC SUPPLY.—The report of the directors for the year ending December 31st, 1907, states that the business shows satisfactory progress. During the year 73 installations, representing 3,595 8-candle-power lamps have been connected to the mains; the total at the end of 1907 being 1,016 actual consumers with 57,673 equivalent 8-candle-power lamps. In progress there are 28 installations with 1,504 equivalent 8-candle-power lamps. After providing £1,821 2s. 8d. for interest on loans and debentures and adding £2,000 to reserve for depreciation, the net profit for the year is £2,132 5s. 5d., to which must be added the amount of £100 17s. 4d., brought forward from the previous year. The directors recommend that a dividend of 7 per cent. be declared on the shares, which will absorb the sum of £1,750, leaving a balance of £483 2s. 9d. to be carried forward, subject to provision for directors' fees.

ARON ELECTRICITY METER.—At the eleventh ordinary general meeting last Tuesday the report and accounts, referred to on page 907 of our last issue, were adopted. Mr. H. Hirst, who presided, said he had very little to add to the report, which showed a record six months in their history. He referred to the approval by the Board of Trade of their prepayment meter for alternating currents, and looked forward to a great increase in the method of metering now that, owing to the introduction of high efficiency metal filament lamps, electric lighting bid fair to become the poor man's illuminant as well as that of the rich. The success of the company's new taximeter for cabs was also mentioned.

BIRMINGHAM & MIDLAND TRAMWAYS.—At the annual general meeting held in London on Thursday, the report and accounts given in our last issue were adopted. Mr. C. S. B. Hilton, Chairman of the company, who presided, said that although the name of the company was the Birmingham & Midland Tramways Co., as a matter of fact they derived their income from three distinct sources, namely, from the tramways, from the electric supply, and from investments from subsidiary companies, which are controlled and worked by a joint committee. Having dealt with the general figures in the report, he pointed out that there was a tendency in very direction to endeavour to reduce the price of electrical energy, but the policy of the Board had been, and would be, to take no business that did not show a fair margin of profit. With regard to the motor-omnibus service, the results of this had been so unsatisfactory that in December last the directors decided to entirely discontinue it altogether, and only maintain those horse routes which were entirely free from competition from the municipal tramways, or which actually showed a profit on the work. The motor-omnibuses were now being used for pleasure traffic in various towns, for which purpose some of them had been sold. He regretted to say that so far no agreement had been arrived at respecting the lease of the lines from the Corporation of Dudley, the terms sought by the Corporation being so onerous that to accept them would probably mean in some instances that no dividend could be paid, and that in others the dividend would be reduced. The dividends paid by any of the companies interested was only 5 per cent., and the Board regarded it as inequitable that, in addition to paying interest and sinking fund on the purchase price, the local authorities should endeavour to extract a profit rental which would cripple the companies, and leave no fair return. In addition, the company was being continually asked to make the stages longer, to give halfpenny fares to children, and lower fares to workmen. So far they had been able to resist this pressure, and in some instances the fares had even been slightly raised, but the general result has only been to prevent a further drop in the average fare. The directors considered that the controlling interest which the company had acquired in the Shropshire and Worcestershire Power Co. would justify additional capital expenditure whenever it was required.

BRUSH ELECTRICAL ENGINEERING.—The nineteenth ordinary general meeting was held on Tuesday, and the report and accounts, abstracted on page 907 of our last issue, were adopted. Lord Vaux of Harrowden, who presided, characterised the output of the works for the year as a record, but said that the profits were disproportionate to the amount of work done owing to the excessively low prices at which business had to be undertaken owing chiefly to competition, labour troubles, and insufficiency of working capital. On account of the failure of a scheme put forward in January for providing further capital meeting the approval of the debenture-holders, a fresh scheme, involving the issue of £120,000 5 per cent. debentures, had been decided upon. A revival in the business of building tramcars was looked forward to. Criticism was offered by shareholders of the policy of the directors and the advisability of issuing new debentures, and in reply to a question it was pointed out that the consent of the existing debenture-holders to the new issue was not necessary. Mr. E. Jarke was elected to a seat on the board, and will act, for a time, as chairman, owing to the resignation of Lord Vaux. An extraordinary meeting was subsequently held, at which it was agreed to subdivide the 150,000 fully-paid non-cumulative 7 per cent. preference shares of £1 6s. 8d. each, and the 105,732 ordinary shares of a like amount into four fully-paid shares of 6s. 8d. each respectively.

BUENOS AYRES & BELGRANO ELECTRIC TRAMWAYS.—An extraordinary general meeting was held on Friday for the purpose of passing a winding-up resolution on the completion of the sale of the undertaking to La Compagnie Generale de Tramways de Buenos Ayres. The winding-up resolution provided that the sum of £7,500 be paid to the directors as additional remuneration for their special services in carrying out the sale, and £5,000 additional remuneration to the officers and servants of the company. Mr. J. Barber Glen proposed the resolution, which was carried unanimously. Mr. J. B. Concanon, Chairman of the company, who presided, thanked the shareholders for the support which the directors had been given, and mentioned that the only dissent to the sale and winding-up had come from a shareholder who held 50 shares.

MADRAS ELECTRIC SUPPLY.—At the annual general meeting on Wednesday last week, the report and accounts given in our issue for June 4th were adopted. Mr. A. Walrond, who presided, said that Messrs. Crompton & Co., the contractors for the generating plant, had practically finished all the machinery, but its delivery had been delayed by the backwardness of the building. This latter had been largely occasioned by the scarcity of bricks, it having been anticipated that the work would have been completed by the end of 1907. The company, having invested £20,000 in preferred ordinary shares of the Madras Electric Tramways Co., had obtained the contract to supply that concern with a guaranteed minimum of 1,000,000 units per annum.

MARKET DRAYTON ELECTRIC LIGHT & POWER.—The report for the year ending December 31st, 1907, shows that the company has again made progress, the total connections being increased from 8,772 to 9,470 equivalent eight c.p. lamps, and the revenue from sale of current being increased from £1,106 to £1,187. The profit on the year's working amounts to £425, which, with the balance brought forward from last year, gives a total of £836 to be dealt with. The directors have decided to carry forward £400 to the reserve for renewal fund account, and recommend that the balance of £436 be carried forward to the next account. At the meeting last week the report and accounts were adopted.

SHEERNESS & DISTRICT ELECTRIC POWER & TRACTION.—The report for the year ended December 31st, 1907, shows that the receipts from the light railways amounted to £3,160, and from the electricity supply to £3,228, making with sundry receipts, a total of £6,413. The expenses (including debenture and other interest) amounted to £6,713, leaving a loss on the year's working of £300. Adding this loss to the debit balance of £676 from last account, there is a debit of £976 to be carried forward. The capital expenditure at the end of the year amounted to £75,167. The balance to the credit of working account on the traction section has risen from £88 in 1906 to £656 in 1907, the improvement being largely due to a closer adaptation of the service on the light railways to the requirements of the district. Negotiations have taken place between the company and the promoters of a light railway of about a mile and a half in length, proposed to be constructed from a physical junction with the company's line at the Sheerness East terminus to the village of Minster, and the company has offered to supply the necessary electrical energy, and to work the proposed light railway on terms. The high price of coal during the twelvemonth under review materially increased the operating expenses. The additions to the power-house and extension of mains referred to in the last report are now in course of completion, but the benefit of these extensions will not be felt until the second half of the current year. The company has joined the British Electrical Federation, Ltd., formed by various electric traction and lighting companies, for the purpose of co-operation and joint action in matters of common interest. The number of units sold during the year was 260,C01, and the maximum demand upon the station was 326 kw. The mileage of light railways in operation has not been added to during the year, and represents 2·479 miles of routes, 2·254 miles being double track, and 0·225 miles single track. The number of passengers carried increased from 759,538 to 834,511, but the average receipts per passenger dropped from 0·98d. to 0·88d. At the meeting on Thursday, the report and accounts were adopted.

TRAMWAYS AND LIGHT RAILWAYS ESTATES.—The report for the year ended December 31st, 1907, shows a total revenue of £1,400 and expenses of £813. The directors recommend that £100 of the balance should be allocated to the reduction of goodwill account, and that a dividend of 3 per cent. per annum upon the ordinary shares be paid, leaving a balance of £186 to be carried forward.

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MISCELLANEOUS BUSINESS NOTES

PRICE OF COPPER.—Messrs. George Smith & Sons, of 5 Philpot Lane, London, E.C., inform us that the price of electrolytic wire bars, net c.i.f. port of arrival, quoted Tuesday night, was £59 10s. to £60 per ton (last week £59 5s. to £59 15s. per ton).

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—A meeting of the creditors of Henry Gorton, trading as H. Gorton & Co., Electrical Engineers, of 19 Grand Parade, Highgate, and 535 High Road, Tottenham, was held last week. Liabilities amount to £1,240, and the assets were expected to produce £1,060. A committee was appointed to investigate and report to the creditors.

Creditors of the St. Albans & District Electric Supply Co. are requested to send particulars of their claims to the liquidator, Mr. James McLeod, 101 Finsbury Pavement, London, E.C., by July 31st.

A meeting of the Electric Traction Construction and Equipment Co. will be held at 5 New Court, Lincoln's Inn, London, W.C., on July 21st, at 3 p.m., to hear the Liquidator's account of the winding-up.

MESSRS. J. H. HOLMES & CO.—The silver jubilee of J. H. Holmes & Co., Newcastle-on-Tyne (founded 1883), was celebrated on Saturday, the 6th inst., by the partners of the firm inviting their staff to an excursion on that day to "Glen Allen," the country house of Mr. J. H. Holmes (the founder of the firm), near Whittingham.

MESSRS. L. E. WILSON & CO.—In order to deal with increasing business in the Liverpool district, Messrs. L. E. Wilson & Co., of 20 Cross Street, Manchester, have decided to open a branch establishment at New York Buildings, 67 Stanley Street, Liverpool. Telephone: Central, 87; telegrams: "Telephony," Liverpool. They have also appointed Mr. F. L. Monkhouse, M.I.E.E. (late manager in Liverpool for the Walsall Electrical Co., Ltd.) as Managing Engineer.

THE LINOLITE CO.—A very successful outing of the staff of this company was held last Saturday. The party journeyed by rail to Clandon, and were accompanied by Mr. and Mrs. A. S. E. Ackermann and Mr. R. L. Matthews.

The Electric Railway Journal.—It was announced a few weeks ago that the McGraw Publishing Co., of New York, the proprietor of our well-known traction contemporary, the *Street Railway Journal*, and other periodicals, had purchased from the Wilson Co. the *Electric Railway Review*, formerly published at Chicago, with a view to the foundation of a consolidated periodical covering the entire field of electric traction. The first issue of the new form of the paper appeared under the title of the *Electric Railway Journal* on June 6th. Its external appearance resembles that of the *Street Railway Journal*, with the volume of which the numbering is consecutive, and the way in which the good points of both papers are combined in the contents augurs well for the success of the combined venture. The *Street Railway Journal* was started in November, 1884, at New York, as a monthly periodical, but was changed into a weekly paper in 1901. The younger member of the consolidation also appeared originally as monthly, under the title of the *Street Railway Review*, but since 1899 was issued during the conventions of the American Street Railway Association in a daily edition. In June, 1906, with a change in ownership, the title *Electric Railway Review* was adopted, and at the beginning of last year was changed from a monthly to a weekly paper.

Telegraph Traffic.—The cable between the Dardanelles and Constantinople is again in working order, repairs having been effected on the 10th inst. On the following day the cable between Djedda and Souakim, which ceased operating on June 9th, was also put in order. The *viâ* Fao and Hanekin routes have once more been in trouble, interruptions of the land lines having occurred between Alep and Bagdad, between Alep and Diarbekir, and between Sivas and Diarbekir, but they were both restored to working order on the 13th inst. On this day also the West India and Panama Telegraph Company successfully re-established telegraphic communication between Demerara and Trinidad, their cable-repairing steamer, the *Henry Holmes*, having repaired the cable between those two places. The question of a wireless system between these two British possessions, as a means of duplicating the submarine cable, does not appear to have advanced.

Extensions to the Cavendish Laboratory.—The new wing of the Cavendish Laboratory of Experimental Physics at Cambridge was opened by Lord Rayleigh, Chancellor of Cambridge University, on Tuesday in the presence of a large assembly. In his speech he referred to the five years he had himself spent as Cavendish Professor, and to the assistance rendered at the time of Drs. Garnett, Glazebrook, and Shaw, and others, especially in the work of evaluating the fundamental electrical units, and paid striking tribute to his distinguished successor, Prof. J. J. Thomson. The Cavendish Laboratory was opened on the same day of the year in 1874.

PARLIAMENTARY INTELLIGENCE

LONDON ELECTRIC POWER BILLS.—Our report of the proceedings before Lord Cromer's Committee of the London Electric Power Bill will be found on pages 937 to 939.

AUDIT OF ELECTRIC LIGHTING COMPANIES' ACCOUNTS.—In the House of Commons on Monday Mr. Chiozza Money asked the President of the Board of Trade if it had been decided in future to accept the audit of the electric lighting companies' own auditors as sufficient for a public audit of the Electric Lighting Acts. Mr. Churchill, in reply, stated that there had been some misapprehension as to the action taken by the Board of Trade in this matter. Official auditors were still appointed by the Board of Trade, and were especially instructed to direct their attention to the protection of the interests of the consumers and the possible purchasing authority. In all cases these official auditors were professional accountants, and in some cases were identical with the shareholders' auditors, an arrangement which avoided a certain amount of unnecessary duplication of work, though it might carry with it some possible disadvantages. But it had not been adopted in any case in which the local authority could purchase the undertaking upon the basis of capital expenditure. He would watch the present arrangements carefully in case any change should be necessary. (We discussed the whole question of the new policy of the Board of Trade with regard to audit in a long article in our issue for February 20th, page 281.)

RAILWAY ELECTRIFICATION.—Mr. Chiozza Money has given notice of the following question which he will address to the President of the Board of Trade on Tuesday next:—Whether his attention has been directed to the fact that the Prussian State Railways Administration is about to electrify some parts of its system; if, in the interests of British trade and locomotion, he can direct the attention of British railway companies to the fact; and if, in the event of British railway companies neglecting to avail themselves of electrical power, he will, in the public interest, introduce legislation to nationalise British railways in order to make them as efficient and as economical as those possessed by our greatest commercial rival.

PROGRESS OF ELECTRICAL BILLS.—The Central Ireland Electric Power Bill was read a third time in the House of Commons on Wednesday last week. The Bristol Tramways, Nottinghamshire & Derbyshire Tramways (No. 2), and the South Wales Electrical Power Distribution Bills, were read a second time on the same day.

MISCELLANEOUS CITY NOTES

ALUMINIUM CORPORATION.—According to the *Financial Times* the balance-sheet shows the following items:—Debit: issued capital, less calls in arrear, £285,830; creditors, £20,975; total, £306,805. Credit: property account, £86,140; construction and equipment of works at Dolgarrog and Wallsend to date, £100,455; contribution to cost of Wallsend electrical sub-station, &c., £6,200; expenditure on transmission line, £4,453; cash, £41,185; debtors, £1,333; stocks of material and aluminium, £3,808; expenses *re* Cowlyd Water Bill and Light Railway Order, £1,369; underwriting commission and preliminary expenses, £58,658; general expenditure during construction, less rents, &c., £2,606; other items, £598; total, £306,805.

ANGLO-ARGENTINE TRAMWAYS CO.—Applications have been invited for £565,000 four per cent. debenture stock at 92. The stock will be redeemable by purchase at not exceeding 102 and current interest, or by drawings at 102, by the operation of annual sinking fund, calculated to redeem the whole stock by June 30th, 1968. The company have a right to redeem the whole or any part of the stock at 102 at six months' notice after June 13th, 1918. The stock will be secured by a trust deed creating a floating charge on the undertaking of the company subject only to the existing 6 per cent. debenture stock.

BRITISH INSULATED & HELSBY CABLES.—The transfer books will be closed from the 17th to the 30th inst., both days inclusive, for the preparation of warrants for interest on the debenture stock. The warrants will be posted on the 30th inst.

BUENOS AYRES GRAND NATIONAL TRAMWAYS CO.—A final dividend of 2s. 6d. per share, less income tax, making 5 per cent. for the year to March 31st, 1908, has been recommended upon the 5 per cent. cumulative preference shares.

INTERNATIONAL ELECTRICITY CO. OF VIENNA.—The *Financial News* announces that a net profit of 2,555,000 kr. has been made and a dividend of 8 per cent. for the year declared.

LA COMPAGNIA DE GAS Y ELECTRICIDAD DE LA HABANA.—The numbers have been published of the 5 per cent. debentures which have been drawn for redemption at par on July 1st, at the office of Messrs. Greenwood & Co., 38 Austin Friars, E.C.

MELBOURNE TRAMWAY & OMNIBUS CO.—Cable advices have been received that a dividend at the rate of 15 per cent. per annum has been declared for the quarter ending 30th inst.

SAO PAULO TRAMWAY, LIGHT & POWER CO.—A quarterly dividend of 2¼ per cent. has been declared.

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THE RECENT FIRE AT THE CLAPHAM COMMON STATION OF THE CITY AND SOUTH LONDON RAILWAY

MR. A. P. TROTTER, Electrical Adviser to the Board of Trade, has given the following report on the slight fire at the Clapham Common Station of the City and South London Railway, reported in our issue of May 28th last :—

I have the honour to report, for the information of the Board of Trade, the result of my inquiry into the accident that occurred on May 24th to an electric locomotive belonging to the City and South London Railway Company at the Clapham Common Station.

I visited the Stockwell Depôt of the City and South London Railway on May 25th, and inspected the locomotive which had been destroyed by fire. I was informed that the last train stopped at 11.40 p.m. on Saturday, 23rd, and that the electric current was shut down at 12.20 a.m. on Sunday morning. All the staff left the station, except the night watchman. He usually remains all night, but as the traffic does not begin until 11.30 a.m. on Sundays, he leaves at 3 a.m. on Sunday morning. He reports that he left everything in good order at that time. At about 7.30 a.m. smoke was seen coming out of the station and the fire brigade was called. The men had some difficulty with smoke on the stairs, and because they did not know the way. When they reached the platform there was less smoke, and they extinguished the burning locomotive.

There seems to be no evidence to show that the fire was due either directly or indirectly to the electric current, and it is impossible to connect it with any electrical cause.

It seems to have burned most fiercely at the corner where a cupboard stands, and at the opposite corner where there is a considerable collection of insulated cables. The contents, including controllers, and other machinery above the floor level were destroyed. A little woodwork remained not quite burned, and this was extinguished by the firemen. The amount of wood has been reduced in the newer locomotives. The carriage next to the locomotive was uninjured inside; the glass of the door was broken by heat, and the paint blistered.

If any servants of the company had been present when the fire first broke out, it could have been extinguished in a few minutes. But being allowed almost to burn itself out, it afforded an interesting and satisfactory test. The wooden platform showed no traces whatever, and the only signs that there had been a fire was a little smoke on the roof, split tiles, and the partial burning of a few feet of wood moulding round the advertisements. The complete escape of the carriage coupled to the locomotive is a point in favour of separate locomotives.

The cause may have been (1) a lighted match thrown down by a man just before leaving, or (2) the emergency oil lamp which may not have been extinguished, or (3) spontaneous firing of oily waste in the cupboard. No large amount of oily waste is kept on the locomotives, and spontaneous firing, I believe, does not occur with small quantities.

APPOINTMENTS AND PERSONAL NOTES

Messrs. Kennedy & Jenkin announce that they have taken into partnership Mr. John MacFarlane Kennedy and Mr. Sydney Bryan Donkin. The name of the firm remains unaltered.

After four and a half years' work as technical editor, Mr. W. Perren Maycock has severed his connection with the Westinghouse Companies' publishing department, and intends to take up a wider sphere of activities. Mr. Maycock, on leaving the Westinghouse works, was the recipient of a substantial cheque, subscribed for by no less than sixty of the chief members of the engineering and commercial staffs.

Mr. Lovick, late canvasser to the Stoke Newington Electricity Department, having been appointed to a similar position under the Fulham Borough Council, his arrangement with the Stoke Newington authority as a whole-time officer has been determined, and a new arrangement has been entered into whereby Mr. Lovick will devote a portion of his time only (during the evening), upon the same commission terms as heretofore, but without salary.

National Electric Light Association, Chicago Convention.—The total attendance at the thirty-first convention of the association, held in Chicago, on May 18th to 22nd, was 1,788, exceeding by 100 the attendance at Washington last year. An exhibition of electrical appliances was held in connection with the convention. The following are some of the Papers read before the convention :—"Distribution in Suburban Districts," by O. H. Lukes: "The Small Station and its Economical Operation," by J. T. Whittlesey and P. Spencer. Reports of various committees, including the "Progress Committee," the committee on the "Grounding of Secondaries," and another on the system of accounting for electric lighting companies. A Paper on "Some Observations on Photometric Precision," by Prof. A. E. Kennelly and S. E. Whiting, and others on "Low-pressure Steam Turbines," "Gas Engines," "Meters," and also three Papers relating to tungsten filament lamps. Abstracts of the more important of these Papers will appear shortly in our columns.

NEW COMPANIES

ETABLISSEMENTS SELBACH.—This company was registered on June 5th with a capital of £12,500 in £1 shares (5,000 preference) to carry on the business of contractors, designers, mechanical and electrical engineers, builders and proprietors of motor-cars, motor-boats, engines, carriages, and launches, &c., and to adopt an agreement with P. Piellat and O. C. Selbach. The subscribers are : O. C. Selbach, C. F. Davies, W. A. Dickinson, H. Carpmael, M. W. Thompson, M. Ludwig, C. C. Crowther. No initial public issue. The number of directors is not to be less than two, nor more than five; the first are O. C. Selbach (managing director), L. P. Piellat, C. F. Davis, and W. A. Dickinson. Qualification (except first directors), 250 shares. Remuneration as fixed by the company. Registered office : 77 Camomile Street Chambers, E.C.

C. LARKINS & CO.—This company was registered on June 4th with a capital of £1,500 in £1 shares (1,400 preference) to adopt an agreement with S. O. Hoad and F. P. Spicer for the acquisition of the business carried on by them at Bush Lane House, E.C., as "C. Larkins & Co.," and to carry on the business of electric and general engineers and contractors, builders, decorators, bank, office, and shop fitters, &c. The subscribers are : F. L. Spicer, R. T. Dalton, E. Adams, A. L. G. Distin, F. P. Spicer, S. O. Hoad, P. W. Ladcoat. No initial public issue. The number of directors is not to be less than two, nor more than 10; the first are S. O. Hoad and F. P. Spicer (both permanent; special qualification, 25 ordinary shares). Registered office : Bush Lane House, Bush Lane, Cannon Street, E.C.

LEEDS & BRADFORD DISTRICT ELECTRIC RAILWAYS.—This company was registered on June 5th with a capital of £60,000 in £1 shares (40,000 preference) to adopt an agreement with the Railway & Tramway Trust, Ltd., relating to the transfer to the company of the Morley & District Light Railway Order, 1901, &c., and to carry on the business of tramway, railway, omnibus, electric, steam, or other mechanical carriage and van proprietors, carriers of passengers and goods, electricians, electric, water, and gas engineers, suppliers of electricity, &c. The subscribers are : W. A. Hill, R. G. Cheshire, H. P. Dakin, E. Edwards, F. R. Mills, A. R. Warren, A. Northam. No initial public issue. The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first. Qualification (except first directors), £200. Remuneration, £150 each per annum (chairman, £200).

McLAUGHLIN & BLAIR.—This company was registered in Dublin on June 12th with a capital of £5,000 in £1 shares, to acquire and carry on the business of plumbers' furnishers, electrical engineers, carried on by J. McLaughlin & W. Blair, as "MacLaughlin & Blair," at Belfast. The subscribers are : J. McLaughlin, W. Blair, W. R. Rawlinson, H. B. Brandon, W. J. Scott, H. A. McCann, W. J. McKerr. The number of directors is not to be less than two, nor more than five; the first are J. McLaughlin, W. Blair, and E. Lowden. Qualification, 100 shares. Registered offices : 20 Waring Street, Belfast.

MAGNETA TIME CO.—This company was registered on June 4th, with a capital of £30,000 in £1 shares, to take over the business and assets of manufacturers and installers of and dealers in synchronised time systems carried on by the Magneta Fabrick Electrische Uhren Actien Gesellschaft, of Zurich, at Millbank, London, and elsewhere (but only in the United Kingdom), as the "Magneta Co.," also to acquire for a certain period the services of A. R. Upward. The subscribers are A. R. Upward, F. Coveli, W. L. M. Benson, K. H. Young, W. H. Glendining, E. S. Saxton, and L. P. Turner. No initial public issue. The number of directors is not to be more than three; the first are A. R. Upward and one or two others to be nominated by the subscribers. Registered office : Millbank House, Millbank, London.

ORLING'S TELEGRAPH INSTRUMENTS SYNDICATE.—This company was registered on June 4th, with a capital of £1,500 in £1 shares, to acquire the benefit of certain provisional protections in respect of improvements in electro-capillary apparatus, for the transmission of a series of electric impulses along land lines or cables, and for improvements in cable telegraphy, to adopt an agreement with A. Orling, and to carry on the business of electrical and mechanical engineers, manufacturers of electrical and other apparatus, appliances, and machinery, &c. The subscribers are J. M. Horner, F. W. Burger, T. Inkersole, A. Orling, W. T. Moore, V. A. Wood, and E. Oldenburg. No initial public issue. Registered without articles of association by W. T. Moore, 24 Budge Row, E.C.

PREMIER ELECTRIC HEATERS.—This company was registered on June 4th, with a capital of £2,000 in £1 shares, to adopt an agreement with G. H. Collins and H. F. Collins for the acquisition of the business carried on as the "Premier Electric Heating Co.," and to carry on the business of manufacturers and sellers of electrically-heated appliances of all kinds, resistances for heaters, controllers, and regulators, &c. The subscribers are A. Barter, Mrs. E. Collins, A. J. Collins, W. T. Tonkin, G. H. Collins, E. Mackenzie, and H. F. Collins. No initial public issue. The number of directors is not to be less than two, nor more than seven; the first are G. H. Collins, H. F. Collins, and A. J. Collins. Qualification, £100. Registered office : Ashley Street, Birmingham.

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ANNUAL PATENTS REPORT

THE twenty-fifth annual report of the Patent Office for the year 1907 has just been issued. The first few pages of the report are taken up by a digest of the Patents and Designs Act of 1907, the main contents of which were given on pages 434 to 436 of ELECTRICAL ENGINEERING, Vol. II. The alterations in Patent Office procedure consequent upon the Act, which came into force on January 1st, 1908, were outlined in our issue of January 2nd, 1908, page 5. The following is a summary of the report for the year 1907.

In dealing with the financial state of the Patent Office, the report says: The receipts from Patents Fees were £265,012, as compared with £255,646 in 1906, an increase of £9,366; from Designs Fees £5,473, as compared with £4,544, an increase of £1,129; and from Trade Marks Fees £18,447, as compared with £15,559, an increase of £2,888. The increase in Trade Marks Fees is due partly to the revised scale of fees which only came into operation in the course of the previous year, and partly to the large increase in the number of Trade Marks registered. The receipts from the sale of Patent Office publications (which are paid over to the Stationery Office) were £11,457, as compared with £10,593, an increase of £864. The total receipts were £300,389, as compared with £286,142, an increase of £14,247. The total expenditure on behalf of the Office amounted to £176,230, as compared with £175,272, an increase of £958. The payments for salaries and pensions exceeded those of the previous year by £10,000 and £1,000 respectively, while there was a saving of nearly £6,000 in the expenditure upon stationery, books, &c., a decrease of £1,000 in the amount paid for rent, &c., and of £3,000 in that for the Patent Office extension.

The number of letters and correspondence forms despatched from the Office in 1907 was 296,000, and the number of parcels of publications 95,000, as compared with 283,000 and 93,000 respectively in 1906. The staff of assistant examiners was increased during the year from 153 to 177, and the total number of persons employed in the Office was 619 in 1907, as compared with 572 in 1906. The number of readers who made use of the Library in 1907 was 148,198, as compared with 143,750 in 1906, an increase of 4,448 or 3·09 per cent., and the largest number recorded in any one year. The number of volumes added to the Library was 6,116, of which 1,227 were volumes of patent specifications or journals (English and foreign), and 351 were trade catalogues. The remaining 4,558 volumes were text books or periodical publications relating to scientific and technical subjects, and of these 3,527 were obtained by purchase, and 1,031 by donation. The number of works in the library at the end of the year was 35,449, and the approximate number of volumes (exclusive of duplicates) was 115,000.

Under the heading of "Patents," the following information is given: The sum received from renewal fees was £155,127, as compared with £149,142 in 1906, an increase of £5,935; and that from sealing fees was £16,071, as compared with £14,311, an increase of £1,760. The applications received in 1907 numbered 29,049, as compared with 30,030 in 1906, a decrease of 990 or 3·3 per cent. Of these applications 19,630 were accompanied by a provisional specification, and 9,410 by a complete specification. The applications accompanied by complete specifications continue to increase at a more rapid rate than those accompanied by provisional specifications. The proportion of the latter to the former was in 1885, 87 to 13; in 1895, 83 to 17; in 1905, 72 to 28; and in 1907, 68 to 32. The number of complete specifications filed after provisional specifications was 9,483. The total number of specifications received was 38,523, as compared with 39,268 in 1906, a decrease of 745, or 1·9 per cent. The largest number of applications received on any one day was 183—on June 29th, and the smallest 49—on January 5th. The applications received from women inventors numbered 560, as compared with 600 in 1906. There were 1,646 applications made by way of communication from abroad; of which 828 came from the United States of America, 453 from Germany, 70 from France, 38 from Switzerland, 30 from India, 29 from Canada, 27 from Austria-Hungary, 22 from Italy, and 22 from the Transvaal. The applications made in this country under the provisions of the International Convention of 1883 by inventors living in other States of the Union numbered 2,286, as against 2,044 in 1906. Of these, 819 were received from Germany, 587 from the United States, 548 from France, 91 from Sweden, 79 from Belgium, 56 from Italy, 47 from Switzerland, 26 from Norway, 17 from Denmark, 6 from New Zealand, 5 from Spain, 2 from Portugal, 2 from Australia, and 1 from Japan. None were received from Brazil, Ceylon, Cuba, Mexico, The Netherlands, San Domingo, Servia, or Tunis. The number of applications received from persons resident in England and Wales was 17,380 in 1907 as compared with 18,579 in 1906, a decrease of 6·5 per cent.; from Scotland 1,278, as compared with 1,307, a decrease of 2·2 per cent.; and from Ireland 349, as compared with 379, a decrease of nearly 8 per cent. As regards the Colonies, there was a decrease in the number of applications received from every State of the Australian Commonwealth except New South Wales, and also in those from Natal and Hong Kong. The number received from Canada was nearly the same as in 1906, while there was a small increase in those from New South Wales, New Zealand, Cape Colony, Orange River Colony, Rhodesia, the Transvaal, and India; and a more substantial increase in those from the West Indies. As regards foreign States, the numbers from Austria-Hungary, Holland, and Switzerland decreased; while those from Belgium, Denmark, France, Germany, Italy, Norway, Roumania, Sweden, China, Japan, and the United States increased. The foreign country which supplied the largest number of applications was again Germany, from which 3,541 applications were received in 1907 as compared with 3,253 in 1906. The numbers from the United States and France were respectively 3,104 and 1,042, as against 3,003 and 1,002 in the preceding year. The following gives the nationalities of the inventors to whom patents were granted during the last five years, the communicator of the invention being regarded as the patentee for this purpose:—Out of a total number of 16,272 patentees in 1907, 2,792 were resident in the United States of America, 2,608 in Germany, 753 in France, 299 in Austria-Hungary, 178 in Switzerland, 160 in Canada, 138 in Sweden, 128 in Belgium, and 112 in Italy.

Patents were sealed upon 16,300, or 54·2 per cent., of the applications made in the year 1906, and 525, or 4·3 per cent., of the patents sealed upon the applications made in the year 1894 were maintained for the full period of 14 years. The total number of patents which expired during the year was 14,470 and the total number of new patents sealed was 16,272. Thus the number of existing patents was increased during the year by 1,802. The names of 7 patent agents were added to the Register during the year, the total number on the Register on December 31st being 254.

A table in the appendix shows the progress of inventions from the year 1855 up to the end of 1906 in each of the 146 classes into which inventions are divided according to the official classification. The total number of complete specifications, which fell from 16,185 in 1904 to 15,459 in 1905, increased to 17,073 in 1906. The number of complete specifications relating to electric lamps, which was 329 in 1904, and 292 in 1905, rose to 370 in 1906. Specifications relating to telegraphy number 292, 293, and 294 in the same three years. The number of complete specifications under the heading of road vehicles increased from 257 in 1905 to 337 in 1906. Inventions relating to steam generators fell from 341 in 1904 to 259 in 1906.

The general trend of invention in matters of electrical interest during the year 1907 is summarised as follows:—The great inventive activity in connection with the motor-car industry, which has produced such a large number of applications for patents in recent years, now shows signs of falling off. Judging from the titles only, the number of inventions relating to motor road vehicles during the year 1907, although still large, has decreased nearly 35 per cent. from that of the previous year. The occurrence during the year of several serious railway accidents owing to the failure of signals has caused much attention to be given to automatic electrical systems of signalling, in which the services of signalmen are entirely dispensed with, and the signals are given on the engine itself instead of by means of the usual wayside devices. Several applications have also been made for stopping trains automatically when the signals are against them. The occurrence of accidents in lifts has directed the attention of inventors towards the improvement of devices for preventing a mine or lift cage from falling down the shaft in the event of its hoisting-cable breaking. A large increase is also observable in the subject of wireless telegraphy, and some attention was given to the transmission of portraits and designs by telegraphic means.

AN ELECTROLYTIC RECTIFIER

MANY users of motor-cars who have an electric supply available would be glad to use the same for charging their ignition cells if they felt they could do so with confidence and without danger of spoiling the accumulators. With direct current this can readily be accomplished by connecting the cells in series with an incandescent lamp, although it is not a very efficient method. With alternating current, some sort of converter is necessary in order to obtain a uni-directional current. The motor-generator, while fairly efficient at full load, has many drawbacks, not the least of which is its relatively great expense.

Electrolytic rectifiers have been in use to some extent for this purpose for some time. Such a cell in its simplest form consists of two electrodes immersed in an electrolyte, the combination being such that, through the chemical reactions, one electrode becomes covered with an insulating skin, which opposes the flow of the current in that direction. On placing such a cell on an alternating-current circuit, the currents in one direction will be stopped, but those in the opposite direction will be able to pass. This throttling effect is most marked when aluminium is used as one of the electrodes, the other element being usually carbon, lead, or iron. The electrolyte may be an acid, alkali, or a salt solution. The aluminium covers itself during formation with a thin skin, which weakens or throttles the positive current, and there is a certain maximum or critical voltage, partly depending upon the electrolyte, which

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the aluminium will be able to stop. By connecting four cells in the manner suggested by L. Graetz, so as to provide two paths for the current, one only of which is open to the current at any moment, the two alternating waves are converted into uni-directional wave pulses. The pulsations may be smoothed out considerably, if desired, by the use of condensers or inductive resistances, but such additions are unnecessary when used for charging accumulators, as the insulating skin on the aluminium electrode prevents the cells discharging themselves through the rectifier while the voltage is below that of the cells. Herein is a great advantage over a motor-generator, which requires the addition of an automatic cut-out to disconnect the accumulators should the voltage drop from any cause. With a rectifier the cells may be left connected indefinitely without danger of discharging. Although the rectifier takes care of the current, it does not reduce the voltage of the supply. The most satisfactory and efficient way of doing this is to use some form of static transformer which can be wound to give any desired voltage to the rectified current. In order to reduce the initial cost of the apparatus, incandescent lamps are sometimes used as a resistance to absorb the excess voltage, but such a method is the most wasteful one that could be devised, and at best is only suitable for small currents.



The illustration shows an improved form of rectifier, the invention of S. W. Cuttriss, Leeds, and which is being manufactured by P. J. Pale, Dewsbury Road, Leeds. This arrangement has the advantage of only requiring one cell instead of four as hitherto used, and at the same time it utilises both semi-phases of the current. It is extremely simple in operation, and inexpensive to maintain. No acid is used, only an inexpensive salt (sodium phosphate), which does not give off any corrosive fumes, and has no action on the electrodes when not in use. By raising or lowering the aluminium electrodes, the current can be regulated within wide limits while the apparatus is in use. Ventilating chimneys are provided which prevent the electrolyte becoming unduly warm when in action. A special form of transformer has been designed for use with the cell, in which the circuits are so arranged that both currents always pass through the cell in the same direction. The transformer, which can be wound for any desired voltage on the direct-current side of from 2 to 50 volts, forms part of a complete switchboard, which also contains an ammeter, switch, fuse, and the necessary terminals. No additional apparatus is, therefore, required, and the current may be taken direct from a lamp-holder by means of an ordinary connector.

In addition to charging accumulators, such an apparatus may be used for working direct-current motors, medical appliances, arc lamps for optical lanterns, electrolysis, and any purpose where a direct current is required.

AUTOMATIC FIRE ALARMS

IN an article in the *Deutsche Bauzeitung*, Mr. Wendt, the State Inspector of Buildings in Berlin, describes two systems of automatic fire detection which are largely in use on the Continent. These are the automatic fire detector of Schöppe, Leipzig, and the "Dania" automatic fire detector of Tvermoes & Abrahamson, Copenhagen. An automatic fire-alarm system consists of the following parts:—The fire detector or thermostat, the system of wiring, and the alarm apparatus. The thermostats should be placed high up under the ceiling or roof near to doors, windows, lifts, and other ventilating channels, and there should be one detector for every room that is not larger than 30 ft. by 30 ft. and 12 ft. high. For larger rooms the number of detectors must be increased in proportion. In factories each division must be treated as a separate room and supplied with thermostats according to size. The thermostat in the Schöppe system consists of a bent spring or strip of metal fixed at each end to a cast-iron base. A screw, fitted with a platinum contact, and insulated by means of a porcelain collar from the base, faces another platinum contact on the spring. These platinum contacts are surrounded by a piece of rubber tubing as a protection against dust. An increase in temperature causes the spring to bend, and contact is either made or broken according to whether the open or closed circuit system is adopted. The temperature at which the thermostat operates can be fixed by means of the adjustable contact screw. The "Dania" thermostat consists of two independent elements: the "Differential" element, which works as soon as the heating rate of the room exceeds the normal rate at which the room can be heated by means of the usual heating apparatus, and the "Maximum" element, which works as soon as the temperature of the room has reached a certain value. The Differential element is a U-shaped sealed glass tube, about half filled with mercury. Over the mercury is placed in both branches a small quantity of a volatile liquid hydrocarbon. Before sealing all the air is extracted, so that the space in both branches is filled with vapour of the liquid only. A platinum wire conducts the current into one branch, and two wires in the other branch afford alternate circuits, one through a resistance and one direct to the main circuit. The branch in which one wire only is sealed has a thicker glass wall than the other branch. If the two branches have the same temperature there will be equal vapour pressure in both, and the mercury will stand at the same level. If both branches are acted upon by a current of air, whose temperature is rising at a certain rate, the heat will pass into the branch with thick walls at a slower rate than into the other. This means that the difference in pressure goes on increasing so that the mercury is pressed down in the thin-walled branch. As soon as the mercury comes below the top platinum wire, the current is diminished, as it can now only pass on through the resistance. When the current is thus diminished a danger call is given. After a short time the mercury will also come below the second contact, and the circuit will be totally broken, and a fire signal will be given. Thus the "Differential" element has nothing to do with a fixed temperature; the giving of the signals depends only on the heating rate and the actual temperature of the room is therefore immaterial. The "Maximum" element consists of a bent closed glass tube, in which are sealed three platinum wires conducting the electrical current through mercury contained in the tube. The mercury is supported by a solid non-conducting substance, that melts at a certain temperature. When the substance melts at this critical temperature the mercury sinks down. By this means the contact with the top platinum wire is broken, and the current must now go through the second platinum wire and a resistance. A danger signal is then given. When the mercury sinks still further the circuit is totally broken and a fire signal is given. The "Maximum" and the "Differential" elements are connected up in series.

As above stated, the Schöppe thermostat can be wired for the open or closed circuit system; the "Dania" thermostat, on the other hand, can be used on the closed circuit system only. The advantage of the open system is that an existing bell system may be utilised, and no extra wiring is needed. With the closed circuit system, however, a fault is at once disclosed automatically, and this system is therefore safer. In closed circuit-systems, a current of from 8 to 30 milliamperes is used, the alarm apparatus being operated by relays which come into operation if the detector circuit is broken. In the case of the "Dania" system, a break in the detector circuit not due to a fire will cause a sudden cessation of current, not preceded by a diminution of current. By an ingenious arrangement of the relay armatures, this is caused to give a warning signal only and not a fire signal. The alarm apparatus consists of an indicator board and alarm bell in each of the above systems.

CORRESPONDENCE

THE HART ACCUMULATOR CO.

To the Editor of ELECTRICAL ENGINEERING.

SIR,—Some misunderstanding having arisen through the notice published relative to the winding up of the Hart Secondary Battery Syndicate, Ltd., I should like to state that this liquidation in no way affects the Hart Accumulator Co., Ltd., beyond the fact that the Hart Accumulator Co., Ltd., have purchased the foreign patents of the syndicate with the intention of further developing their foreign and Colonial trade in accumulators.

The similarity of name has evidently caused some confusion, and I should be very glad if you will give me the opportunity of making this explanation.

Yours faithfully,
HART ACCUMULATOR CO., LTD
(*J. H. Poulton, Sec.*)

Stratford, June 10th, 1908.

CATALOGUES AND PAMPHLETS RECEIVED

ACCUMULATORS.—A list from Richard Pape, Ltd., of Albion House, New Oxford Street, W.C., gives particulars of several types of the "Fors" accumulators now manufactured by this firm for ignition and lighting purposes. The positive and negative plates are separated by porous partitions, and, on account of this, freedom from short-circuit, and retention of charge for a long period, are claimed. An output of 18 watt-hours per lb. of complete cell is guaranteed. A 4-volt 40-ampere-hour (ignition capacity) accumulator of this make weighs 5¼ lb. with a celluloid cell. An 8-volt 75-ampere-hour (one ampere continuous discharge) carriage lighting accumulator in a teak case weighs 36 lb. complete.

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ELECTRICAL ENGINEERING

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☞ The present number concludes Vol. III. of *Electrical Engineering*. An Index for this volume will be given away as a Supplement to *Electrical Engineering* of July 16th, at which date Binding Cases will also be ready.

Binding Cases for Vol. III. may now be ordered, price 2s. each, post free 2s. 4d. Readers can have their volumes bound by their own bookseller; or they may send their numbers to us, carriage paid (with the reader's name and address), and a remittance of 4s 6d. under separate cover. The volumes will then be bound and returned carriage paid to any address in the United Kingdom, or carriage forward to the Colonies or abroad.

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SUMMARY

The House of Lords Committee, presided over by Lord Cromer, has decided to pass the London and District Electric Power Bill (the Parshall-Hammond scheme) in an amended form. The company is to be authorised to supply "in bulk," and to supply railways, tramways, &c., but, so far as general power supply is concerned, consent of the "authorised distributor" is necessary in accordance with the so-called "Kitson" clause, by which the Board of Trade may intervene if consent is "unreasonably" withheld. The "linking-up" powers, and the powers to supply tramways and railways running outwards from their areas, are to be granted to the group of eight companies, but the elaborate scheme in the Bill for the formation of a Joint Committee has been thrown out. (Pages 952 and 953–959.)

The report of the Finance Committee of the London County Council upon the audit of the tramway accounts by Messrs. W. B. Peat and F. W. Pixley has been adopted by the Council after protracted discussion. The principal recommendation was that the repayment of the debt in respect of obsolete capital expenditure outstanding on the horse tramways, estimated at about £1,000,000, be spread over a period of 15 years, commencing March 31st, 1914. Reports have also been submitted by the Highways and Finance Committees on the question of provision for renewals in the tramway accounts, recommending the establishment of separate renewals and reserve funds, and considering the distinction between repairs and renewals for various parts of the equipment. (Page 959.)

A meeting of members of the Institution of Electrical Engineers is to be held next Tuesday to consider a scheme for the provision of a new home for the Institution by the purchase of the building on the Victoria Embankment, between the Savoy Hotel and Waterloo Bridge, now used as an examination hall, &c., by the Royal Colleges of Physicians and Surgeons. (Page 963.)

The thirteenth Annual Convention of the Incorporated Municipal Electrical Association will be held at Nottingham next week, from Tuesday to Friday inclusive, under the Presidency of Mr. H. Talbot, Chief Electrical Engineer to the Corporation of Nottingham. After the Presidential address on Tuesday, a discussion will take place on a Paper by Bailie Wightman, Convener of the Electricity Committee, Govan. On Tuesday afternoon the car-sheds and repairing shops of the Nottingham tramways and one of the power houses for the lighting and traction will be inspected. Thursday morning will be devoted to the Annual Business Meeting, when the Council's Report will be presented and the new President and Council will be elected. In the afternoon, Papers emanating from Dundee and

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Worcester, on the design of generating stations will be discussed; and on Thursday Papers will be presented on "Alternating-current Accumulator Sub-Stations," and on the work of a testing and standardising department. We publish short biographies of the readers of the Papers, and portraits of these and other gentlemen who will fill prominent positions at the Convention. (Page 961.)

THE electricity supply of Nottingham is carried out by the Corporation from two coal-fired stations and one destructor station. At the three stations there are in all 34 sets, all consisting of Siemens continuous-current dynamos, driven by Willans central-valve engines running non-condensing; all the sets are under 500 kw. capacity. (Page 965.)

ON the Nottingham Tramways the British Thomson-Houston Co.'s new "electro-mechanical" track brake is being introduced. Other features are the use of trolley wheels with renewable centres, the replacement of the wooden shoes of the ordinary slipper-brakes with cast-iron shoes, and the gradual introduction of grooved trolley wire and mechanical ears. (Page 971.)

THE Annual Convention of the American Institute of Electrical Engineers is to be held at Atlantic City next week. The Convention of the Canadian Electrical Association was held last week at Toronto. (Page 970.)

COL. H. H. YORKE has now issued his Board of Trade Report on the accident on the Glasgow Tramway system last January, when a car ran away down a hill and collided with several vehicles. Owing to the death of the driver, it is impossible to ascertain the exact cause of the car getting out of control. The reversing handle of the rear controller had, however, jammed, and had been allowed to remain in the forward position, and with the particular type of controller used this may possibly have led to a cutting out of the magnetic brake circuit by an accidental shifting of the main spindle of the rear controller. (Page 973.)

THE causes which underlie the corrosion and rusting of iron are of perennial interest, and much work has been done upon the subject. Under "Electrochemistry and Electrometallurgy" we again refer to the subject, and show that solution of iron in water may take place without actual red rusting being apparent. Other subjects dealt with are the electric production of carbide and ferro-silicon, uses of aluminium, and a method for studying the effect of temperature during annealing upon the magnetic properties of iron. (Page 975.)

UNDER "Electrical Science," in the British and American Section, a novel rectification effect in vacuum tubes is described. In the Papers abstracted in the Continental Section, DOLEZALEK describes a new instrument called the Binant electrometer, and WITTE pleads for an electromagnetic theory of mechanics. (Page 976.)

THE accounts of the Brighton Corporation Electricity Department for the year ended March 31st last show a loss of £3,657 as compared with £10,233 for last year. The scheme for running a tramway service through the centre of Brighton from Worthing to Kemp Town has been rejected.—The accounts of the Dundee Corporation Electricity Department show a net profit of £1,078 after meeting interest and sinking fund.—After discussions extending over three years the Dunfermline Town Council has decided to lease their Provisional Order to the Fife Electric Power Co.—At the last meeting of the Edinburgh Town Council, it was decided that the period for the repayment of loans upon the electrical undertaking should be reduced from 30 to 25 years.—The St. Pancras Borough Council has had under discussion the question of wiring houses through the medium of private contractors at accepted schedules of prices. There was some opposition, and the matter has been referred back for further report. (Pages 977 to 980.)

THE Farnworth Council proposes to expend £7,000 upon its electric lighting undertaking. Six double-deck tramcars are required by the Pontypridd Corporation, and a feeder cable by the St. Anne's-on-Sea Council. The Metropolitan Asylums Board has decided to light the North-Eastern Hospital by electricity at the cost of £4,500. (Page 980.)

IT is proposed to register a new company with a capital of £250,000 to carry on the business of Messrs. Bruce, Peebles & Co. The report of Messrs. J. G. White & Co. for the year ended February, 1908, shows a net profit of £36,162. (Pages 981 and 982.)

THE report of the British Electric Traction Co., for the year ended March 31st, 1908, shows a gross profit of £250,539, whilst the expenses, including interest on 5 per cent. and 4½ per cent. debenture stock, amounted to £144,829. The balance to be dealt with, including the amount brought forward, is £118,824. The directors, after careful consideration, recommend that the full dividend on the preference shares at the rate of 6 per cent. per annum be paid for the six months ended September 30th, 1907, which is at the rate of 3 per cent. for the financial year. The sum of £35,000 is added to the reserve fund, and £35,393 is carried forward. (Page 985.)

A SHORT illustrated article is given on a 1,000 h.p. gas engine recently installed in this country, which, it is claimed, is the largest vertical gas engine in the world. (Page 987.)

JUDGMENT in the case between Messrs. Scott & Mountain, Ltd., and the Kent Collieries Co., Ltd., was given in the Official Referee's Court on Tuesday last. The generating plant delivered to the Kent Collieries Co. was found to be not according to the contract, and Messrs. Scott & Mountain were accordingly awarded only a portion of the balance due. The Kent Collieries Co. lost the case with regard to their counter-claim, with the exception of a small sum for damages, on account of breach of contract. (Page 987.)

AMONG the Patent specifications published last Thursday by the Patent Office is one by S. DE PONT, which gives a process for the manufacture of an insulating material which is non-inflammable and affected by neither water nor oil. Another, by G. ELLISON, describes a combined starting resistance, over-load cut-out and no-voltage release for use with three-phase induction motors. A specification by the COMPAGNIE PARISIENNE DES VOITURES ELECTRIQUES relates to the control of petrol-electric vehicles, and provides a method whereby the power supply to the motors can be stopped without breaking the main circuit. The composition of a magnetite arc-lamp electrode for use with alternating current is given in a specification by G. M. LITTLE, and A. P. STROHMENGER describes the manufacture of a separating material for use in secondary cells. THE WOLFRAM METAL FILAMENT LAMPS, LTD., have applied for amendments to several specifications relating to the manufacture of metal filaments for incandescent lamps. The amendments consist in striking out all references to molybdenum and limiting the inventions to tungsten. A patent for an improved Wheatstone automatic transmitter, and another relating to sealing and junction boxes for lead-covered cables, expire during the current week. (Page 988.)

NOTTINGHAM is to be doubly honoured this summer. Next week the Incorporated Municipal Electrical Association will hold its Convention there, under the presidency of Mr. H. Talbot, the Borough Electrical Engineer, and in September Mr. John Aldworth, general manager of the Nottingham tramways, will preside over the summer meeting of the Municipal Tramways Association in the same town. Although

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from the point of view of the electrical engineering industry, Nottingham can hardly be described as one of the chief centres, yet it is a flourishing town with nearly a quarter of a million inhabitants, and is identified with a flourishing industry, lace and hosiery manufacture. In this, electric driving is being gradually adopted with considerable advantage, and this fact is a significant sign of the change in popular ideas and prejudices. Nottingham was one of the towns in which, just about a hundred years ago, the serious "Luddite" riots against the replacement of handwork by machinery centred, and hundreds of stocking frames were broken up. Now the new method of machine driving is welcomed, not only by the manufacturers, who see in it increased efficiency, better products, and greater output, but also by the operators themselves, who realise the improvement electricity is gradually effecting in the conditions under which they work.

WE are glad to be able to announce that steps are being taken to provide a permanent home for the Institution of Electrical Engineers, which shall render it possible for the meetings to be held without having to take advantage of the hospitality of other societies. Some particulars are given, in another column, of the building which it is proposed to acquire, and we can say at once from a personal inspection that it is one which can be excellently adapted to the purposes of the Institution. Alteration may be necessary, in the future, to the lecture theatre to meet the growing numbers attending the meetings, but even in its present form the seating accommodation is practically equal to that of the Institution of Civil Engineers, which we know so well. Some wonder may be felt among members as to ways and means for the provision of the £50,000 mentioned as the probable purchase price, and the couple of thousand required annually for ground rent, as no financial scheme is outlined in the circular convening the meeting. It may be thought that, at a time when the electrical industry generally is not overburdened with surplus revenue, an appeal to the generosity of members would be inadvisable, although we doubt not that there would be a ready response. Happily, however, the financial position of the Institution is such that the scheme could be got through without relying to more than a limited extent upon donations from the membership. It is estimated that the property which the Institution acquired some years ago in Tothill Street would realise about £25,000, and that the remaining half of the sum required might at a pinch be available from invested capital and other property, although this would deplete the funds of the Institution somewhat seriously. With regard to the ground rent, it is anticipated that this would be more than covered by rents from subletting the portions of the building not immediately required for the purposes of the Institution. In any case, however, the present annual surplus shown in the accounts is sufficient to provide the amount required. We trust that there will be a full meeting of members and associate members next Tuesday, so that the matter may be well discussed in all its bearings.

AN abstract of Colonel Yorke's report to the Board of Trade upon the remarkable tramway accident in Glasgow on January 3rd of this year, when a car ran away for 1,000 yards and collided with eight vehicles in succession, is published in this issue. The evidence available was imperfect, owing to the fact that the motorman was killed, but there is little doubt that the magnetic brake was out of action, and Colonel Yorke's conclusion is fully justified, viz., that the driver relied upon this brake to control the car down the long but not very steep slope between Cathedral Street and Glasgow Cross, and that by the time he found it useless the car was travelling too fast to be pulled up by the other means available. The way in which the magnetic brake was probably disabled is fully explained in the report, and is an example of unforeseen consequences, following upon the irregular use of apparatus which is well designed for its intended method of operation. The driving of a car with a stuck reversing handle at the rear end, and none at the driving end, is a contingency which the designer of the controller can hardly have contemplated; but it is surprising to learn that there are at this date controllers in use from which the driving handle can be removed when it is in any but the "off" position. Although the usual practice (in Westinghouse controllers, as well as other makes) prevents the removal of the handle, unless it is in the "off" position, it is quite possible to move the power barrel after the handle has cleared the retaining ring, but is not off the "square" of the spindle. The special lesson of the accident is that cars should not be kept in service with a glaring defect in the electrical equipment, since neither motormen nor inspectors, however intelligent and well taught, can be expected to foresee all the possible consequences of using the equipment in a totally different way to that intended by the designers and makers. Another lesson which this case reinforces is that where a power-brake is fitted, it should be used in regular service, and not reserved for special or "emergency" use. The progress of the British Thomson-Houston combined mechanical and magnetic track brake, described in this issue, will be watched with interest in this connection, for it is a brake whose efficacy as a magnetic brake is not impaired by its being employed as a hand brake, and, in fact, it should be one of the brakes which will assist in the dangerous hand wheel brake being consigned to the museum of antiquities.

JUST as we go to press, Lord Cromer has announced the decision of the House of Lords Committee on the London Electric Power Bills. The London and District Electric Power Bill, the scheme promoted by Mr. PARSHALL and Mr. HAMMOND, for the erection of a 60,000 kw. generating station at Barking, to supply all London "in bulk" and for power purposes, is passed with certain alterations making it acceptable to the London County Council. As amended the Bill gives powers to the new company to supply existing electricity undertakings "in bulk," and to give supply to railways, tramways, docks, canals, &c.; and also to supply for power purposes only with the sanction of the existing "authorised distributor," but if consent is "unreasonably" withheld, there is to be an appeal to the Board of Trade. Presumably the withholding of consent would be considered unreasonable if the new company offers to supply a consumer at a far cheaper rate than the present supply authority, but a small decrease in price would not be considered sufficient ground for the Board of Trade to intervene, as the Board will have

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to take account of the less favourable position of the present suppliers with regard to the ultimate period of purchase. "Linking-up" powers are given to eight of the present London companies, but the complicated scheme for the establishment of a Joint Committee is not sanctioned. Permission to supply railways and tramways running outwards from these companies' areas is also given. The Bills have now to be gone through clause for clause by the Committee, and when brought into shape they will be reported for third reading in the Lords. After this, the present fight will be more or less repeated in the House of Commons, probably in the autumn session. Still, as the London County Council supports generally the decision of Lord Cromer's Committee, it may be expected that this decision will not be reversed.

ARRANGEMENTS FOR THE WEEK

TO-DAY, THURSDAY, JUNE 25TH.

Institution of Electrical Engineers.

8.30 to 11 p.m. Annual Conversazione at the Natural History Museum, Cromwell Road, London, S.W.

FRIDAY, JUNE 26TH.

Physical Society.

3.30 p.m. The meeting arranged to be held at the National Physical Laboratory, Bushy House, Teddington, has been cancelled on account of the death of Prof. W. Cassie, M.A., one of the honorary secretaries of the Society.

Royal Society.

4.30 p.m. Meeting at Burlington House, Piccadilly. Among the Papers to be read are the following:—(1) "The Emission and Transmission of Röntgen Rays," by C. W. C. Kaye; (2) "Further Notes on a Luminous Glow Generated by Electrostatic Induction in an Exhausted Vessel Made of Silica," by Rev. F. J. Jervis-Smith.

TUESDAY, JUNE 30TH.

Incorporated Municipal Electrical Association.

10.30 a.m. Annual Convention at Nottingham. Meeting at University College, when Mr. H. Talbot, Chief Electrical Engineer to the Nottingham Corporation, will deliver his Presidential Address. The following Paper will then be read and discussed:—"The Experiences of a Convener in the Establishment of an Electricity Undertaking," by Bailie Wightman (Govan).

2.30 p.m. Visits to Trent Bridge car shed and repair shops and the St. Ann's power station.

WEDNESDAY, JULY 1ST.

Incorporated Municipal Electrical Association.

Second Day of Convention at Nottingham. Day excursion to Dovedale. Special train leaves Nottingham (Midland) for Matlock Bath, at 8.40 a.m.

THURSDAY, JULY 2ND.

Incorporated Municipal Electrical Association.

10 a.m. Third Day of Convention at Nottingham. Annual General Meeting at the University College.

2.30 p.m. Meeting at the University College, when the following Papers will be read and discussed:—(1) "Some Considerations on the Design of a Generating Station," by H. Richardson (Dundee); (2) "The Reconstructions of an Electric Lighting Scheme with Observations on the Working of a Combined Steam and Water Power Plant," by C. M. Shaw (Worcester).

7.30 for 7.45 p.m. Association Dinner at the Exchange Hall.

Royal Society of Arts.

9 p.m. to 12 p.m. Conversazione at the Natural History Museum, South Kensington, S.W.

FRIDAY, JULY 3RD.

Incorporated Municipal Electrical Association.

10 a.m. Fourth Day of Convention at Nottingham. Meeting at the University College, when the following Papers will be read and discussed:—(1) "A.C. Accumulator Sub-station, and the Use of Accumulators for Peak Loads," by A. M. Taylor (Birmingham); (2) "The Work and Equipment of a Testing and Standardising Department," by H. A. Ratcliff (Manchester).

DECISION ON THE LONDON POWER BILLS

The Parshall-Hammond Bill passed by the Lords Committee

WHEN Lord Cromer's Committee on the London Electric Power Bills met yesterday (Wednesday) afternoon, the Chairman announced that the London and District Electricity Supply Bill would be allowed to proceed, on the assumption that the new "Cessor of Powers" clause, the full text of which the Committee has not yet seen, was satisfactory. The Committee were of opinion, he said, that it should be provided in the Bill that a larger proportion than one-fifth of the £600,000 which has to be guaranteed in the first instance should be actually paid up within twelve months. With regard to the "Kitson" clause (to the effect that the company may supply power in any area with the consent of the "authorised distributor," but may appeal to the Board of Trade if this consent is "unreasonably" withheld, and that the power user may be supplied with lighting up to 20 per cent. of his power consumption), the Committee will wish to consider, when the clause comes up for consideration, whether any modification of the 20 per cent. limit should be made

As regards the new clause relating to a maintenance and renewals fund (p. 958 of this issue), the Committee will wish to consider whether the contributions to this fund should not in certain circumstances be made obligatory.

Another point mentioned by the Chairman was that, in the schedule of maximum prices to be charged, three different kinds of electrical energy are specified with three maximum prices, and the Committee thought there seemed to be considerable difficulty in making a comparison with a single average price, as was done in the new clause relating to a sliding scale of dividends according to the price. The Committee would wish this point to be considered in the discussion of this clause.

Incidentally the Chairman mentioned that the Coal Smoke Abatement Society wished to be heard, and he thought the points raised by the Society in a letter to Lord Welby should receive consideration.

With regard to the London Electric Supply Bill, the Chairman announced the Committee had come to the conclusion that this should proceed, but only in respect of the following clauses:—

The clause giving power to the companies to supply electrical energy for haulage, traction, &c., for use in other areas than that of the Company supplying.

The clauses granting the companies powers to associate for the purpose of mutual assistance, with the omission of two small paragraphs providing for the construction of enlarged or extended stations by any one or more of the companies in combination and the laying of mains, &c., in connection therewith. An addition is to be made, however, empowering the existing companies to lay mains in districts intervening between their various power stations. The Chairman also stated that the Committee were of the opinion that a "Route" clause should be inserted, giving the local authority the right to prescribe the routes of mains in their districts.

A short discussion took place as to future procedure, when Mr. Seymour Bushe, K.C., on behalf of the third Bill before the Committee, promoted by the Westminster, St. James's, Notting Hill, and Kensington Companies, stated that there was no opposition to the preamble of this Bill, although there would be some discussion of clauses. It was therefore decided to hear the case for this Bill to-day (Thursday), and to take the clauses of the London and District Power Bill on Monday. The clauses of the other two Bills will then be discussed together.

G.B. Surface Contact Tramways in London.—It was stated by Mr. Whittaker Thompson, chairman of the Highways Committee of the London County Council, on Tuesday that the Board of Trade had inspected the equipment of the line in the Mile End Road on Monday, and that a certificate covering the ensuing period of six months had been received that morning. He believed that this was the usual form of certificate given in such cases. The matter was also referred to on Monday in the House of Commons, when in reply to Mr. B. S. Straus, Mr. Winston Churchill said he would do all in his power to urge forward the opening of the line.

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LONDON ELECTRIC POWER BILLS

OUR report of the proceedings before Lord Cromer's Committee, in our last issue, took us to the adjournment on Tuesday, June 16th, when Mr. J. S. Highfield, Engineer-in-Chief to the Metropolitan Electric Supply Co., and joint Engineer for the "linking-up" proposal of the eight companies, was under cross-examination.

WEDNESDAY, JUNE 17TH. (TWENTY-SECOND DAY.)

Mr. BALFOUR BROWNE asked the Committee to consider whether they could visit some of the generating stations of the companies. It was a very important matter, unless the Committee were fully acquainted with generating stations, to realise what they were, and he suggested a visit either to the Bankside, Bow, or Willesden stations.

The CHAIRMAN promised to confer with his colleagues upon the matter.

Mr. TALBOT, K.C., then continued his cross-examination of Mr. HIGHFIELD on behalf of the London & District Electric Power Bill (the Parshall-Hammond scheme). He first asked as to what provision had been made for reciprocal supply from each of the six stations. Did he intend that any of the six stations should be able to supply any portion of the whole area. Mr. Highfield said, "No," but any authorised distributor would have a supply from two stations, *i.e.*, one station would be capable of giving all that a distributor required, and the other station only part. Mr. Talbot characterised this as splitting up the whole area into districts, and supplying each from one station; it was not linking up at all. Mr. Highfield agreed that "linking up" was a most misleading term, but they must regard the undertaking as one having all the various systems of supply linked up. Although the three-phase system was proposed under the Bill, he admitted that he had been an advocate of the high-tension direct-current series system, and, as a matter of fact, he regarded it as a question whether this system would not be the best for the western area of the Metropolitan Electric Supply Co. He had prepared estimates, and these were now under consideration by other engineers to see if their opinions agreed with his, as to the suitability of the Thury system for the particular area. With regard to the particular stations in which the new plant would be erected, Mr. Highfield said he could not say at the moment; it all depended upon where the load arose, and in reply to a question as to how he had been able to prepare estimates of the trunk mains if he did not know where the plant was to be, Mr. Highfield said that certain assumptions had had to be made, but the probability was, when the scheme came to be worked, the estimates for trunk mains would be reduced.

Mr. Talbot next dealt with the use of gas engines, and asked Mr. Highfield if he had had any personal experience of the use of gas engines in a scheme comparable with this, and had they worked successfully in parallel with steam plant? Mr. Highfield said he had no personal experience, but he was informed that they were working successfully at Essen in Germany and in the Westinghouse works; they were also in use at Ryde and Guernsey. It was true that these were working on a low-tension direct-current system. Mr. Talbot reminded Mr. Highfield that these were quite small stations, and asked if he was aware that gas engines had been used on a large scale in Johannesburg, and had been abandoned, and also that the Walthamstow Council was abandoning its gas-engine plant. Mr. Highfield said he happened to be particularly well acquainted with the circumstances at Johannesburg, but it was a fact that the gas engines were being replaced by steam-generating plant. He was not aware of what was being done at Walthamstow. As to the size of gas engines to be adopted, he thought these would be about 1,000 h.p. to begin with; these engines were not made in very large sizes at present, and they would necessarily have to go slowly. Some questions were then put to indicate that the sites of the majority of the existing stations were not comparable with that at Barking from the point of view of coal and water supply. Mr. Highfield said the difference between sea-borne and rail-borne coal was only about one shilling per ton, and he disagreed with the suggestion that the full advantage of steam turbines could not be obtained if cooling towers had to be employed.

Mr. HARPER, for the Middlesex County Council, wanted to know the position of the bulk portion of the undertaking of the Metropolitan Electric Supply Co., if the other portion of the undertaking was purchased in 1932 or 1952. Apparently, the Willesden station would be purchased, and, consequently, the Metropolitan Co. would be left with its West Middlesex bulk area—which could not be purchased—without a generating station. Mr. Highfield said that if such a state of affairs arose, they would have to build another station.

Mr. J. CONACHER, General Manager of the Metropolitan Electric Supply Co., spoke as to the agreements between the various companies for supplying the Joint Committee with energy during the period in which the Joint Committee will have no works of its own. For instance, the County of London Co. has agreed to supply the Joint Committee with electrical power from the Wandsworth and City Road station for three years from January 1st, 1909, to the extent of 3,000 kw. in 1909, 3,000 kw. in 1910, and 2,000 kw. in 1911, price to be settled by the standing arbitrator provided for under the Bill. The agreement further provides that the County Co. may be called upon within five years to erect buildings for 5,000 kw., with additional accommodation for a further 5,000 kw. All such plant will be the property of the Joint Committee, but will be worked by the company as part of their undertaking, the Joint Committee paying a rent for the accommodation.

The CHAIRMAN raised the question of possible difficulties in connection with a standing arbitrator, but Mr. Conacher said he had had great experience of Committees to which a standing arbitrator had been appointed, and he had never found any difficulties arise. Asked as to the difficulty of separating the plant belonging to the Joint Committee from that belonging to the company, Mr. Conacher said that in many cases there would be sufficient land to build a separate station.

Continuing his evidence, Mr. Conacher said he regarded the raising of £1,000,000 as a certainty, in view of the fact that last year, after paying debenture interest, the six companies who, under the Bill, guarantee the interest, had the sum of £331,000 divisible as profits, which was eight times the sum necessary if the stock was raised at 4 per cent., which he thought would be easily done. But he did not think they could raise the capital, if the ordinary terms of purchase were enforceable in 1932 (the time when the local authorities could purchase the existing companies). The Bill safeguarded the rights of the local authorities for purchase of the distributing mains in 1932 or 1952, if the Joint Committee's undertaking was then purchased by a central authority. The effect of this would be that the local authorities would be in possession of the distributing systems, whilst generation would be in the hands of the central authority. At the same time those portions of the companies' undertakings, which are not purchasable, are to be made purchasable upon arbitration terms. The charge of £4 10s. per kw. and 0·5d. per unit, which it was sought to have inserted in all provisional orders, was intended to apply to consumers of five kilowatts and over.

Mr. FITZGERALD, for the London and District Power Bill, cross-examined at first upon the constitution of the Joint Committee, and pointed out that if all the companies and local authorities came in, there would be 40 members, viz., 14 companies, 24 local authorities, and two London County Council representatives. Mr. Conacher said he failed to apprehend any difficulties from this. Mr. Fitzgerald asked what would be the position of the Joint Committee if the agreements came to an end. They were terminable at any time, and were not to be scheduled to the Bill. Mr. Conacher said the Joint Committee could put up their own stations. Mr. Fitzgerald retorted that no powers were taken in the Bill for land, but Mr. Conacher said they could come to Parliament for power. With regard to purchase he agreed that if no purchase took place by the London County Council or any other public body in 1932 or 1952, the whole of the rights of the local authorities would disappear. Even the special rights of the City of London Corporation to purchase in 1914 would disappear.

Mr. CLEASE, for the London County Council, indicated, by his cross-examination, that the view of the Council was that unless the Joint Committee erected a large generating station, there could not be a unified system, and there were no powers in the Bill compelling the Joint Committee to erect a station. He next drew attention to the fact that the maximum price in the Bill was higher than that proposed to be inserted in the Provisional Orders of the authorised distributors, so that, assuming the maximum price was charged, the distributors purchasing from the Joint Committee would have to supply at a loss. Mr. Conacher said this would be so, and although it was unlikely that the maximum price was charged, yet, if it were, the scheme provided for two-thirds of the profits over a certain amount to go to the authorised distributors. Mr. Clease next dealt with an agreement between the Joint Committee and the South Metropolitan Power Co., by which the latter agree to supply certain quantities of energy for three years from 1909, and afterwards to erect plant in their buildings, which would be the property of the Joint Committee. The agreement also provided, in the latter case, for the payment to the company of rent for accommodation of plant, rent for land, allowance for any other plant placed at the disposal of the Joint Committee, and the cost of working the Joint Committee's own plant. Mr. Conacher said he did not think this a complicated matter, and saw no difficulty in working under such agreements. In reply to a question as to why the Joint Committee was introduced, and if the companies had to work the plant, why they should not provide it, Mr. Conacher said the promoters regarded the formation of the Joint Committee as the only way of carrying out the recommendation of the Select Committee of 1906, that there should be one central authority controlling the supply of electrical energy; it was also the only means of safeguarding the interests of all the existing authorities.

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THURSDAY, JUNE 18TH (TWENTY-THIRD DAY).

In reply to Mr. Morton, for the West Ham Corporation, witness said the promoters were quite willing to agree not to supply docks, &c., situated wholly within any individual borough.

In re-examination, Mr. Conacher said if the local authorities gave notice in time they could be represented at the first meeting of the Joint Committee, and have a hand in the election of the standing arbitrator. Furthermore, as at the first meeting, no stock would have been issued, the companies' representatives would only have one vote each, equally with the local authorities, so that it a sufficient number of local authorities applied, they might actually have a majority of votes at the first meeting.

The CHAIRMAN interposed with a question as to whether it was the intention of the promoters to proceed with this Bill before they knew another Bill was to be promoted.

Mr. CONACHER said yes. It was the intention to proceed with it from the moment it had had to be withdrawn last Session through lack of time.

The CHAIRMAN: Would you proceed with your Bill in the event of the other Bill being passed?—The other Bill is in two parts, viz., the bulk supply, and the competition. We dread the competition very much, but so far as this Bill is concerned we mean to go forward.

The CHAIRMAN: But do you consider the other proposal destructive of yours?—We dread it very much, and think it unnecessary.

In reply to some questions with regard to the working of the Joint Committee, Mr. Conacher pointed out that in the Port of London Bill it was proposed to have 25 members, whilst the Clyde Trust, a very important body, had also a large number of members, and he had never heard of any disputes.

Mr. J. B. BRAITHWAITE, chairman of the City and County of London Companies, said he had had considerable experience of raising capital for electrical enterprises, his firm of Foster & Braithwaite having raised over £1,000,000 for lighting and traction undertakings. The London companies had promoted this Bill, as they regarded it as the only possible and the best solution of the problem of the supply of electricity in London. Obviously, the Bill would solve the problem at a considerably smaller capital expenditure than in the case of a new company, which would have to put down an entirely new generating station, feeders, and distributing mains.

The CHAIRMAN: When you say it will solve the problem, you mean within the area in which you operate?

Mr. BRAITHWAITE said he meant it would solve the problem for London. They had taken in a considerable "fringe," and it would be many years before this was completely developed; he was certainly of the opinion that the scheme would solve the problem for the next 25 years.

In further answer to questions by the Chairman, Mr. Braithwaite said he did not suggest that the £1,000,000 under the Bill would be sufficient for the next 25 years. They would have to come to Parliament for further capital expenditure.

Mr. BRAITHWAITE, continuing his evidence, referred to the pioneer work of the companies, and to the fact that they had followed invention so closely in the machinery installed in their stations that considerable "scrapping" of plant out of revenue had taken place. If allowed to carry out the present project, they would unify the electric supply of London into one homogenous whole ready for the purchasing authority in 1932 or 1952. He also laid stress upon the greater security of supply for a number of stations compared with that from a single station, say, at Barking. Another point in his opinion which was in favour of the present Bill was that it involved no consideration as to what he termed "watered" capital, which under the previous Bill would exist to the extent of the £300,000 which was to be paid in interest out of capital during construction, and would have to be paid back by the purchasing authority, although it was not represented by assets. Summing up, he said there would be the minimum interference with the streets, owing to such a large network of mains being already laid, and this should appeal to the local authorities.

Lord LAMINGTON asked what would be the effect upon the scheme if the local authorities did not join in?

Mr. BRAITHWAITE said it would not then help London very much, but the companies would have the powers of linking up.

With regard to the finance of the Bill, he considered the guarantee of all the companies for the stock would be a very great factor in raising the necessary capital. For the year 1907, after paying interest on debentures, the companies had the sum of £377,294 available for the interest upon the stock, many times the amount which would be necessary.

In the course of further evidence, Mr. Braithwaite said the existing conditions had forced the companies to build a large number of generating stations and to spend much more capital than would have been necessary otherwise, and it was most unfair that the effect of these circumstances should be made use of as the foundation for arguing that a new company should be allowed to be formed. On the effect of the promotion of power Bills for London upon the securities of the existing companies, he endorsed the views of Mr. Seale, referred to in our last issue.

Lord WELBY suggested that the large number of generating stations erected in the area had been rather the result of jealousy between the local districts.

Mr. BRAITHWAITE said the position would never have arisen if Parliament had districted London only into, say, three large areas.

Mr. FREEMAN, cross-examining on behalf of the London County Council, pointed out that far from being a comprehensive scheme, this Bill only included eight companies; five others were promoting a scheme of their own, whilst the South London Electric Supply Corporation was not a party to either scheme. Mr. Braithwaite said this was so, but he claimed that the scheme of the Bill was a comprehensive one, and that as the other companies and local authorities came to see the advantages of it, they would join in. Mr. Freeman then dealt with a suggestion made in the report by the Board of Trade upon the Bill (given on p. 955), that the powers of the Bill should be limited to allowing mutual supply, and asked why, if the companies received this power, they wanted the Joint Committee. The answer was that the power to supply local authorities was an essential part of the scheme. On the question of the alteration in the prices to be charged by authorised distributors, Mr. Braithwaite agreed that it was a novel proposal, and he was aware that the Board of Trade had reported its doubt as to the companies being competent to legislate in this way, but novel things would have to be done if this problem was to be attacked. The whole circumstances in London were unprecedented.

Lord LAMINGTON asked if the primary object of the Bill was to make for more economical working of the companies' undertakings or the interests of London as a whole.

Mr. BRAITHWAITE said the supply of London was the first consideration of the Bill.

Lord LAMINGTON: Your evidence has rather been that the more economical working of the companies' undertakings was the first consideration.

Mr. FREEMAN, in further cross-examination, said that, under the terms of the Bill, if the Joint Committee was purchased in 1932, the purchase price of the stock was 110, in addition to goodwill. A good deal of discussion took place on this matter, Mr. Braithwaite maintaining that whether purchased in 1932 or 1952, the stock was purchasable at par. Eventually, however, Mr. Balfour Browne, for the promoters, agreed that Mr. Freeman was correct, but it certainly was not the intention of the Bill. The redemption at 110 in 1932 was as between the stock-holders and the Joint Committee, and did not concern the purchasing authority, &c. The Bill, therefore, should be made quite clear on this point, as he did not think this proposition would be fair.

Mr. BRAITHWAITE had previously mentioned that the interest out of capital during construction paid by the new company would be "watered" capital, which would have to be paid back by the purchasing authority, whereas under the present Bill there would be no "watered" capital; but Mr. Freeman suggested that if the stock under this Bill was issued at 80, there would be considerable "watered" capital to be repaid by the purchasing authority in this case also. Mr. Braithwaite said Mr. Freeman had no right to assume that the stock would be issued at 80, and therefore he could not agree that there would be watered stock.

Mr. TALBOT, K.C. for the Camberwell Borough Council, questioned Mr. Braithwaite as to the extinction of the present rights of the Council as to purchase by the Bill. He put it that the new conditions were absolutely against the obligations accepted by the company to secure the Council's consent to their order originally. Mr. Braithwaite did not dispute the facts, and said it was the effect of the general scheme.

Mr. TALBOT then cross-examined on behalf of the promoters of the London and District Electric Power Bill, and confined himself to endeavouring to ascertain the circumstances which led up to the promotion of the Bill. It appeared that in August last year all the London companies agreed to promote a power Bill upon the lines of the present one, but in October or November some of the companies came to the conclusion that the power business in their area was not of sufficient interest to warrant them continuing in the promotion. Consequently these particular companies promoted a separate Bill, asking for smaller powers.

Mr. TALBOT suggested that the present Bill was only introduced as a weapon for opposing the London and District Power Bill, although there were certain clauses in it which would be of value to the companies.

Mr. BRAITHWAITE said this was certainly not so, for the Bill was decided upon before the companies heard of the London and District Bill.

In re-examination, Mr. BRAITHWAITE, upon the question of transfer of undertakings to the Joint Committee, and the consequent extension of life, said that such transfers must be by the consent of the Board of Trade, and, further, an application would have to be made to Parliament for the necessary capital powers, as the £1,000,000 by the present Bill was not applicable to this matter at all.

Mr. W. F. FLADGATE, Chairman of the Charing Cross, City, & West End Electricity Supply Co., said he had been for two years Chairman of a committee of the London companies which had been formed for considering the question of electric supply, and the present Bill was practically the one which was withdrawn last Session. A good deal had been made of his state-

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ment at the annual general meeting of his company, that there was no intention of raising £1,000,000 immediately, and that a few thousand pounds would probably suffice at first. This had reference to the position of the Charing Cross Co. as a guaranteeing company towards the £1,000,000 which it was proposed to raise under the Bill, and was in comparison with the enormous sums which the new company would have to raise. He meant by a few thousand pounds something in the nature of £200,000 or £300,000.

The cross-examination of Mr. Fladgate was very brief, and this closed the case for the Bill.

Board of Trade Report upon the "Eight-Company" Bill.

As mentioned in the cross-examination of the companies' witnesses, the Board of Trade has reported upon the proposals of the Bill, and we give below the main points in this report:—

The Board observes that the Bill contains provisions for the formation of a Joint Committee of the London Electric Supply Companies, for the supply of energy by them in bulk throughout London, and an area surrounding London, and for agreements between the companies, not only for the mutual supply of energy in bulk, but also for the joint management and working of generating stations and works, the appropriation and division of receipts, and the provision of capital. The report does not deal with the general questions of policy raised by these proposals, but only with the details of the clauses.

Clause 2. (Interpretation):—The definition of the expression "authorised distributor" limits the bodies who could be supplied with electrical energy in bulk under the Bill, to bodies engaged in the business of supplying energy at the date of the passing of the Act. This would exclude from all benefits under the Bill any undertakers in the area, who, though authorised to supply, have not yet commenced to supply. Such exclusion seems to the Board undesirable. The definition of the expression "power purposes" limits the consumers who would obtain any benefits from a reduction of price under Clause 42 of the Bill to consumers whose maximum demand is not less than 5 kilowatts. It appears to the Board that this might exclude a large number of small users.

Clause 30. (Agreements between Joint Committee and companies and distributing authorities):—The first proviso to paragraph C of the clause provides for Board of Trade approval of agreements for the acquisition of stations and works. The Board would prefer not to have the duty placed upon them of approving these agreements.

Clause 35. (Supply of energy for haulage, traction, &c.):—The Board observe that there is no provision in the clause as to the price to be charged for a supply, or the conditions under which the supply is to be given, or for penalty in case of failure to supply. The definition of "power-purposes" in Clause 2 of the Bill does not appear to include haulage, traction, &c.

Clause 38. (Guaranteed Stock):—The Board observe that the stock may be issued at such prices as the Joint Committee may think fit. It appears to the Board that this might affect the question of purchase under Clause 43 of the Bill. The Board observe also that the stock is redeemable in 1932 or 1952, but that there is no provision for redemption of the stock after the last-mentioned date.

Clause 41. (Application of revenue):—The clause provides, *inter alia*, for the formation of a reserve fund. There is apparently no limit to the reserve fund, and no provision as to what it is for or what becomes of it on the purchase of the undertaking.

Clause 42. (Supply of electrical energy by companies and distributing authorities for power purposes):—This clause limits the price which may be charged for power purposes by London electric supply companies and local authorities authorised to supply in the Administrative County of London. As pointed out above, consumers whose maximum demand is less than five kilowatts are excluded from the benefits of this clause. The Board doubt whether it is competent for this Bill, promoted by London electric supply companies, to limit the prices which may be charged by local authorities. The clause provides that the Board of Trade may fix temporarily prices in excess of those named in the clause. This provision is unusual. The Board think that the promoters should not be allowed in any case to charge prices higher than the maxima fixed by the Bill. It is a matter for consideration whether the prices named in the clause are sufficiently low, having regard to the benefits sought by the promoters under the Bill.

Clause 43. (Purchase of undertakings of Joint Committee and London electric supply companies at one and the same time):—The Board observe that the sub-clause 3 provides for the purchase of the undertakings mentioned in the clause in 1932 or 1952, but that there is no provision for purchase after the last-named date. Sub-clause 9 contains provisions under which the local authority for any district may purchase from the purchasing authority the distributing mains, plant, and works, within the area of such local authority. It appears to the Board that the expediency of this provision is somewhat doubtful. In the event of the provision being allowed, the Board call attention to the fact that there is no provision as to who is to decide what proportion of the purchase prices "may reasonably be attributed to the mains, plant, and works so purchased."

Clause 45. (Authorising agreements between companies for mutual assistance):—The Board observe that the provisions for joint management and working of the generating stations and undertakings, and for the appropriation and division of receipts, and the provision of capital, are not necessary for the general purposes of the Bill as regards mutual supply of energy in bulk, and the Board think that an agreement under the clause for the purposes aforesaid might lead to some confusion as to who would be the undertakers liable to the public in any particular district. The Board suggest for the consideration of the Committee, that the clause should be limited to a provision enabling the companies to supply electrical energy in bulk one to another.

Case for the Opposition to the "Eight-Company" Bill.

WEST HAM.

Mr. MORTEN, for the West Ham Corporation, said the whole point on preamble between him and the promoters was as to the supply of energy for railways, docks, canals, &c. If it could be made clear by any form of words that there would be no competition in respect of docks, &c., in West Ham, then practically the whole case of the Corporation would go, and he would only have a few clause matters to discuss later. Of the two Bills, the Corporation much preferred the present one.

FRIDAY, JUNE 19TH. (TWENTY-FOURTH DAY.)

Some Explanations of the Scope of the "Eight-Company" Bill.

At the commencement of proceedings the Chairman put a number of questions, in order, he said, to clear up in the Committee's minds the effect of the purchase clause and one or two other clauses connected with it. He said it appeared to him that, under the purchase clause, the Joint Committee could purchase generating stations or works of any electrical supply companies or distributing authorities. Did that mean the whole system?

Mr. CRIPPS, for the promoters, said that it was not intended to apply to the distributing system, and the words could be altered if they were too wide at present. The promoters only intended the words to apply to the generating side of the undertaking, including, of course, the mains as far as, and including, sub-stations.

The CHAIRMAN next pointed out that under Clause 43 any generating station and works purchased by the Joint Committee ceased to become the property of the electric lighting company. In that event, he read the Bill to mean that, whereas these undertakings, so transferred, would, in the ordinary course, be purchasable under the terms of the Electric Lighting Acts, after transfer they belonged to the Committee, and would not be sold at the then value. He assumed the purchasing authority would then have to purchase the Joint Committee's stock at par, *plus* compensation for the loss of business by all the companies for the next 20 years, although if the Committee did not purchase any of the electric lighting companies' undertakings, these undertakings would be purchasable under the Electric Lighting Acts.

Mr. CRIPPS said that might be the effect of the Bill as it stood at present.

The CHAIRMAN: Surely it is the effect, and it would obviously be an enormous advantage to the companies to sell to the Joint Committee.

Mr. CRIPPS said that this had been brought to the notice of the promoters, and they were considering it at the present moment. Although he would like to postpone discussion of it in the absence of Mr. Balfour Browne, he would like to point out that no transfer could take place to the Joint Committee without the consent of the Board of Trade, and, further, the capital powers of the Joint Committee were quite insufficient for purchasing any undertaking.

Lord SAUNDERSON asked, if the purchasing authority did not purchase until 1952, could any one of the local authorities purchase the undertakings in their areas in 1932?

Mr. CRIPPS said the local authorities could not purchase then.

Opposition to the "Eight-Company" Bill (Continued).

CITY OF LONDON CORPORATION.

Sir RALPH LITTLER, for the City Corporation, said he opposed the Bill for the reason that it aimed at utterly defeating the objects of past legislation with regard to purchase, so far as the City Corporation were concerned. When the City & Charing Cross Companies were granted orders for supply in the City, a bargain was made with the Corporation by which they were given a right to purchase so much of the two undertakings as was necessary for the purpose of the City of London, on certain terms, in 1914. Under the Bill this right would be absolutely overridden without any consideration whatever. If the undertakings of the two companies supplying the City were transferred to the Joint Committee, the Corporation could not purchase at all, and he maintained that the one object of the

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Bill was to make the £13,000,000 capital of the companies of London more valuable than it was at present.

LORD LYTTON asked how the City would be affected by the "linking up" powers.

SIR RALPH LITTLER replied that the City would not be affected at all, provided new mains were not laid in the City.

WILLESDEN.

Mr. BLENNERHASSETT, addressing the Committee on behalf of the Willesden Urban District Council, complained that, as the Bill stood at present, his Council could not obtain a supply from the promoters of this Bill without the consent of the North Metropolitan Power Co., Willesden being marked as an area already supplied by a bulk company. As a matter of fact, the North Metropolitan Power Co. had no compulsory powers of supply in Willesden, and were merely supplying the Council under an agreement. Therefore, when this agreement came to an end, the Council wished to be free to go to the Joint Committee for a supply if this Bill passed. At present they would have to obtain the consent of the North Metropolitan Power Co. under the Bill.

Lord SAUNDERSON said that if Willesden was not in the area of the North Metropolitan Power Co., as Mr. Blennerhassett had stated, then he failed to see how they would have to get their consent.

Mr. BLENNERHASSETT said that he only wanted it made clear that the consent of the North Metropolitan Co. would not be required before Willesden could go to the Committee.

Mr. CRIPPS, for the promoters, said that at present Willesden was supplied by the North Metropolitan Power Co., and, therefore, was in the area of supply. His opinion was that when this agreement expired, Willesden would have a free hand.

WESTMINSTER, ST. JAMES'S AND PALL MALL, NOTTING HILL, AND KENSINGTON COMPANIES.

Mr. SEYMOUR BURKE, K.C. for these four companies, said that so far as the Bill was based on the principle of association between companies for mutual assistance, it commanded his entire sympathy and support. But he objected to the Joint Committee, for the reasons already put forward by other opponents, and he also objected to the purchase clause, for reasons which would be very clearly set forth by Mr. Blennerhassett, on behalf of the Westminster City Council. Apart from that, the sympathy of his companies was entirely with the promoters.

The CHAIRMAN: Has the question of linking up your stations with those of the other companies been considered?

Mr. BURKE said he supposed it could quite well be done, but he had not considered the question, and was not prepared to express an opinion.

MARYLEBONE.

Mr. E. R. DEBENHAM, Chairman of the Marylebone Electric Lighting Committee, said that the measure of public control provided by the Joint Committee was insufficient, for the reason that, whilst the Marylebone Council approved of the idea of a Joint Committee, this one was not representative of the whole supply authorities of London. In addition to the voting power of the companies being sufficient to out-vote the Councils, it appeared that a minority on the Committee could only go to the standing arbitrator on a question which affected their own local interests, and not on a question of general policy. In order to get proper control, every local authority should have the opportunity of guaranteeing to the extent of their own particular interests. Probably in this way local authorities would prefer to take a supply in bulk and guarantee, rather than spend further capital on new plant themselves. He also objected to fixing the price of power for seven years under the Bill.

Mr. C. A. Cripps, K.C., cross-examining for the promoters, asked for the witness's views as to what sufficient public control should consist of. Mr. Debenham said the only way appeared to him was that everybody should be compelled to come on to a Joint Committee, and guarantee either in proportion to their output or capital expenditure. Mr. Cripps suggested that at present all the local authorities could come on to the Committee and have the same voting power, if they guaranteed stock to the same amount, but Mr. Debenham saw no chance of the local authorities coming on to the Committee as the result of a private Bill.

Mr. Cripps next asked witness's views as to the arbitration clause, and Mr. Debenham said that supposing only the Marylebone Council came on to the Committee, and the Committee proposed to erect a new generating station which the Marylebone representative did not think was sufficiently good for London as a whole, or even for Marylebone, he would have no power to refer to the arbitrator. He wanted the minority to have the power of bringing questions before the arbitrator.

In re-examination, witness said that, as things were at present, local authorities could not join the Committee and guarantee stock without the consent of the Local Government Board.

Mr. A. B. CANE, addressing the Committee on behalf of the St. Marylebone Borough Council, said they opposed with the greatest reluctance, because they recognised that the principles upon which the Bill was founded, or purported to be founded, were the right principles upon which a solution of the problem of supply of electricity in London must proceed. In any such scheme the existing undertakings should be made use of, and a semi-public body formed to manage the supply, and to utilise the foundations laid by the pioneer concerns rather than to demolish them. But he argued that, with the committee constituted as proposed by the Bill, if there were two courses open, the companies would, by the aid of their majority of votes, naturally adopt the course which would be best suited to their own interests. Another objection to the scheme was that everybody was to have one vote irrespective of the size of their undertakings. The Marylebone Council had a very large undertaking, and felt they would have a right to a greater weight in the councils of the Committee than would be given under the scheme. At present, the companies were finding the money, and he agreed that, in these circumstances, they must have the control, but if passed in its present form the scheme would tend to create an electrical trust which would make the solution of the problem more difficult than ever. With regard to Clause 43, regulating the power prices to be charged by authorised distributors, this would not affect the Marylebone Council very much, as they were able to supply well within the proposed charges, but it was an unprecedented thing to alter general legislation in a private Bill.

MONDAY, JUNE 22ND.—(TWENTY-FIFTH DAY.)

Mr. CRIPPS, referring to the Chairman's question on Friday with regard to purchase, said the promoters had considered the point, and it was never the intention to obtain an enhanced price for any works which were at present purchasable under the terms of the Electric Lighting Acts, and words had been inserted in the purchase clause to make it absolutely clear that the works now purchasable under the Electric Lighting Acts should remain so. Thus it would not be to the advantage of the companies to transfer their undertakings to the Joint Committee from the point of view of ultimate purchase.

WESTMINSTER.

Mr. BLENNERHASSETT, for the Westminster City Council, said that over portions of seven companies the Council had powers of purchase in 1931, and they wished these powers to be maintained intact. The Bill was a gross attempt to deprive them of these powers without any compensation whatever, and anything more like confiscation he had never heard of. It had been said that the local authorities of London could not exercise their purchase powers owing to the fact that many of the generating stations supplied more than one area. But the question was a simple one in Westminster, as the Council could purchase the whole of the undertakings of the Westminster, St. James's, and Central Co.'s, with power stations, in addition to the greater part of the Kensington & Knightsbridge Co. The whole effect of the Bill was to make the Westminster City Council a distributing authority, a position which they refused to take up. The Council also strongly opposed the scheme of linking up under clause 45, because, although in theory the rights of purchase would not be affected, in practice they could not be enforced, for the reason that once all the undertakings were linked up any purchasing authority proposing to purchase their own local company would have to pay such heavy compensation for severance from the whole linked-up undertaking that the purchase powers could not be put into effect.

Mr. JOHN HUNT, Town Clerk of Westminster, gave evidence in support. Mr. Hutchinson, in cross-examination, put it to witness that the Westminster Council had two alternatives, either to pay a heavy price for severance, in addition to "their value," or, if they only purchased those companies which were wholly within Westminster, then they would be subject to competition from the companies not purchased. Mr. Hunt did not dispute these facts, but said the Bill would impose an extravagant claim for severance in respect of those companies which were at present wholly within Westminster.

CAMBERWELL.

Mr. TALBOT, K.C., for the Camberwell Borough Council, mentioned the special position of that body with regard to the purchase of the County of London Electric Supply Co.'s undertaking in that area. The Council could purchase at any time before 1931 by repaying the capital expenditure properly expended by the company in respect of Camberwell, plus 33 per cent., and also the making up of the company's dividends to 5 per cent. from the commencement; or they could purchase at "their value," plus value of goodwill, to be determined by arbitration, whilst they had, in addition, the ordinary rights in 1931 of purchase under the Electric Lighting Acts. The whole of these rights were to be taken away under the Bill, without any justification whatever, and he asked that Camberwell should be excluded from the purchase clause of the Bill.

In answer to the Chairman, Mr. Talbot said that the Camberwell Council had petitioned against the London and District Electric Power Bill, but the promoters of that measure had agreed to a clause safeguarding the purchase rights of the Council, and they did not now oppose the other Bill.

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BARNES.

Mr. READER HARRIS, K.C., asked for exclusion on the following grounds:—(1) There would be no advantage to the Council by the passing of the Bill; (2) the district of Barnes was not necessary to the success of the Bill; (3) there was no precedent for including Barnes.

STEPNEY.

Mr. WILLIAMS, for the Stepney Borough Council, said they had tried to give the Bill the most favourable consideration. In fact, they were favourable to the linking-up powers, but there were several matters which were detrimental to the Stepney Council's interests. For instance, they claimed the right to demand a supply in bulk on reasonable terms, but the maximum prices named in the Bill were unreasonable. His next point was that the agreements between the companies and Joint Committee were not binding, and that to ensure the terms not being altered hereafter, the agreements should be scheduled to the Bill. He also objected to competition, although the Council and the promoters had practically come to terms, the remaining points being more in the nature of clause questions. Mr. Williams' next objection was to the proposal to alter the charge which shall be made for electrical energy for power purposes, and challenged the right of an independent body, such as the Joint Committee, to alter the present charges, or, as the clause provided, to bring the authorised distributors to arbitration on the question. The whole point was foreign to a private Bill, and in support of a request to have the clause struck out he quoted the Board of Trade report on the Bill.

MIDDLESEX.

Mr. POLLOCK, K.C., for the Middlesex County Council, asked to have all portions of that county struck out of the Bill, especially as a very much smaller portion was included in this Bill than in the last one. Discussing the details of the Bill, he complained that the Middlesex County Council would have no power, under the Bill, to representation upon the Joint Committee. This demonstrated the difficulties the promoters felt themselves to be in, and justified the position the Middlesex County Council took up, viz., that complications were certain to be encountered the moment the area of more than one county council was dealt with. The only reason put forward by the promoters for including Middlesex was the report of Mr. Luke White's Committee, and, with every respect, he suggested that the Committee should not be guided by this report on such an important matter.

At the midday adjournment, Mr. CRIPPS handed in clauses providing that in sanctioning any transfer of the companies' undertakings to the Joint Committee, the Board of Trade shall have regard to the terms upon which the undertaking is purchasable by the local authority, and also that the Joint Committee shall not receive any enhanced value in comparison with the present purchase terms.

The CHAIRMAN announced that, pending a decision upon the London and District Bill and the present Bill, the Committee proposed to postpone hearing the Bill of the other four companies.

ISLINGTON.

Mr. W. F. DEWEY, Town Clerk to the Islington Borough Council, said his Council strongly opposed the Bill, although they were not appearing by counsel.

LONDON COUNTY COUNCIL.

Mr. FREEMAN, K.C., in opposing the Bill for the London County Council, said that body was still of the opinion that the solution of the problem was one comprehensive scheme over an area greater than London alone, and not a mere linking up of the existing undertakings for general purposes. The County Council was entirely in favour of the powers in Clauses 45 and 46 (which authorised the companies to give mutual assistance), with the exception of the provision that new generating stations could be set up by a combination of the companies. These voluntary powers, so far as the companies themselves were concerned, gave all that could be required, apart from the comprehensive scheme. Thus the companies would be enabled to fill up the gap, and meet the demand, whilst a larger and more comprehensive scheme was being brought into existence. But the proposal to create the Joint Committee, the County Council did not regard as in the public interest. The Council did not desire to take part in any combination of trading companies and local authorities, for the reason that this, in their opinion, could not form a satisfactory solution of the problem. Dealing with the clause providing for the transfer of undertakings to the Joint Committee, Mr. Freeman pointed out that, inasmuch as the Board of Trade in their report refused to accept the duty of sanctioning such agreements, it must be struck out, for it was contrary to Parliamentary practice to thrust upon a Government Department duties which they did not desire to have. The same remark applied to the modification of the purchase clause put in that day, because the Board of Trade was again brought in against its will. Another provision to which exception was taken was the unprecedented power, in a private Bill, of altering the existing prices of supply, both as regards local authorities and companies. The County Council saw no reason for the creation of the Joint Committee, and failed to see what it could accomplish, which the companies, so far as they themselves were concerned, could not accomplish under Clause 45, viz., the power to associate. The real reason for the Joint Committee was on the financial question, for the Joint Committee was empowered to raise stock which might be issued at 70 or 80, and which would have to be redeemed at par by the purchasing authority in 1932 or 1952. And further, in the same connection, the effect of the amendment to the purchase clause with regard to taking over the existing undertakings was that these were removed from the category of separate undertakings, and placed in that of the undertaking upon which the capital expenditure had to be repaid; he admitted that it removed the extra 20 years' purchase granted by the Bill as drafted, but it did not alter the terms of purchase. Summing up the position of the County Council in this matter, Mr. Freeman said that they were very much in favour of there being a central authority which could purchase all the generating stations at a particular period, and they were very strongly in favour of the terms of purchase remaining those of the Electric Lighting Acts, viz., the then value, which was a perfectly well recognised commercial basis. But the Council did object to the elaborate machinery of the Joint Committee, and all that was implied in it, for the reason that they said it was not necessary for the purpose of carrying on the supply of electricity in London. They regarded it merely as machinery for fictitiously enhancing the value for purchasing purposes, and it ought not to be allowed. The Council would strike out everything from this Bill except the power to the companies to associate, and to supply authorised distributors in bulk.

Mr. FREEMAN, in reply to the chairman, said that the attitude of the London County Council with regard to the first Bill was that whereas the Council was in favour of bulk supply from one large generating station, they objected in the first place to the clause substituted for the Kitson clause, and also to the purchase clause, but, as a matter of fact, several interviews had taken place between the promoters of the London and District Electric Power Bill and the London County Council, and he was in a position to say that the two parties were now substantially in agreement as regards these two clauses.

The Chairman then put some questions with regard to the financial prospects of the London and District Electric Power Bill, in reply to which Mr. Freeman said that the Council did not think they were in a position to express any opinion upon this apart from the raising of the £600,000 during the first twelve months, which had been agreed to by the promoters. The question of finding the further capital, the Council desired to leave to the committee after having heard all the evidence.

The CHAIRMAN said that obviously neither the House of Lords, the House of Commons, the London County Council, nor the promoters could say definitely whether the capital would be raised until the promoters endeavoured to get it.

One other question from the Chairman elicited the answer from Mr. Freeman that whilst the London County Council regarded the proposal of the combined companies with regard to linking up as a means of filling a gap, it should not be allowed as a permanent proposal.

PROMOTERS OF LONDON AND DISTRICT ELECTRIC POWER BILL.

The Honourable J. D. FITZGERALD, K.C., then commenced his speech on behalf of the promoters of the London and District Electric Power Bill against the Companies' Bill, in which he combined his reply to the case against his own Bill. He said that the opposition to his own Bill resolved itself into three sets of opponents, viz., the Local Authorities, the Companies, and the County Councils. There were 93 local authorities in the area within which it was proposed to supply, of which 34 were authorised distributors, and of these only ten appeared before the Committee. There were also the special oppositions of the City of Westminster and the City of London. So far as the latter were concerned, he hoped that the modified Kitson clause, which he would suggest later, would meet the views of Westminster, whilst with regard to their opposition to the clause allowing the promoters to acquire undertakings, he was quite ready to show that any modifications to this clause should not be assented to. So far as the City was concerned, he confessed he was at a loss to understand their opposition, for the only contribution which this historic body had made towards the elucidation of the problem of the electric supply in London had been the expressed wish that mains should not be laid in the City. Passing to the opposition of the authorised distributors, he said this was based mainly upon two grounds: first, that they did not want a supply in bulk because they could generate more cheaply themselves, and secondly, they objected to the competition. For his part, he maintained the position he took up in opening the Bill, namely, that the opportunity of obtaining a supply in bulk from a large generating station was a valuable option to the authorised distributors, and at the same time there was no obligation of any kind upon them to take it. But he rather thought the fear of competition was at the bottom of all the opposition to the Bill, and he asked the Committee to keep in their minds what was the character of the competition that was to be set up, and whether it was

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of a kind that ought to be prevented or obstructed by Parliament. Undoubtedly the greater proportion of the income of the present authorities was from lighting, and in the case of both the companies and the local authorities the competition of the power company would be in respect of only one-tenth of their total business. The suggestion had also been made that the clause providing that 20 per cent. of the supply given to a power user might be used for lighting was too liberal in view of the use of metallic filament lamps. No material facts had been given to the Committee on this point, but if any evidence could be produced to show that 20 per cent. was too high a proportion under the new conditions he was prepared to have this reduced. So far as the competition with consumers of over 250 kilowatts was concerned, he maintained that this was a perfectly reasonable competition. Why should not large manufacturers get their current at the cheapest possible rate. In the interests of the public alone, he asked the Committee to pass the Bill. The companies and local authorities in possession, lost sight of the fact that in opposing his Bill they were ignoring the interests of the manufacturer, but the manufacturer in London was exposed to competition both at home and abroad, and in opposing competition in the supply of electric power the existing authorities looked upon the large manufacturer merely as a source of income. There was one aspect of the case to which he was bound to refer. Both local authorities and companies were emphatic on the point that they could supply more cheaply than the power company, but if this was so, what had they to fear from competition. They could not have it both ways. It had been said, in some cases by the same witness, that the authorised distributor would be ruined by competition, and then that he could supply much more cheaply than the power company. Special reference was then made to the opposition of the Stepney Company, which had made an agreement with the Administrative Company in 1905, and during his cross-examination of the promoters' witness, Mr. Williams for the Stepney Council, had asked whether this company would be prepared to give similar terms. In reply to this, the promoters asked Mr. Williams to submit a clause, but no such clause had yet been submitted, and he could only presume that the Stepney Council, as in 1905, was waiting to see whether the Bill passed the House of Lords before they came forward with a proposal. In his case for the companies against the Bill, continued Mr. Fitzgerald, Mr. Balfour Browne had made a feature that there had been a Parliamentary bargain which in effect would prevent Parliament from passing this power Bill, and, of course, from passing any other power Bill for London. Was there any sort of foundation for such a suggestion? On the contrary, Parliament went out of its way to give notice to every company and local authority having a provisional order under the Act of 1882 that they were not to acquire in any shape a monopoly, and that they might be subject to competition hereafter.

At this point the CHAIRMAN interrupted Mr. Fitzgerald to inform him that the Committee did not wish to hear any more from him with regard to the case against his Bill, with the exception of his remarks upon the modified Kitson clause, and the Purchase clause. Beyond this, would he confine himself to his opposition to the Companies' Bill?

TUESDAY, JUNE 22ND. (TWENTY-SIXTH DAY.)

Mr. FITZGERALD handed in a number of substituted clauses which have been agreed in order to get over the opposition of the London County Council to the London and District Electric Power Bill. We give the substance of the vital clauses below.

All reference to supplying consumers taking 250 kw. and over is deleted from the Bill, and the ordinary form of Kitson clause inserted, giving the promoters authority to give a supply in any area with the consent of the authorised distributor, subject to reference to the Board of Trade if that consent is unreasonably refused or withheld. There is one addition, at the instance of the London County Council, viz., that the Board of Trade, in any arbitration proceedings as to the consent of the authorised distributor, shall be directed to have regard to the financial position of the latter.

A clause providing for a sliding scale of dividends in relation to price has been inserted in the Bill, but the maximum dividend of eight per cent. still remains.

The whole of the original purchase clause has been deleted.

A separate "maintenance and renewals" clause has been drafted, which provides that, before ascertaining the profits of the company, a sum not exceeding 1½ per cent. per annum of the capital expenditure may be set aside as a maintenance and renewals fund. This will prevent the plant being allowed to get into a state of disrepair, but as a matter of fact, in view of the altered terms of purchase, it will be seen that this clause does not assume very great importance.

The "insurance fund" clause, to meet exceptional demands from strikes or accidents, now relates to this only; it formerly included the "maintenance and renewals" clause.

The new purchase clause provides that "The undertaking shall be liable to purchase by any county council or Joint Committee of county councils, body of trustees, or other public authority, who may be authorised by Parliament to purchase the undertaking." The period of purchase has been fixed at 52 years, viz., 1961, upon "then value" terms, on twelve months' notice, but the right is given to purchase in 1951 or any subsequent 10 years on condition that in this event, in addition to "then value" of the undertaking, compensation is paid for any profits that might have been made during the period between the date of purchase and the year 1961. The "then value" is to be determined by arbitration, if necessary. All maintenance and renewals, reserve, and insurance funds remain the property of the company.

A revision of prices clause has also been inserted.

In all these matters the London County Council and the promoters are agreed, the only outstanding point being that the promoters object to specifically naming the former in the Bill as the purchasing authority, owing to the strong opposition of other county councils, and the implied threat of obstruction in the House of Commons should this be done. The promoters also object to Parliament settling this question so many years in advance, although they have no objection to the London County Council *per se*.

The CHAIRMAN decided to leave this point over for discussion on clauses, should these be reached.

Upon one other matter the promoters of the London and District Power Bill, and the London County Council have also agreed, viz., that £600,000 of capital shall be raised within one year, and a substantial commencement of works made within two years.

Mr. FITZGERALD then addressed the Committee in opposition to the "eight company" Bill. He said he could not regard this Bill as a serious attempt to deal with the problem of electric power supply in London. It was not a businesslike or workable proposal, and if it were passed it would only have the effect of leaving matters very much as they were now. Whatever happened, the six "guaranteeing" companies would control the whole of the voting on the proposed Joint Committee. Even if the whole of the local authorities came on to the Committee, the companies would still be in the predominant position as to voting. He could conceive of nothing else than constant appeals to the standing arbitrator, and the whole constitution and working of the Joint Committee would be more like a board set up in a comic opera with the standing arbitrator brought on to dance a breakdown. Even with the Committee controlled by the "guaranteeing" companies, it would not be a very happy family, for these companies were for the most part in strong competition with each other. Coming to the other side of the question, what was the Committee proposing to do; merely to utilise the surplus plant in the existing stations, and if necessary to erect new plant, which would be worked by the individual companies. The argument as to the capacity of any of the companies to give a cheap bulk supply was beyond question. They could not, from the position and circumstances surrounding their stations, give such a supply. Both the Metropolitan and Charing Cross Co.'s had had bulk supply powers for several years, but they had never been able to put them into force owing to the high prices which they had of necessity to quote. The four large stations from which they proposed to supply in bulk were all upon different systems, and the new plant would be upon yet another system. He characterised it as a patchwork, peddling scheme, and asked the Committee to say that it was not one which would solve the problem of electric supply in London.

In answer to the CHAIRMAN, as to the position of the London County Council with regard to the purchase of electrical undertakings in the area, Mr. Freeman said it was the desire of the County Council that either itself, or some other purchasing authority, should have power under the Bill to purchase all the generating stations, in order to bring them into one hand. At present they regarded the purchase rights of the local authorities as of very little value indeed, owing to the stations supplying several districts. He admitted that this would take away the rights of the local authorities, but the justification for it was that it would turn an illusory power of purchase into a real one.

Mr. BALFOUR BROWNE, K.C., in replying to the case against his Bill, said he was obliged for this explanation by Mr. Freeman, for what the County Council desired was provided for in this Bill. It showed that the County Council agreed with the aim of the Bill, viz., that a central authority for unifying the present state of affairs was a necessity. This, therefore, contradicted Mr. Fitzgerald's statement that this Bill was not a serious attempt to deal with the problem. Replying generally on the case, he contended that to allow a power company to compete would be a breach of a Parliamentary bargain, for the Electric Lighting Acts distinctly said there might be competition only by provisional order or licence. In respect of bulk supply, both these Bills were similar, with the difference that this one did not interfere with any existing rights, and the result was seen in the attitude of the local authorities in regard to the two Bills. The local authorities fiercely opposed the London and District Bill, whereas they approved the principle of his Bill. On the question of purchase, he asked the Committee to recollect that his clause provided for purchase in 1952, whereas in the other Bill the period was fixed at 1961, The earlier date was, of course, much more in the interests of the public, and he could not understand this attitude of the London

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County Council. The London County Council had also wished to limit the powers of the Bill to coupling up of the companies, but this was not the main object of the Bill. If this were done, there would be no option to authorised distributors to demand a compulsory supply, and there would be no central authority to unify the systems in the area. Dealing with the criticisms of the working of the Joint Committee. Mr. Balfour Browne said that no evidence had been called as to difficulty in working such bodies, whereas such Committees, as Mr. Conacher had said, were working all over the country in a perfectly satisfactory manner. The whole reason why the companies with bulk supply powers had not been able to put them into force was because of the jealousies of local authorities, which would all be swept away if the Joint Committee were formed and they could get the local authorities to come on to it. Coming to the report of the Board of Trade upon the Bill, Mr. Balfour Browne said the Board had no right to dictate to Parliament as to the duties put upon it. Parliament had every right to put duties upon public departments, and had done so in hundreds of cases—in fact, under the Electric Lighting Acts, the Board of Trade had to sanction transfers of undertakings, which was the point in dispute, so far as putting duties upon the Board was concerned. On the principle of the purchase clause, Mr. Balfour Browne pointed out that the evidence of Sir Hugh Bell for the other Bill was that there could be no guarantee of raising the capital unless investors were certain of getting their money back. But the new purchase clause was upon the "then value" basis, and, therefore, there seemed to be no guarantee that the capital for the London and District Bill would be raised.

Mr. TALBOT, for the promoters of the London and District Bill, interrupted to point out that Sir Hugh Bell had been the chief party in the consultations which had led up to the new purchase clause.

Mr. BALFOUR BROWNE, continuing, said that, so far as raising the £1,000,000 under this Bill was concerned, he would be willing to a clause stipulating that the stock must not be raised at less than 95. Mr. Balfour Browne then drew the attention of the Committee to restrictions under which the existing companies are now working, and urged that to allow a new power company to compete would be most unfair. For the next six or seven years the scheme of the companies was certainly the best, and he asked that it be allowed to proceed.

The Committee then adjourned until two o'clock yesterday.

L.C.C. TRAMWAYS

Provision for Renewals: Audit of Accounts

A REPORT has been presented to the Council by the Highways Committee dealing with the question of the amount which should be set aside in order that the tramways renewals fund may be established and maintained on an adequate basis. The general directions between repairs, which should be met out of revenue and renewals, for which a special fund should be provided, is dealt with in some detail under the following heads :—

Permanent Way.—This is the most important item to be provided for in a renewals fund, but in considering the amount of the provision necessary to be made, the question arises, what shall be regarded as renewals as distinguished from repairs in view of the fact that short lengths of rail are continually being replaced out of revenue in the work of repair of the permanent way? The officers suggest :—

(i.) That the cost of replacing rails shall be charged as repairs, and met directly out of revenue, if for less than a quarter of a mile of single line (and as renewals if for more than that length), provided that the replacement of special work and curved lines of less than 400 ft. radius shall always be regarded as renewal, irrespective of the length of the line affected. This proviso is necessary, as there is a large amount of wear and tear on the special work at junctions and on sharp curves, and there is no difficulty in distinguishing such renewals from repairs.

(ii.) That, subject to the foregoing, the provision for renewals shall include the replacement of rails (both track rails and slot rails), repaving in connection therewith (but not in connection with repairs), conductor tees, road boxes, &c., but that concrete foundations and the conduit shall be omitted from the computation as being practically permanent and not requiring renewal from time to time.

Cables.—The officers suggest that replacement of lengths of 100 yards and upwards should be classed as renewals, anything less than 100 yards being charged as repairs.

Cars.—These are continually being renewed in parts, and every year each car has to be thoroughly overhauled for the purpose of obtaining the annual licence issued by the Commissioner of Police of the Metropolis. The result of this is that the cars are always kept in first-rate condition, and the question of renewal beyond that which takes place from year to year does not arise. It would be extremely difficult to separate repairs from renewals, and the most satisfactory plan would appear to be to defray the whole cost of repairs and renewals of cars directly out of revenue account as the expenditure is incurred, and to exclude cars from the operation of the renewals fund. Moreover, as the number of cars is very large, and the expenditure on renewing parts of the cars falls to be incurred at various dates, the burden of repairs and renewals tends automatically to equalise itself. We are advised that, apart from the question of obsolescence, the necessity for replacing cars will not arise.

Other Electrical Rolling Stock and Traversers.—The officers suggest that the same rule as in the case of cars should be applied to other electrical rolling stock, and to the comparatively small item of traversers in the car sheds, which require a good deal of upkeep, and are closely identified with the cars.

Sub-station Machinery and Switchgear, and Sundry Plant and Tools.—The machinery and switchgear in the sub-stations are governed by considerations very similar to those applying to rolling stock. The main switch cells are built into the structure, and may be regarded as permanent, but the smaller parts have to be constantly attended to and kept in a state of efficiency by small renewals, and the officers suggest that they should be dealt with in the same manner as cars, as should also sundry plant and tools, including insulators.

Ducts.—The officers state that the stoneware ducts laid by the Council are, for all practical purposes, permanent, and will not have to be renewed. Cables are drawn through the ducts, and old cables can be withdrawn and new ones substituted without interfering with the surface of the streets in which they are laid. In the opinion of the chief officer, there is no likelihood of larger ducts being needed, and the original ducts will therefore serve for an indefinite period without any expenditure on renewals.

Track in Car-sheds.—This is a comparatively unimportant item. The track is only used for the passage of cars into and out of the sheds, and will last for a very long period without renewal.

Motor-cars and Lorries.—All electrically-driven vehicles travelling on the tramway tracks should, we are advised, be classed with cars and excluded from the provision for renewals. Provision should, however, be made in the renewals fund for the other vehicles used in connection with the tramways, which comprise motor-cars (petrol), petrol lorries, steam lorries, ticket vans, cable vans, and sundry horse vehicles.

Generating Station.—The whole of the equipment of the station must necessarily be kept in a high state of efficiency, and, as the cost of repairs and small renewals of parts of machines is met directly out of revenue, the renewals fund will only be called upon for large replacements—that is, when a whole machine or boiler is worn out.

Generally.—The question arises, if the renewal of certain items, such as cars and sub-station machinery, is to be paid for directly out of revenue account, and excluded from the provision for renewals, how far the present charge on revenue account for repairs falls short of what may be considered to be the normal average. There can be no question that in the first two or three years after a line is electrified the cost of repair and maintenance is less than afterwards, but the chief officer is of opinion that the time quickly arrives when this expenditure approaches a normal average. For example, he considers that the expenditure now being charged to revenue in respect of the lines south of the Thames may be regarded as having already reached an average figure, bearing in mind that considerable expenditure is being charged to revenue in respect of anchoring rails, which will be completed within the next year or two. Moreover, if, on the one hand, the undertaking should be slightly benefiting for the time being by the charge for repairs being somewhat less than the full average charge which will presently accrue, it must be remembered, on the other hand, that the system adopted by the Council of liquidating the tramways debt by equal instalments of principal will result in later years in a large diminution in the charge for interest, and thus provide what may be regarded as a substantial reserve, available for contingencies, such as any unexpected increase in the cost of repairs.

The final recommendation appended to the report is as follows :—

That provision be made for renewals in respect of the Council's electric tramways undertaking in accordance with the proposals set forth in the above report at the rate of two-thirds of a penny per car mile on the total car mileage run on the electric tramways each year; and that the question of the adequacy or otherwise of this provision be again considered at the expiration of five years from the present time.

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This report of the Highways Committee has been considered by the Finance Committee, who submit a further report thereon in general agreement with that of the opinions of the Highways Committee, and concluding with the following recommendations :—

(*a*) That the "Renewals Reserve Fund" established in connection with the Council's tramways be in future called the "Renewals Fund."

(*b*) That a "General Reserve Fund" to provide for general contingencies be established in connection with the Council's tramways; and that, for a period of five years from April 1st, 1908, any surplus which may be available, after a sufficient sum has been credited to the renewals fund to bring it up to the full amount necessary on the basis of two-thirds of a penny per car mile run by electric traction, be paid into the general reserve fund.

(*c*) That the sum of £34,634, being the amount of £30,772, transferred to the renewals reserve fund on April 1st, 1904, in respect of the horse system, together with interest accumulated to March 31st, 1908, be transferred to the general reserve fund.

The Finance Committee's Report on the "Commercial Audit"

THE report of the Finance Committee of the London County Council upon the report of Mr. W. B. Peat, President of the Institute of Chartered Accountants, and Mr. F. W. Pixley, upon the accounts of the tramways department (see ELECTRICAL ENGINEERING, March 26th, page 465), has now been presented.

With regard to the question of obsolete capital, that is, the losses on displaced assets of the horse system, the accountant estimated that the approximate loss still to be provided for must exceed £1,000,000, and said, "while we recognise that the Council had no means of writing off at once the loss on the displaced assets of the horse system, we consider that such loss should be provided for out of revenue more rapidly than by the charging of the annual instalments in repayment of the debt. Until these losses are provided for, there can be no profits applicable for the relief of the rates." The Finance Committee express the opinion that the Council should accept the advice of the accountants in regard to writing off this obsolete capital, and proceed in their report to consider the date from which the new charge should commence, the amount of obsolete capital to be dealt with, and the extent to which the repayment of debt should be accelerated. It is suggested that the repayment of debt represented by obsolete capital should be deferred until the reconstruction of the horse tramways is practically complete, and give March 31st, 1914 as an appropriate date from which to commence the more speedy writing off of the obsolete capital, which will then be outstanding. After going into some detail, the actual obsolete capital not written off is put as £961,954, and it is proposed to write it off in fifteen equal annual instalments, so that the whole is paid off by March 21st, 1929.

With regard to provision for renewals, the committee write as follows :—"We are entirely in favour of the establishment of an adequate renewals fund in connection with the tramways undertaking, and are in accord with the accountants in holding that no moneys from the undertaking can be considered as available for relief of the rates until full provision for such a fund on a proper scale has been made. We are not able, however, to agree that such a provision for renewals has no relation to the provision required to be made for the repayment of capital. The question of the relation between a renewals or depreciation fund and the repayment of capital by a local authority is one upon which difference of opinion prevails even amongst expert accountants. It seems to us that the statutory obligation resting upon a local authority to repay its capital within a period approximating to the life of the undertaking constitutes a fundamental difference between the position of an undertaking worked by a municipality and one operated by a company which cannot be ignored in any comparison between the two." One or two smaller points are then dealt with, and, in general, agreement is expressed with the accountants' report.

The Finance Committee's report continues :—"The accountants refer to the growing cost of repairs. This is a feature of the accounts which has not escaped attention, but it may be pointed out that there has been no difficulty in meeting the cost out of current revenue, while there has been an increase in the amount available for and appropriated to the renewals reserve fund. In connection with this point, reference may be made to the method adopted by the Council for repayment of debt by equal annual instalments of principal, so that the interest charge diminishes each year by the amount of interest on the debt paid off, and this constitutes a very substantial margin against the increasing cost of repairs or any other head of expense." Tables are then given illustrating this point.

The question of apportioning the cost of street improvements is admitted to present great difficulty. In general terms the accountants express the opinion that "the proportion of the cost of the street improvements and widenings which should be charged to the tramways should bear a direct relation to the benefit derived or to be derived by the tramways :—

"(*a*) When the improvements were undertaken wholly to accommodate the tramways and were not otherwise necessary.

"(*b*) When improvements were undertaken along a route concurrently with the construction of a tramway.

"(*c*) When the improvements were undertaken with the object of accommodating general traffic and also providing a sufficient width of thoroughfare for a contemplated construction of tramways.

"(*d*) When the tramways although constructed derive, in common with the general traffic, benefit from the improvement." And they say, further, that "in assessing the benefit apportionable to tramways the Council should be guided by the advice of experts, who would take into account all the circumstances of each particular case."

As regards the improvements falling in group (*a*) the Council resolved on November 20th, 1906, that the whole cost of such improvements should be charged to the tramways account. It is believed that the majority of improvements connected with proposals for tramways fall under heads (*b*) and (*c*), and it is in regard to these that the difficult questions arise.

The Finance Committee do not propose in this report to discuss the propositions laid down by the accountants in this matter, as they have received a memorandum from the Improvements Committee suggesting a conference with the Highways Committee in reference to the Council's resolutions of November 20th, 1906, on this subject, and think that the whole question, together with the accountants' report thereon, should be considered by the three committees with the view to a joint report to the Council.

The report continues :—"With regard to the suggestion of the accountants that expert advice should be obtained, we think it would be difficult to find an outside expert who could usefully advise the Council in a matter of this kind, and the expense would be considerable."

In conclusion the recommendations are given as follows :—"(*a*) That the amount of capital expenditure rendered obsolete from time to time owing to the conversion of the horse traction system to electric traction, and the provision made *per contra* for the liquidation of the debt thereon, be in future shown in the balance-sheet of the tramways undertaking; (*b*) that, subject to the approval of H.M. Treasury being obtained in due course, provision be made within a period of 15 years from March 31st, 1914, for the repayment of the debt in respect of obsolete capital expenditure outstanding on that date on the horse tramways; (*c*) that the sum of £5,547 be charged to the revenue account of the tramways as on March 31st, 1908, for additional central office establishment charges for the period prior to April 1st, 1907, when the standing order, No. B 198, made by the Council on July 31st, 1908, came into force : (*d*) that it be referred to the Finance, Improvements, and Highways Committees to consider the resolutions of November 20th, 1906 as to the allocation of the cost of street improvements connected with tramways, together with the report of Messrs. Peat and Pixley on the same subject, and to report jointly to the Council as to the action which should be taken thereon."

The Highways Committee have also presented a report on the same subject, which is in general agreement with the conclusion of the Finance Committee.

After a discussion lasting several hours on Tuesday, the Finance Committee's report was adopted by 73 votes to 41.

Electric Railway from Frankfurt to Wiesbaden.—It has been proposed to connect these two towns by an electric railway, part of which (between Rossmarkt and the Mainzer Landstrasse) would be underground. Permission to prepare preliminary designs was granted last April to the Elektricitäts-Aktiengesellschaft vormals W. Lahmeyer & Co., of Frankfurt.

International Electrical Congress at Marseilles.—According to *La Revue Electrique* (Paris), the arrangements for the international congress on the applications of electricity, to be held from September 14th to September 20th in connection with the Marseilles Exhibition, are well advanced. The object of the congress is defined as the examination of technical, commercial, and administrative problems, which have arisen in practice during the last few years. These different questions will be treated in reports, which will be submitted for discussion. The fee for membership is 20 francs, and particulars can be obtained from M. le Trésorier du Congrès international des Applications de l'électricité, 63 boulevard Haussmann, Paris. Special arrangements for reduced fares to members on the French railways are being made. Visits will be paid during the congress to works and objects of technical interest in the neighbourhood. The congress will be divided into the following sections : I. Legislation. II. Construction and protection of distributing systems. III. Technical and commercial developments. IV. Lighting and domestic applications. V. Applications to industry, mining, traction, and agriculture. VI. Electrochemistry and electrometallurgy. VII. Telegraphy and telephony. VIII. Education and measurements. IX. Applications to hygiene and medicine. In these sections over 60 discussions will be opened by well-known French engineers and others.

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THE THIRTEENTH CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION

THE Incorporated Municipal Electrical Association will hold its thirteenth annual Convention in Nottingham next week, under the presidency of Mr. H. Talbot, Chief Electrical Engineer to the Borough of Nottingham. Mr. Talbot has been connected with the Association since its formation in 1896, and was elected to the Council in 1901. In 1906–7 he was elected Vice-President, and at the Convention in Sheffield last year he was chosen as President for this occasion. Although it is usual that the meeting should be held in the town in which the President for the year is engineer-in-chief, there is no absolute rule to this effect, and at first it was an open question whether another town should not be chosen, chiefly because the hotels in Nottingham are comparatively small, and it would not be possible to accommodate all the members under one roof. Several members were in favour of a seaside town being chosen this year, but eventually Nottingham was decided upon.

A feature of the meetings of the Association is that only a portion of the time is taken up by the reading and discussion of Papers, and a considerable part is devoted to excursions and visits to works. At Nottingham this arrangement is being followed. The whole of the second day, Wednesday, will be taken up by an excursion to Dovedale; train is taken from Nottingham to Matlock Bath, and thence the members will drive through some of the finest scenery in the neighbourhood.



H. FARADAY PROCTOR
(*City Electrical Engineer, Bristol*),
Hon. Sec. to the I.M.E.A.



H. TALBOT
(*Chief Electrical Engineer, Nottingham*),
President of the I.M.E.A.



C. MCARTHUR BUTLER.
Secretary of the I.M.E.A.



JOHN ALDWORTH.
(*General Manager of the Nottingham Corporation Tramways.*)



THE MAYOR OF NOTTINGHAM
(COUNCILLOR SPALDING).



SIR JOHN TURNEY, J.P.
(*Chairman of the Nottingham Electricity Committee*).

On Tuesday afternoon, after a luncheon to which the Association has been invited by Sir John Turney, J.P., Chairman of the Electricity Committee, a visit

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will be made to the Trent Bridge car-sheds of the Nottingham tramway undertaking, and to the St. Ann's Power House.

At the car-sheds, in addition to the interest that attaches to the sheds themselves, the workshops and the recreation rooms for the men, attention should also be given to matters of technical detail. For instance, some of the cars are fitted with the new B.T.H. "electro-mechanical" track brake, a magnetic track brake which can also be applied by hand, and there is also a trolley wheel with renewable centre, used on a large number of the cars, which creates considerable saving in trolley-wheel renewals. The replacement of the wooden shoes of the ordinary hand track brake is also worth noting, as is also the method employed for fixing loose armature spiders. A description of these, together with a brief sketch of the tramway undertaking generally, appears on page 971 of this issue.

Those who have been able to resist the counter-attractions of the Trent Bridge cricket ground on the other side of the river will, after inspection of the car-sheds and workshops, proceed to the St. Ann's Power House, which is one of the three generating stations of the Nottingham Electricity Department, described in some detail on page 965. These stations supply D.C. current at 500 and 2×220 volts for the lighting and tramways respectively, and are interconnected by 0·75 sq. in. trunk mains. The St. Ann's station is a typical "small unit" non-condensing station, and contains nine Willans-Siemens 440 kw. sets, all practically identical.

The following list of towns in which previous Conventions have been held will be of interest:—

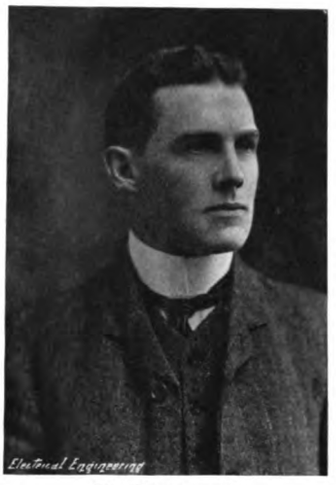
Year.	Town.	President.
1896.	London	Arthur Wright (Brighton).
1897.	Manchester	C. H. Wordingham.
1898.	London	A. H. Gibbings (Bradford).
1899.	Bristol	H. Faraday Proctor.
1900.	Huddersfield	A. B. Mountain.
1901.	Glasgow	W. A. Chamen.
1902.	London	J. H. Rider.
1903.	Sunderland.....	J. F. C. Snell.
1904.	Derby	T. P. Wilmshurst.
1905.	Edinburgh	F. A. Newington.
1906.	London and Kingston-on-Thames	J. E. Edgcome.
1907.	Sheffield	S. E. Fedden.

At practically every Convention of the Incorporated Municipal Electrical Association, a Paper on a subject more particularly of interest to the Chairmen and Councillors is set down for discussion. There is frequently some difficulty in finding an author and a subject, but this year Bailie R. A. WIGHTMAN, Convener of the Govan Electricity Committee, has stepped into the breach with a chatty Paper on "The Experiences of a Convener in the Establishment of an Electricity Undertaking." Mr. Wightman, who is an architect by profession, entered the Govan Town Council in 1893. He was elected Convener of the Watching and Lighting Committee in 1897, and served his first term as magistrate in 1899. In 1900 he was chosen as Convener of the Electricity Committee, in 1906 he was appointed Justice of the Peace in the county of Lanark, and in 1907 he served his second term as magistrate. The Govan electricity works was started in 1900; Mr. T. C. Parsons is the Burgh Electrical Engineer.



BAILIE R. A. WIGHTMAN, J.P.

Mr. H. RICHARDSON, whose Paper on "Some Considerations on the Design of a Generating Station," is down for reading on Thursday, is Chief Electrical Engineer of the Dundee electricity undertaking. Mr. Richardson served his mechanical apprenticeship with Messrs. Frank Ashwell & Co., London and Leicester, and subsequently entered upon his electrical training with Messrs. Siemens Bros. & Co., with whom he remained for three years. He next joined the National Supply Co. at Preston, previous to taking up an appointment as assistant electrical engineer during the construction and inauguration of the Newcastle-upon-Tyne tramways service. Relinquishing this post in December, 1902, he took up the position of Chief Electrical Engineer to the City of Dundee lighting and tramways undertaking, which important position he has since held. His latest work is the erection and equipment of a new H.T. generating station, situated on the banks of the river Tay, with sub-stations, the plans and designs for which he prepared. It is expected that this scheme will cost about £100,000. It has now been got well under way, and the work is being pushed forward with all possible speed; it is anticipated that everything will be complete and ready for next winter's load.



H. RICHARDSON.

Mr. C. M. SHAW, author of the Paper on "The Reconstructions of an Electric Lighting Scheme, with Observations on the Working of a Combined Steam and Water Power Plant," the second on the list for Thursday, is Chief Electrical Engineer at Worcester. Mr. Shaw, who is now 31 years of age, served his apprenticeship with Messrs. Blakey, Emmett and Co., of Halifax, and Messrs. Fairbarn, Naylor & McPherson, of Leeds. In 1894 he was appointed junior assistant in the Dewsbury Corporation electricity works, and remained with them until 1897. He resigned his post as assistant at Dewsbury in 1897, and went as a pupil to the Yorkshire House-to-House Electricity Supply Co., Leeds. In the second week of his pupilage he received the appointment of senior mains engineer. During the four and a half years he was at Leeds 200 miles of high- and low-tension cables and 30 miles of telephone cable were laid, and 55 transforming chambers were erected under his supervision. In May, 1902, he was appointed City Electrical Engineer at Wakefield, where he was responsible for large extensions, and redesigned and altered, the original single-phase system to polyphase supply. In January, 1905, he took up the post of Chief Electrical Engineer at Worcester.



C. M. SHAW.



A. M. TAYLOR.

Mr. A. M. TAYLOR, Assistant Engineer at Birmingham, reads a Paper on "A.C. Accumulator Sub-stations, and the Use of Accumulators on Peak Loads," on the last day of the meeting. Mr. Taylor's

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record is a long one. After passing through a course in electrical engineering with Ayrton & Perry in 1881–4, Mr. Taylor entered Messrs. Siemens Bros.' works at Woolwich. Some of the important work he did for this firm took him abroad, and he also spent two or three years in India on behalf of Messrs. Siemens. Returning from India, Mr. Taylor was at the firm's London office until 1898, when he left to take up the post of chief engineer to the National Electric Traction Co. Mr. Taylor next came to Birmingham as the personal assistant to the Chief Engineer, in which position he has remained ever since.



H. A. RATCLIFF.

Mr. H. A. RATCLIFF, the reader of the last Paper, "The Work and Equipment of a Testing and Standardising Department," is a native of Nottingham, and has been on the staff of the Manchester Corporation Electricity Department since his twenty-first year. Entering their service in 1897, he served first for a short time in the mains surveyor's department, and then in the installation department. On the formation of a separate testing department in 1899, he was promoted to take charge of it, and was mainly responsible for all the detail work in connection with the equipment of what is one of the finest municipal testing departments in the country.

The following gentlemen had notified their intention of attending the Convention up to yesterday (Wednesday):—

Accrington—H. Gray.
Acton—J. M. Blair.
Barking—H. S. Howard, A. W. Smith.
Barnes—C. S. Davidson.
Barrow-in-Furness—H. R. Burnett.
Beckenham—J. E. Tapper.
Bedford—R. W. L. Phillips, S. Kilpin.
Belfast—T. Bloxam.
Birkenhead—W. Wyld, W. Bates.
Birmingham—A. M. Taylor.
Blackburn—P. P. Wheelwright, Mr. Higham.
Blackpool—C. Furness.
Bolton—A. A. Day, Ald. J. Berry.
Bootle—T. D. Clothier.
Bradford—T. Roles, A. Wood.
Bray—W. J. U. Sowter.
Brighton—J. Christie.
Bristol—H. Faraday Proctor, Ald. G. Pearson.
Broughty Ferry—J. L. Turnbull.
Burslem—Aston Bremner, T. Willett.
Burton-on-Trent—P. J. Pringle.
Bury—S. J. Watson, R. D. Duxbury.
Canterbury—C. A. Blascheck.
Carlisle—S. T. Allen.
Cheltenham—W. J. Bache.
Chester—L. E. Britton.
Chesterfield—R. L. Acland.
Colne—A. G. Cooper.
Coventry—Ald. West, Councillor Pridmore.
Croydon—A. C. Cramb, Ald. D. Miller.
Darlington—J. R. P. Lunn.
Derby—T. P. Wilmshurst.
Dewsbury—R. N. Campion.
Ealing—J. D. Knight.
Easthourne—J. K. Prydges.
Eccles—H. W. Angus, Ald. W. Pearson.
Edinburgh—F. A. Newington, Councillor A. Murray (Convener), Bailies A. Stevenson and Neill.
Falkirk—J. McMillan.
Farnworth—R. B. Leach.
Glasgow—W. W. Lackie.
Govan—T. C. Parsons, Bailie R. A. Wightman.
Greenock—J. A. Robertson, N. M. Brown.
Grimsby—W. Vignoles.
Halifax—W. M. Rogerson.
Hanley—C. H. Yeaman.
Harrogate—G. Wilkinson, R. McCourt.
Hastings—R. F. Ferguson, F. A. Langham.
Heywood—T. Popple.
Hornsey—N. Staniland.
Hoylake—C. J. Turner.
Huddersfield—A. B. Mountain, Ald. Chatterton, Ald. Jepson.
Hull—H. Bell, J. Wilkinson.
Ilford—A. Shaw.
Ilkeston—A. C. Gilbert.
Ipswich—F. Ayton.
Kettering—W. A. Walker.
Kilmarnock—A. H. Burbidge.
Kingston-on-Thames—J. E. Edgcome.
Lancaster—W. A. Lester, James Heald, T. Huntington.
Leith—A. Rutherford, Judge G. Craig.
Lincoln—S. Clegg.
Liverpool—A. Clough, E. Lloyd.
Londonderry—R. V. Macrory.
Luton—W. H. Cooke, Ald. Wilkinson.
Maidenhead—C. O. Milton.
Maidstone—E. E. Hoadley, E. Vaughan.
Manchester—S. L. Pearce, H. A. Ratcliff, E. S. Hurlbatt, G. D. Seaton, W. Yates.
Mansfield—E. H. Hewlett.
Morecambe—A. V. Bland.
Newport (Mon.)—H. C. Bishop.
Norwich—F. M. Long.
Nottingham—H. Talbot, Sir John Turney, J. Aldworth.
Oldham—S. Newington.
Paisley—C. Parkinson, Bailie A. Fisher.
Partick.—W. Sillery.
Plymouth—E. G. Okell.
Rochdale—C. C. Atchison, J. P. Fielden.
St. Helens—E. M. Hollingsworth, Ald. J. Beecham.
Salford—V. A. H. McCowen, Councillor Barrett, F. Hill.
Sheffield—S. E. Fedden, A. Cridge.
Southport—A. S. Black.
Stockton-on-Tees—J. J. Smith.
Stoke-on-Trent—P. J. S. Tiddeman.
Sunderland—A. Blackman.
Swansea—A. Sinclair.
Tynemouth—C. Turnbull.
Wakefield—H. A. Nevill.
Wallasey—J. A. Crowther.
Walsall—A. S. Barnard.
Warrington—F. V. L. Mathias.
West Bromwich—W. A. Jackson.
West Hartlepool—H. F. Fredericks.
Weymouth—J. H. Bolam.
Whitehaven—W. Sankey, Ald. W. Hashwell.
Willesden—J. G. Bruce, B. A. Griffin.
Wimbledon—H. Tomlinson-Lee.
Woking—J. G. McLean.
Wolverhampton—C. E. C. Shawfield.
Worcester—C. M. Shaw.
Wrexham—W. Pickvance.
York—J. W. Hame.

Leonard Andrews (Key Eng. Co.), W. Birt, L. Broekman (Chloride Elec. P. S. Co., Leeds), J. V. Corneille (Veritys), H. W. Couzens, P. S. Doherty (Worthington Pump Co.), S. Z. de Ferranti, E. J. Fox (Willans & Robinson), F. Foulds (Faraday House), W. E. Freir, T. E. Gatehouse, G. P. Gregory (B.T.-H. Co.), Robert Hammond, Haydn Harrison, A. Hopkinson (J. Hopkinson, Ltd.), J. Huddleston (Siemens Bros & Co.), F. A. Jerbury, M. Martin, A. Musall (W. T. Glover & Co.), N. New (Gen. Elec. Co.), F. C. Raphael (ELECTRICAL ENGINEERING), T. R. Renfree (British Electric Transformer), J. H. Rider (L.C.C. Tramways), J. Robinson, Prof. W. Robinson (University College, Nottingham), H. S. Russell, R. Schofield (Ferranti, Ltd.), H. Scholey (Dick, Kerr & Co.), E. Sharp (Venner & Co.), Prof. R. H. Smith, J. F. C. Snell, J. J. Stenitz (Brush Co.), N. Sutherland, A. Webster (ELECTRICAL ENGINEERING), B. Welbourn (British Insulated & Helsby Cables), A. G. Whyte, C. Wilson (Robertson Lamp Works), J. H. Wilson.

PROPOSED NEW HOME FOR THE INSTITUTION OF ELECTRICAL ENGINEERS

FOR some time schemes have been under consideration for the provision of new quarters for the Institution of Electrical Engineers, which shall not only possess the increased office and library accommodation so badly needed, but shall render it unnecessary for the Institution to be obliged to depend on the hospitality of the Institution of Civil Engineers and the Society of Arts for the holding of meetings. Generally a headquarters is desirable, worthy of the body representing the electrical engineering profession and industry. The special building fund established with this view has been gradually growing, and a site

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in Tothill Street, Westminster, from which rents are now being drawn, was acquired in the year 1903. This site was subsequently added to and now embraces Nos. 15 to 18, Tothill Street. An opportunity has, however, presented itself for a different solution to the problem, and a scheme is now under consideration for the purchase of an existing building, and the disposal of the site already acquired.

The new home proposed for the Institution is the building on the Victoria Embankment between Waterloo Bridge and the Savoy Hotel, known as the Medical Examination Hall, a view of which is shown in the accompanying illustration.

In connection with the scheme, notice has been given of a Special General Meeting of members, associate members, and associates of the Institution, to be held in the lecture theatre of the building itself on Tuesday, June 30th, at 5.30 p.m., for the purpose of considering and, if thought fit, passing the following resolution:—

"That the purchase of the lease of the site and building known as 'The Medical Examination Hall,' situate on the Victoria Embankment, now the property of the Royal College of Physicians of London and the Royal College of Surgeons of England, for the sum of £50,000, be sanctioned and approved, and that the Council be authorised to sell such of the investments of the Institution and to make such other financial arrangements (including the disposal of the site in Tothill Street now owned by the Institution) as the Council may consider necessary for the above purpose."

It should be pointed out, that the passing of this resolution in no way forces the Council to proceed with the scheme; it is merely permissive in its effect, and has for its object the expression of approval of the body of membership to the scheme. Although the negotiations may be regarded as fairly complete, neither party concerned in the sale and purchase is legally bound until the contract of purchase has been executed, which cannot be done until after the General Meeting. The owners of the property are the Royal College of Physicians of London and the Royal College of Surgeons of England, who hold it from the Duchy of Lancaster on a ninety-nine years' lease dating from 1885, the unexpired portion being therefore seventy-six years. The Council proposes to purchase this lease for £50,000, plus the ground rent of £2,201 per annum. As already stated, the building stands on the Victoria Embankment. It faces one of the Embankment Gardens, and is situated between the Savoy Hotel and Waterloo Bridge. It is midway between Charing Cross and Temple Stations on the District Railway, is within a few minutes' walk of Waterloo, Charing Cross, and St. Paul's Stations, is close to the Strand Station of the Underground Electric Railways, and is almost at the point of junction of the tramways of the north and south of London.

The building occupies a nearly square site of over 20,000 sq. ft., and contains a floor space (exclusive of corridors, entrance halls, and passages) of more than 40,000 sq. ft. The theatre is rather small, but the Council considers that it can be increased and improved without very serious expense. In order to enable members to see the building, the Royal Colleges have kindly allowed the use of the theatre for the special General Meeting, and will permit inspection of the principal rooms of the building after 5 p.m., half an hour before the time of the meeting, on Tuesday, June 30th.

From an inspection of the building it is obvious that it contains a larger number of rooms than would be required at present for the purposes of the Institution, so that a portion of the building would be sublet, and this must, of course, be borne in mind in considering the financial position.



THE EXAMINATION HALL OF THE ROYAL COLLEGES OF PHYSICIANS AND SURGEONS, THE PURCHASE OF WHICH BY THE INSTITUTION OF ELECTRICAL ENGINEERS IS PROPOSED.

The main part of the building, which was built 22 years ago by the Royal Colleges of Physicians and Surgeons, forms four wings surrounding a quadrangle, into which project the main staircase and the semi-circular back of the lecture theatre, and consists of a basement, ground, first, second, and third floors, each containing a number of large and lofty rooms. One of the finest rooms in the building is on the first floor in the front which runs the whole width of the house, but can be sub-divided by folding doors if necessary. The majority of these various rooms are used as offices, examination rooms, class-rooms, laboratories, &c., by the Colleges of Physicians and Surgeons, but a portion is sub-let and used as offices by other tenants. The lecture theatre forms a part of the rear wing, but, as we have said, projects into the central space. It is constructed with semi-circular tiers of seats sloping back one above the other, and a gallery, but at present a temporary level floor is fitted, covering the well. It will accommodate about 450 persons, which is about the same as the hall of the Institution of Civil Engineers, but, by setting back the semi-circular wall, it could be enlarged to hold at least 750 persons. There are four side entrances as well as the main front entrance, and a goods entrance in a private road at the back.

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THE NOTTINGHAM CORPORATION ELECTRICITY SUPPLY UNDERTAKING

A SUPPLY of electricity for lighting, power, and tramway purposes in Nottingham is given by the Corporation from three continuous-current generating stations at different parts of the town. The undertaking had its inception in 1894, when the original station was opened. The electricity department has been presided over during the whole 14 years of its existence by Sir John Turney, chairman of the Electricity Committee, and Mr. H. Talbot, this year's President of the Municipal Electrical Association, has been Chief Electrical Engineer to the Corporation since the commencement of the undertaking.

A glance round the three stations shows examples of plant of various types of design which have had great vogue at different times in this country, and it is of some interest to trace the successive periods marked by the extensions which have been made to the plant from time to time, the more so, perhaps, because practically the whole of the electrical plant is the product of a single firm of manufacturers. The three stations comprise the original Talbot Street station, to which considerable extensions have been subsequently added, the more recently built St. Ann's Power House in St. Ann's Well Road, from which the greater part of the tramway supply is taken, and the Eastcroft refuse destructor station. At the present time most of the supply for private lighting and power is taken from Talbot Street, but, as will be seen hereafter, there

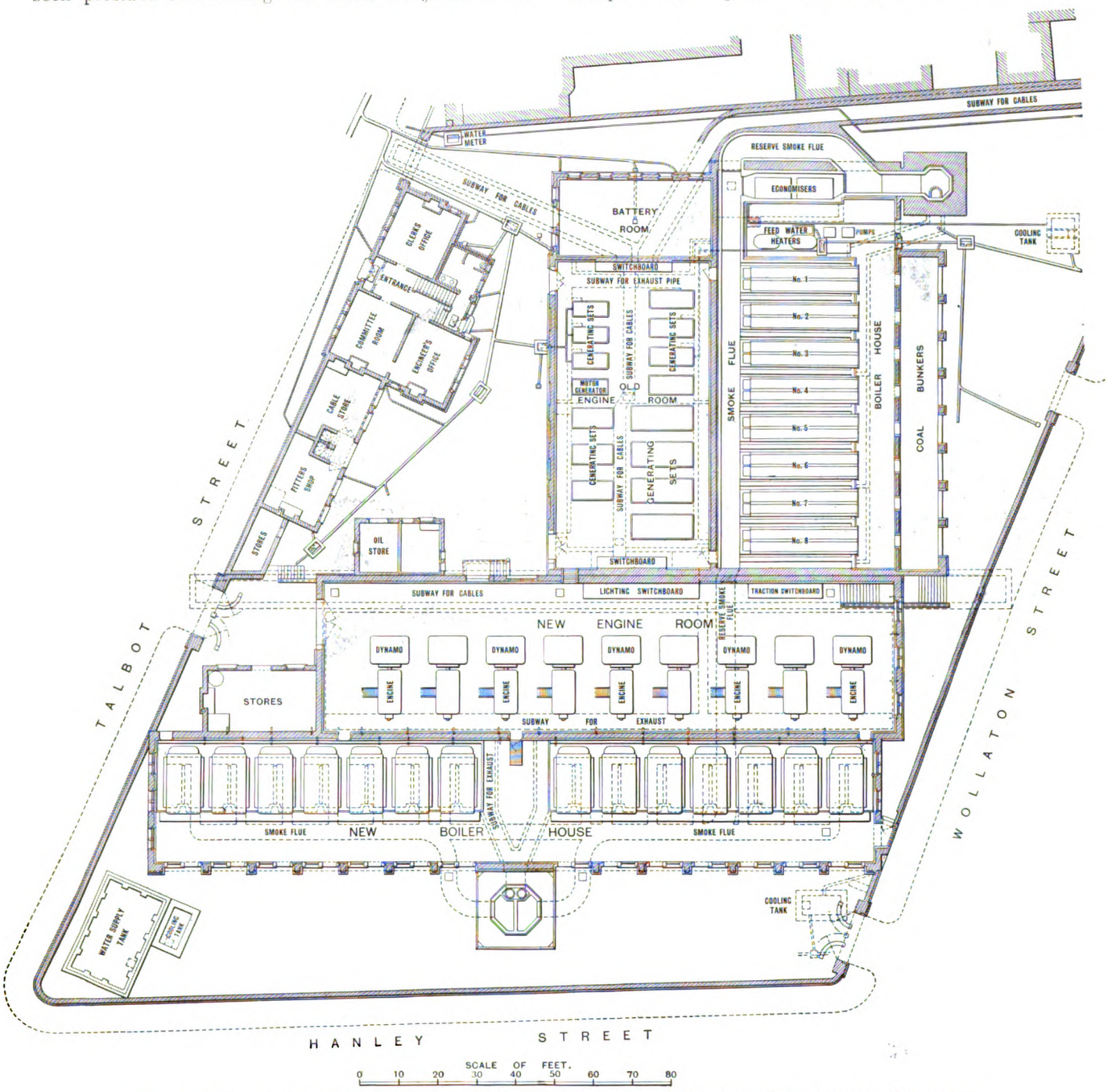


FIG. 1.—PLAN OF TALBOT STREET GENERATING STATION, NOTTINGHAM CORPORATION ELECTRICITY DEPARTMENT.

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are three 440-kw. sets which can be used for traction if required. The St. Ann's station, although originally built for the tramways, also supplies a certain amount of the lighting load. These stations are interconnected by 0·75 sq. in. trunk mains, and a certain number of feeders are brought up to the switchboards in each station. The third station is purely for the utilisation of steam from the destructor, and has connected to it one lighting feeder and one traction feeder.

A plan of the Talbot Street station is shown in Fig. 1, and Fig. 2 is a view of the older engine-room. The original portion, part of which can be seen in the foreground, contained, when first opened, six sets. Three of these were 100-volt Siemens bipolar machines driven by 80 h.p. two-crank Willans' central valve engines, and the other three were 220-volt machines

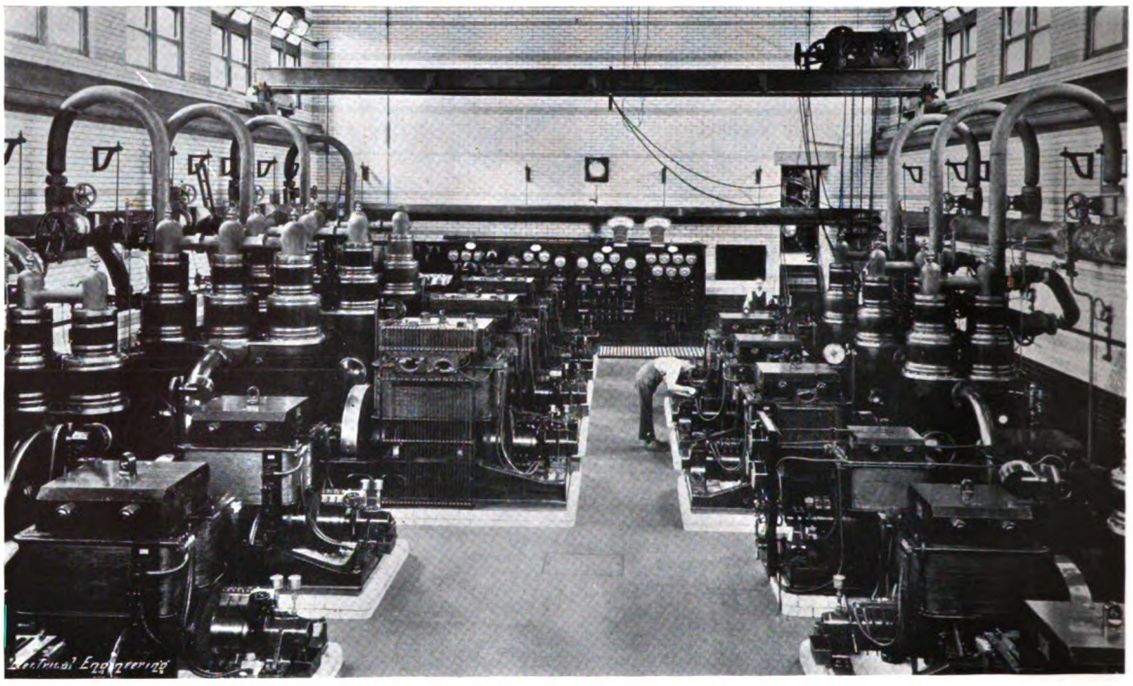


FIG. 2.—VIEW OF OLD ENGINE-ROOM, TALBOT STREET STATION.

driven by 135 h.p. Willans engines. A further set of this size was subsequently added in this part of the engine-room. The sets seen in the background in Fig. 2 were put down when the first extension to the

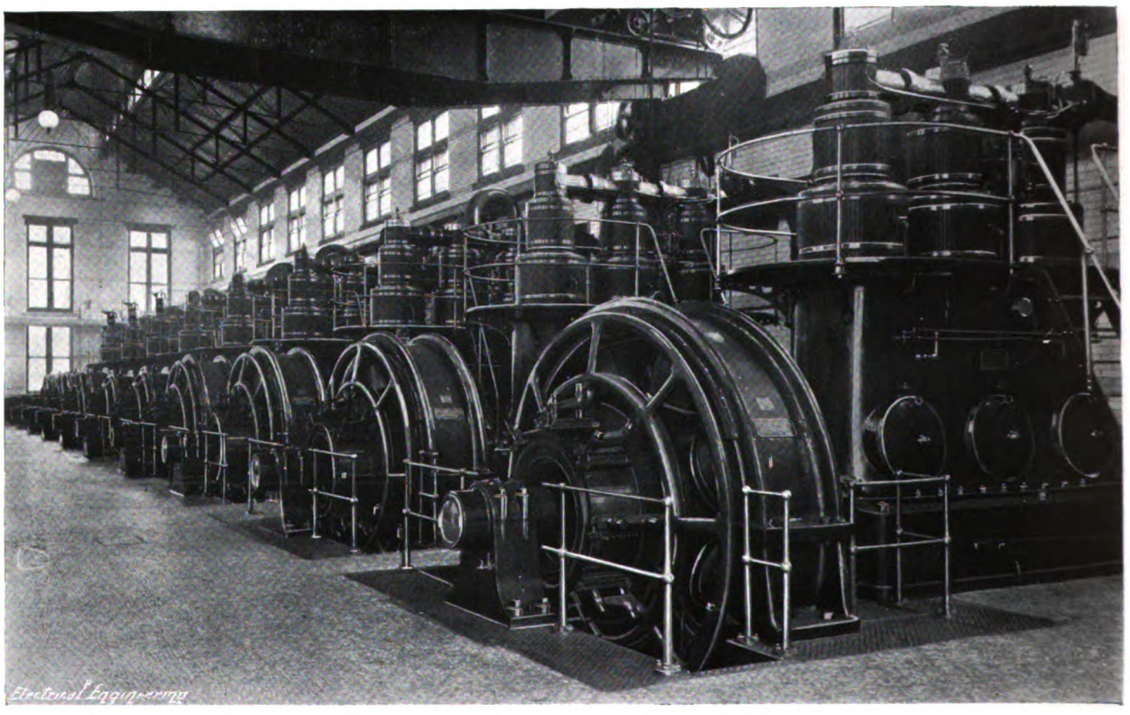


FIG. 3.—VIEW OF NEW ENGINE-ROOM, TALBOT STREET STATION.

engine-room was built in 1896, and consist of three more 135 h.p. sets, and the four larger sets seen on the left, which are driven by three-crank compound Willans engines. The positions of these various sets are shown clearly on the plan in Fig. 1. All the

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engines are exactly similar, except for differences in size, and the fact that some are of the two-crank and some of the three-crank pattern. All run non-condensing, and, indeed, it is due mainly to the absence of condensing water that turbines have not been adopted in any of its stations. The dynamos are all examples of the famous bipolar "H.B." smooth core type, built by Messrs. Siemens Brothers at their Woolwich works in the 'nineties. All these machines are shunt wound. The original 100-volt sets, which, however, can be worked up to about 148 volts, are now principally used for battery charging, and the 220-volt machines are used for balancing on the 440-volt three-wire network. The motor-generator set seen on the right in Fig. 2 is used on one side of the system with the battery on the other for balancing at times when none of the 220-volt sets are running. Its output is 150 amps. at 210 to 230 volts.

The second extension took place in 1899, when an entirely new engine-room at right angles to the original engine-room and with a separate boiler-house was constructed. The generating plant in this section marks the transition from the bipolar smooth core machine with copper brushes to the multipolar generator with slotted core and carbon brushes, as well as the gradual increase in size of the sets, although, as compared with modern practice, the sets are small and numerous. The imposing appearance of the nine sets which, arranged in a single row, form the equipment of this engine-room is seen in Fig. 3. Each set consists of an eight-pole Siemens 440 kw. continuous-current generator driven by a three-crank compound 705-h.p. Willans engine of the size known as three S's. The three furthest machines are compound wound, and can be on the traction load if required, with an output of 800 amperes at from 500 to 550 volts. The engines driving these sets are fitted with Sankey's patent variable cut-off gear. The remaining six machines are shunt wound for running on the 440-volt lighting mains. These engines, like those in the older engine-room, run non-condensing.

Each of these three groups of generating sets has its own switchboard. Taking the more recent plant first, we find in the new engine-room a marble traction board opposite the three traction generators provided with three generator panels and six feeder panels, and interconnected with the St. Ann's station. This board was supplied by Messrs. Siemens Brothers, and is equipped with Messrs. Elliot Brothers' recording instruments. The change-over switches to the three traction generators are placed behind the board. The lighting board, also by Messrs. Siemens Brothers, is shown in Fig. 4. It is provided with nine single-pole generator switches, with minimum releases at the bottom of the board, and provision for twelve feeders and three trunk mains. There are three separate sets of bus-bars, on to which any of the generators or feeders may be connected by means of plugs. These bus-bars may be connected together or can be kept at different voltages if desired. The centre panel is devoted to the middle wire and connections for the pilot wire voltmeters. All the feeders are provided with duplex fuses with change-over switches. The instruments are of the moving coil pattern in ambroin cases, and are of Messrs. Siemens Brothers' own manufacture. The old engine-room has two boards, one at each end, corresponding to the older and newer sections of the generating plant. The board seen in Fig. 2, at the other end of the room, was supplied by Messrs. Blackburn & Starling, of Nottingham, and contains provision for seven generators and six feeders. This board is interconnected with the lighting board in the new engine-room just described, so that supply can be exchanged from one to the other. The original board at the other end of the old engine-room was supplied by the Electric Construction Co., and has six feeders connected up to it. The centre forms a battery panel with regulating switches, but we understand that the battery is not used now so much except for testing and balancing in conjunction with the motor generator already mentioned. Some of the switchgear on this board is interesting from a historical point of view as

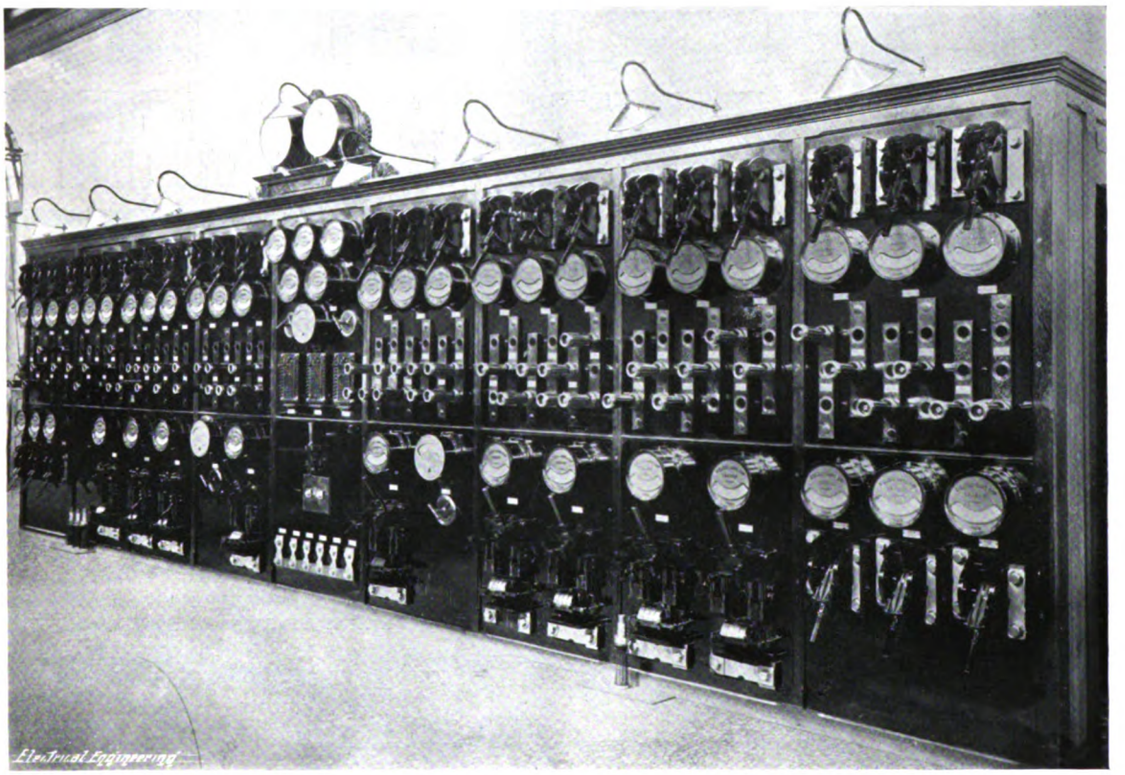


FIG. 4.—LIGHTING SWITCHBOARD IN NEW ENGINE-ROOM, TALBOT STREET STATION.

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embodying a method of regulation of back E.M.F. cells.

The positions of the two boiler-houses are shown on the plan in Fig. 1. The old boiler-house contains eight Lancashire boilers (28 ft. × 7 ft.), made by Messrs. E. Danks & Co., of Oldbury, each of an evaporative capacity of 5,500 lbs. per hour. These boilers are arranged in a single row, and are hand fired. The feed water, which is obtained from the town water supply, is passed through a Berryman feed heater. Weir steam-driven feed pumps are used, but there is also one electrically driven feed pump which is generally kept as a stand-by. A Green's economiser is provided, and we noticed a CO_2 recorder of the Simmance-Abady type in use. Both "Sentinel" and "Giepel" steam traps are fitted to the steam piping. The new boiler house contains a row of fourteen dry-back boilers, each capable of evaporating 10,000 lbs. of water per hour, by the same makers. These are also hand-fired, and the bunkers supplying the mechanical stokers. All this conveying plant is driven from a single 15-h.p. motor, but arrangements are made for an alternative drive from the other end of the shaft by a steam engine, which can be connected when required through a clutch. Green's economisers and Berryman feed-water heaters are used, and, as at the other stations, all the steam piping is electrically welded. The exhaust is carried in a pair of 24-in. pipes to the top of the chimney, which is 220 ft. in height, and it has been found necessary to provide a special silencer for the steam pumps to avoid the deep organ note which was produced by this pipe when first installed and was audible for miles around.

The switchgear is on similar lines to the latest board at Talbot Street, and does not need detailed description. The board, which is also by Messrs. Siemens Brothers, has provision for dealing with eleven feeders. It is interconnected with the switchgear at Talbot Street.

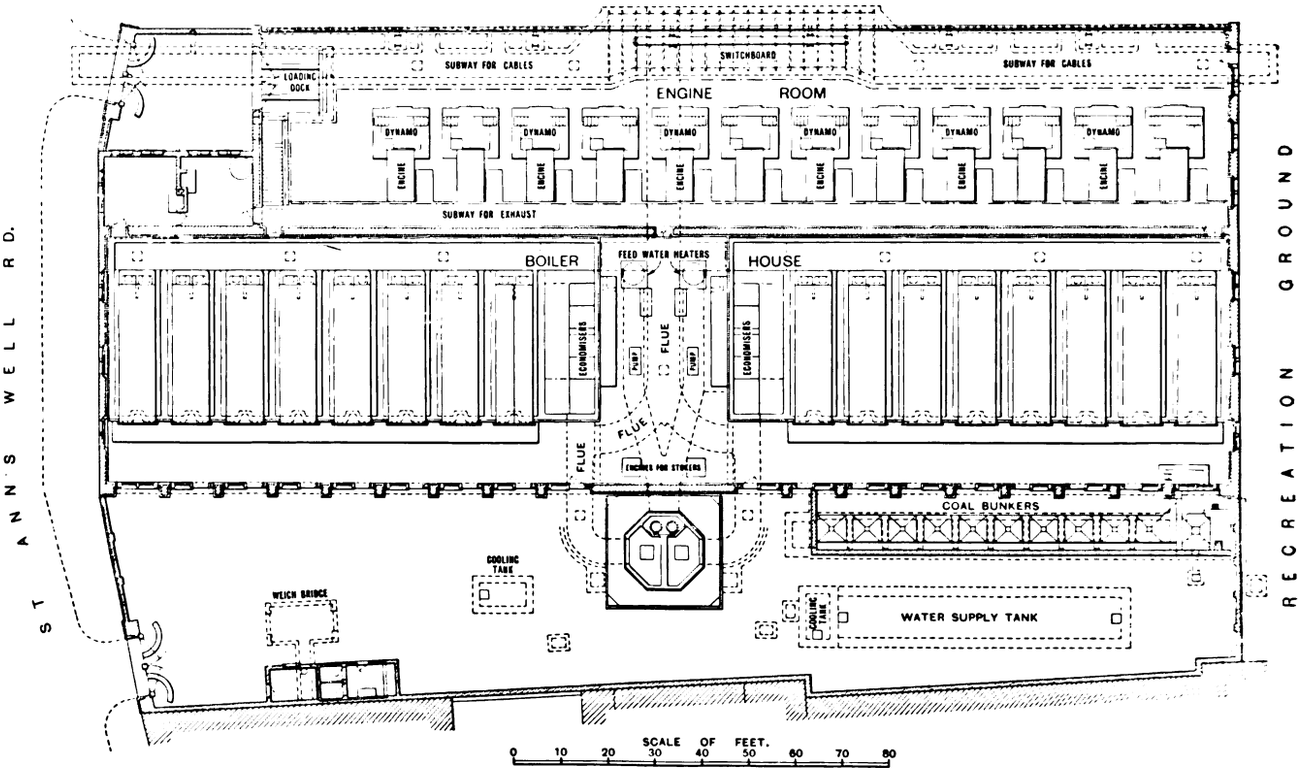


FIG. 5.—PLAN OF ST. ANN'S GENERATING STATION.

similar arrangements for feed heating, &c. are provided to those in the old boiler-house. The steam pipes, and also the feed-water pipes, are interconnected in the two boiler-houses, and in order to maintain the efficiency of the arrangement the alternative supply is made use of regularly once a week.

A plan of the St. Ann's station is given in Fig. 5. The generating plant is practically a replica of that in the new engine-room at Talbot Street, consisting also of a row of nine Willans-Siemens 440-kw. sets. The boiler-house contains eight Lancashire boilers by Messrs. Yates & Thom, of Blackburn, fired by Vicars' automatic stokers, and four hand-fired Lancashire boilers by Messrs. E. Danks & Co. A further set of four Lancashire boilers, by Messrs. Danks, is now being erected. A special form of simply arranged coal-conveying plant is installed in connection with the mechanically fired boilers. A belt conveyor runs under the hoppers in front of the boiler-house, into which the coal is tilted from carts, and from the end of this conveyor an inclined bucket conveyor raises the coal to a further overhead conveyor, from which it is fed into

A plan of the destructor station is given in Fig. 6. The generating plant consists of three six-pole Siemens' continuous-current generators of the type known as 31·2 H for an output of 147 kw. at 440 volts, driven by triple-expansion Willans' two-crank engines at 360 r.p.m. These machines are of a later type than the plant at Talbot Street and St. Ann's, and exhibit one or two differences of design, especially in the construction of the field frames, which are of cast-iron of elliptic section, with the poles cast in, instead of cast-steel of H section, with the poles screwed on. The engines are fitted with Sankey's cut-off gear, similar to that in use on the traction sets at Talbot Street. The switchboard, also of Siemens' manufacture, also marks a transition to later designs, especially as regards the automatic cut-outs, and has connections for one lighting and one traction feeder.

Steam is supplied from six Babcock & Wilcox boilers, arranged in the twelve-cell destructor. This destructor, of the standard type, is by Messrs. Manlove, Alliott & Co., of Nottingham. The boilers are provided with apparatus for coal firing, but this is not

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now used. A feature of the arrangement of the destructor is the way in which the refuse is stored in the actual charging truck on the charging platform over the cells. The clinker from the cells is taken to a paving-stone making plant adjoining the destructor, all the machinery in which is electrically driven. The Electricity Department pay all the wages in connection with the generation of electricity, but the Health Department tip the refuse on to the charging platform and maintain the boilers. During the last year 28,302 tons of refuse were destroyed, and 1,069,885 units were

Some further interesting figures are given below:—

Load factor, lighting, and power	15·28 per cent.
,, traction	33·12 ,,
,, combined	20·56 ,,

	1906/7.	1907/8.
Maximum load, lighting	4216 kw.	4336 kw.
,, traction	1549 ,,	1820 ,,
Total	5765 kw.	6156 kw.

The increase in the traction load is mainly accounted for by the opening of an additional tramway route during the year.

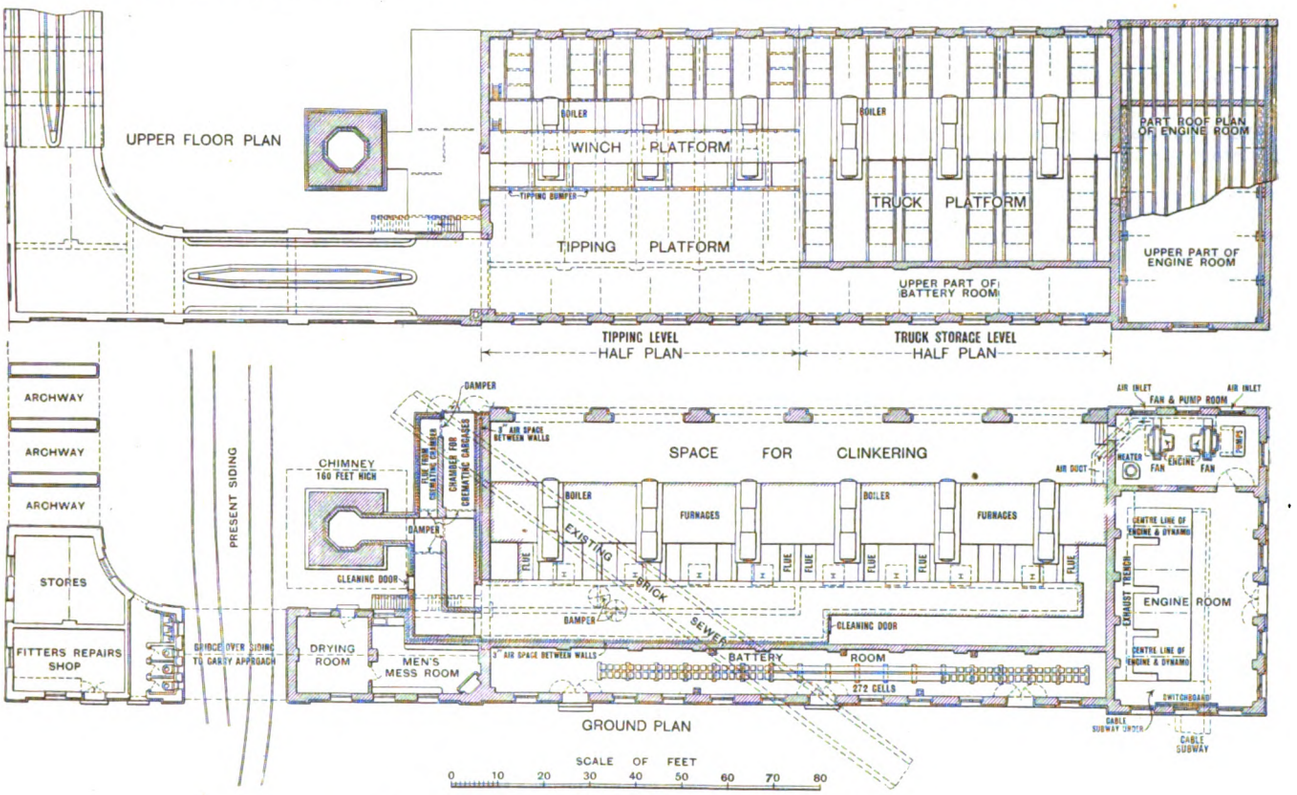


FIG. 6.—PLANS OF EASTCROFT DESTRUCTOR STATION.

generated therefrom, or an average of 37·8 units per ton. The wages paid averaged 0·48d. per unit. All the buildings of the three stations were designed by Mr. Arthur Brown, City Engineer.

The mains throughout the town were supplied by Callander's Cable & Construction Co., and the different portions laid out at different times form examples of the bitumen conduit, drawn in, direct in ground and solid systems respectively. There are three sub-stations containing boosters, and one, at Isandula Road, contains a battery. A certain amount of street lighting is done by 152 arc lamps on the tramway routes affixed to the centre poles. It is probable, however, that these lamps will be done away with when certain projected alterations to the overhead tramway equipment are carried out. Metal filament lamps are not used as yet for street lighting, although they have been very extensively adopted in the town for private lighting.

An idea of the magnitude of the undertaking and the proportions of the lighting, power, and tramway loads may be obtained from the following table of units sold during the last financial year:—

Units sold for private lighting	3,947,167
,, ,, public lighting	165,481
,, ,, power	1,709,208
,, ,, tramways	5,294,979
Total	**11,116,835**
Total units sold in previous year	9,530,096

The costs per unit sold for the last two years are given below:—

	1906/7.	1907/8.
Coal	0·32d.	0·406d.
Oil, waste, water, and stores ...	0·07	0·063
Wages	0·17	0·154
Repairs and maintenance	0·12	0·117
Total works cost	**0·68**	**0·74**
Rates, taxes, &c.	0·17	0·15
Management charges	0·13	0·12
Total cost (excluding capital charges)	**0·98**	**1·01**
Sinking fund, &c.	0·72	0·62
Total cost (including capital charges)	**1·70**	**1·63**

It will be seen that the increase in costs is entirely due to the high price of coal, as every other item has been reduced. The average price received per unit was 1·96d. The charge for power is a flat rate of 1¼ per unit, and we understand that the power load is increasing very rapidly. There are not, however, in Nottingham many factories of large size, but there is a marked tendency to adopt electrical driving in the lace industry, and it is declared by some manufacturers, who are already taking power, that the steadi-

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ness of the electric drive results in the production of an improved quality of lace.

It should be said that since the commencement of supply in September, 1894, only one brief interruption of supply has taken place, and that was due to no worse accident than a switchboard attendant switching in a " dead " machine in error.

In conclusion, we should express our thanks to Mr. H. Talbot, City Electrical Engineer, Mr. A. Armitage, his chief assistant, and other members of his staff, for kindly according us facilities for obtaining the information on which this article is based, for putting at our disposal the drawings from which the accompanying plans have been prepared, and permission to take photographs in the station.

The Telephone Service in Paris.—We have received the following interesting in formation with regard to the telephone situation in Paris :—The agitation caused by the inefficiency of the telephone service continues to find expression in the Press and in public meetings of protest. The Association of Telephone Subscribers, organised four years ago to voice the complaints of the exasperated telephone users, has recently circulated a petition to Parliament calling the attention of the Government to the many defects of the present telephone service, and praying either for a complete reorganisation of the telephone branch of the French Post Office, or, failing that, for the return of the telephone service to private enterprise, from which it was taken by the Government nearly twenty years ago. The new central battery exchange in the Passy district of Paris has increased, instead of decreasing, the volume of the public complaint against the telephone service. Owing to the mistaken policy of the French Administration in maintaining in service the old instruments at the subscribers' stations, which are of a variety of types, and are not adapted to central battery working, the service of the new exchange is even worse than that of the old. The interest of Parliament having been aroused by the intensity and persistence of the public complaints against the telephone service, a Parliamentary Committee of members of the Chamber of Deputies for the various divisions of Paris last week invited the Council of the Association of Telephone Subscribers to attend the committee with a view to giving detailed information regarding the existing difficulties with the telephone service. At this meeting the Association of Telephone Subscribers was represented by the Marquis de Montebello (President), Mr. Archdeacon (Vice-President), and Mr. H. Laws Webb (Consulting Engineer to the Association). The Parliamentary Committee, presided by M. Georges Berry, consisted of some fifteen members representing various divisions of Paris, who gave a sympathetic hearing to the case for the telephone-using public. M. de Montebello explained that the principal difficulties arose from the fact that the telephone service is at present operated merely as a branch of the Postal and Telegraph Administration, and he urged that for efficient working it was necessary to organise the telephone service as a separate department in all respects. A complete reform was necessary, not only in the technical methods of the telephone administration, which had been allowed to fall far behind the times, but also in the selection and training of the staff, in the general business administration of the department and in its financial management. Mr. Archdeacon followed along the same lines, and gave examples of the disorganisation at present existing among the staff of the telephone branch of the French Post Office, quoting figures to show the greatly higher development of the telephone in the other principal European countries and the more favourable tariffs for telephone service which are offered to the public of other countries. Mr. Laws Webb explained to the Committee the essential difference between the telephone service and the postal and telegraph services, and pointed out that for an efficient city telephone service uniformity of plant and special training of the staff are essential requisites. The Committee asked numerous questions of the deputation; and several members made short speeches in which, while strongly opposing the suggestion that the French telephone service should be handed back to private enterprise, they stated that they fully agreed with the views of the deputation that the telephone branch of the French Post Office should be entirely reformed, and should be organised and conducted on the same lines as a commercial concern. Members of the Committee themselves complained very forcibly that they were unable as matters were now conducted to obtain any figures or information giving precise data of the results of the telephone branch of the French Post Office; the Administration did not know itself what it was doing so far as finance was concerned. The Committee unanimously promised to support the Association of Telephone Subscribers, and to take the matter up actively in Parliament, with the object of securing appointment of a special Commission of members of the Chamber and representatives of the telephone subscribers for the purpose of making a thorough investigation of the difficulties under which the French telephone service now labours.

AMERICAN AND CANADIAN ELECTRICAL CONVENTIONS

THE annual convention of the American Institute of Electrical Engineers will be held at Atlantic City, under the presidency of Mr. H. C. Stott, almost simultaneously with the convention of our Incorporated Municipal Electrical Association at Nottingham, viz., from Monday, June 29th, to Thursday, July 2nd. The following Papers will be discussed :—"Modern Developments in Single-Phase Generators," by Mr. W. L. Waters; "A New Large Generator for Niagara Falls," by Mr. B. A. Behrend; "The Relative Proportion of Copper and Iron in Alternators," by Mr. C. J. Fechtheimer; "Application of Fractional-Pitch Winding to Alternating-Current Generators," by Mr. J. Bache-Wiig; "Voltage Ratio of Split-Pole Converters," by Prof. C. A. Adams; "Induction Motors for Multispeed Service with Particular Reference to Cascade Operation," by Mr. H. C. Specht; "The Determination of the Economic Location of Substations in Electric Railways," by Mr. G. B. Werner; "From Steam to Electricity on a Single-Track Road," by Prof. J. B. Whitehead; "Conductor-Rail Measurement," by Mr. S. B. Fortenbaugh; "Fundamental Considerations Governing the Design of Transmission-Line Structures," by Mr. D. R. Scholes; "Tests with Arcing Grounds and Connections," by Mr. E. J. Berg; "High-Voltage Experiments at Niagara," by Mr. R. D. Mershon; "Standard Tests for High-Voltage Line Insulators," by Mr. C. E. Skinner; "Measurements of Lightning, Aluminium Lightning-Arresters, Earth Resistances and Kindred Tests," by Prof. E. E. F. Creighton; "Engineering Features of the Southern Power Company System," by Mr. J. W. Fraser; "The Application of Storage-Batteries to the Regulation of Alternating-Current Systems," by J. L. Woodbridge; "Steam Turbine Plant : Some Possibilities Resulting from Recent Engineering Developments," by J. R. Ribbins; "Thirty-Day Test on Producer-Gas Plant : Discussion of Results in Relation to Cost of Energy," by Mr. J. R. Ribbins; "Three-Phase Power-Factor," by Mr. A. Burt; "Graphical Treatment of the Rotating Field," by Mr. R. E. Hellmund; "The General Equation of the Electric Circuit," by Dr. C. P. Steinmetz; "A Minimum-Work Method for the Solution of Alternating-Current Problems," by Dr. H. Pender; "Notes on the Electric Heating Plant of the Biltmore Estate," by Mr. C. E. Waddell; "Relation of the Manufacturing Company to the Technical Graduate," by Mr. M. W. Alexander; "Relation of the Manufacturing Company to the Technical Graduate," by Mr. B. A. Behrend; "Relation of the Manufacturing Company to the Technical Graduate," by Mr. D. B. Rushmore; "The Measurement of Rotary Speeds of Dynamo Machines by the Stroboscopic Fork," by Dr. A. E. Kennelly and Mr. S. E. Whiting; "Wireless Telephony," by Mr. R. A. Fessenden; "A Study of Multiple-Office Automatic Switchboard Telephone Systems," by Mr. W. L. Campbell; "Primary Standard of Light," by Dr. C. P. Steinmetz; "Water Power Development in the National Forests : A Suggested Government Policy," by Mr. F. G. Baum; "An Imperfection in the Usual Statement of the Fundamental Law of Electromagnetic Induction," by Mr. C. Hering.

The eighteenth annual convention of the Canadian Electrical Association was held at Toronto on Wednesday, Thursday, and Friday of last week in the university buildings, under the presidency of Mr. R. S. Kelsch. Special features of the convention, in addition to the Papers and discussions, were an exhibition of electrical supplies and apparatus, a practical demonstration of electro-metallurgical apparatus, and various excursions and entertainments. The following Papers were down for discussion :—"Power Rates and Factors which Influence Them," by Mr. W. N. Ryerson; "How to Increase the Station Load," by Mr. George Williams; "Lost and Unaccounted for Current," by Mr. C. R. McKay; "Electrical Plant Earnings Per Capita," by Mr. W. A. Bucke; "Various Electrical Power Plants by European Designers," by Mr. C. H. Mitchell; "Modern Arc Lighting," by Mr. A. E. Fleming; "Regulation of Electric Currents or Circuits," by Mr. W. G. Chace; "Various Distributing Systems Adaptable to Cities and Towns," by Mr. R. G. Black; "Electrical Franchises, their Legal Status and Basis of Valuation," by Jas. Bicknell; "Contracts," by Robert McKay; "Grounding of Transformer Secondaries," by W. L. Macfarlane; "The National Electrical Code," by Mr. H. F. Strickland; "The Oscillograph," by H. W. Price. A lecture was also given on "Large Power Plants of America," by Mr. R. J. Clarke.

Wireless Telegraphy in Germany.—According to *The Times*, it has been officially announced that from July 1st the German telegraph service will undertake the dispatch of telegrams by wireless telegraphy. The rates will comprise coastal, ship, and ordinary tariffs.

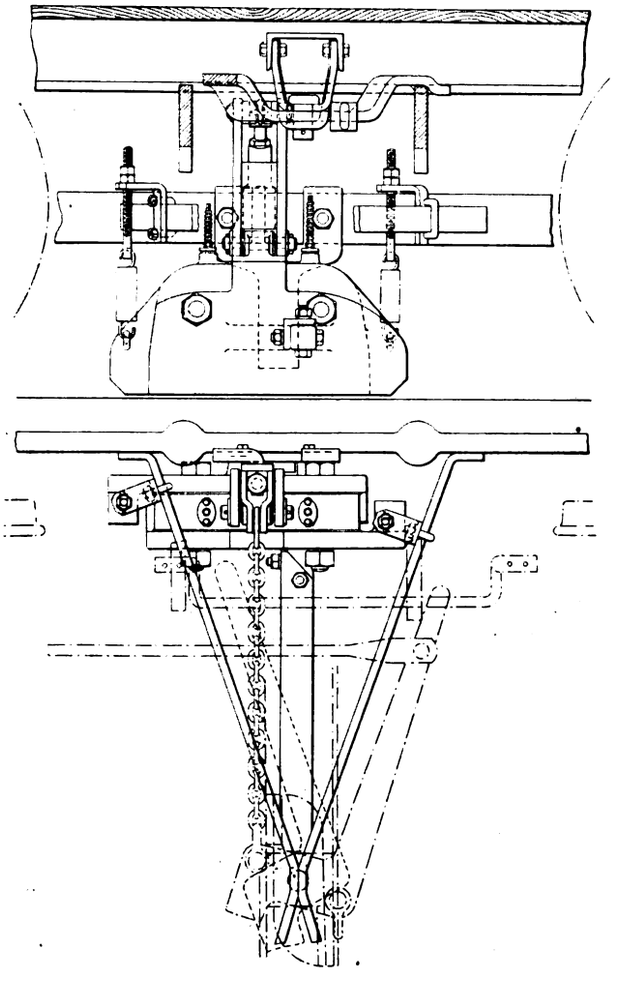
New Mountain Railway in Bavaria.—According to the *Glasgow Herald*, an electric railway to the Zugspitze, the highest Alpine peak on German territory, has been proposed. The Zugspitze could be reached from Munich in three hours with the aid of the new railway.

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THE NOTTINGHAM TRAMWAYS

BY the permission of Mr. John Aldworth, General Manager of the Nottingham Corporation Tramways, whose personal courtesy to us on a recent visit of inspection we desire to acknowledge, we are enabled to give the following information, which will be of interest to members of the Incorporated Electrical Association who will travel on the lines and inspect the car-shed and repair-shops next Tuesday.

At Nottingham there are 19¼ route miles of tramways, equivalent to 38½ track miles, as almost the whole is double track. Standard gauge is employed. The overhead construction is partly with centre poles, partly single bracket poles, and partly span wire. Span wire construction with side poles is being employed on all new work, and in some cases centre poles are being replaced by span wires, chiefly to remove the obstruction in the streets. On the new work, also, grooved wire with mechanical ears is used, and in all replacements mechanical ears are being adopted for the existing 000 B. & S. gauge circular wire.



Current is supplied to the line from the Corporation's combined lighting and traction stations, and is metered to the Tramways Committee at 1½d. per unit.

The cars ar chiefly single truck: there are 109 single truck cars, 10 with "maximum traction" trucks, and 6 with double trucks and 4-motor equip ments. Top covers are popular, and are fitted on the later cars that are purchased, while at the same time covers are being gradually added to the existing cars in the Corporation's own repair-shops.

The lines are fairly hilly—the steepest gradients are 1 in 11½ and 1 in 13, so that the brake equipment is important. Nottingham is one of the first towns to employ the new British Thomson-Houston "electro-mechanical" track brake, which has already been fitted on 10 single-truck cars. This is a magnetic track brake, the shoes of which can also be lowered mechanically by a hand-wheel if desired. The cars fitted with these brakes have hand-brakes for ordinary traffic stops, and the hand-wheel of the track-brake is concentric with the ordinary brake handle.

The brake is applied electrically by turning the controller handle on to the braking notches, thus connecting the exciting coils of the magnets to the motor circuits; while the exciting current generated by the motor is regulated by the rheostats. The magnetic action of the shoes cause them to be drawn down upon the rails with a force of several tons.

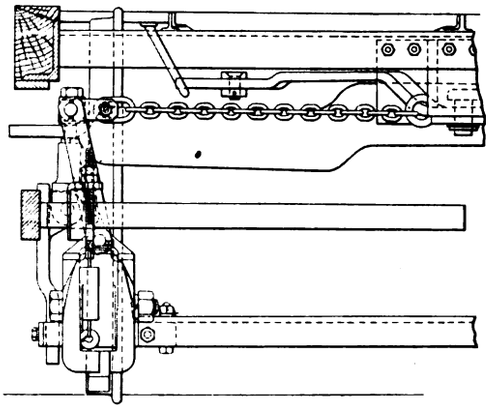


FIG. 1.—THE B.T.H. ELECTRO-MECHANICAL BRAKE.

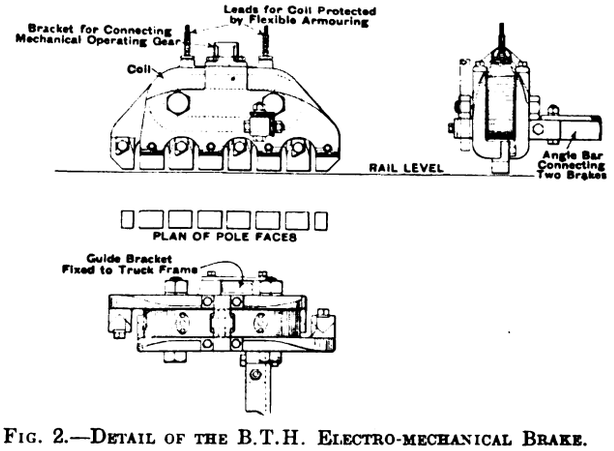


FIG. 2.—DETAIL OF THE B.T.H. ELECTRO-MECHANICAL BRAKE.

To enable the track brake to be applied by hand, a floating lever is supported by a suitable bracket to the centre of the car underframe. The long arms of the lever are each connected in the manner shown in the illustration, by pull-rods to the brake spindle. The short arms of the floating lever transmit the pull through chains to rocking levers on the truck side frames. Each rocking lever consists of an adjustable link, pivoted to a bracket, and of a compression link, the lower end of which is connected to the brake magnet. When the upper ends of the rocking levers are drawn towards the centre of the car by the chains, the compression links force the brake

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magnets downwards on the rails. A drawing of the arrangement is given in Fig. 1.

The use of this combined magnetic and mechanical track brake should afford great security in the operation of cars on steep gradients. By applying the brake mechanically at the top of a gradient, the speed of the car when descending may be maintained at any desired rate, and the car may be brought to rest by further applying the brake either by hand or magnetically. The British Thomson-Houston Co. inform us that tests have recently been made on a car fitted with this brake on a gradient of 1 in 12, and that even with the track brake applied mechanically only, very rapid stops were made at speeds up to 16 or 17 miles per hour. Very satisfactory results were obtained both on wet and very greasy rails. Remarkably rapid stops were made with the brake applied electrically, the rate of braking on level track reaching 12 ft. per second per second.

The brake itself (Fig. 2), consists of a pair of electro-magnets, provided with renewable track shoes. The magnets are connected together by a bar spanning the track, and are suspended from the truck frame by spiral springs, seen in Fig. 1, which normally hold them clear of the rail. The thrust occasioned by the retarding action of the brake is taken on a tongue-shaped steel bracket, which is bolted to the truck and engages with jaws on the side of the magnets. Brackets are also fastened to the upper part of the magnet, to provide connection to the lever for operating the brake mechanically.

The design of the magnet is multipolar. Each magnet consists of two main steel castings which, bolted together, form a spool with deep elongated

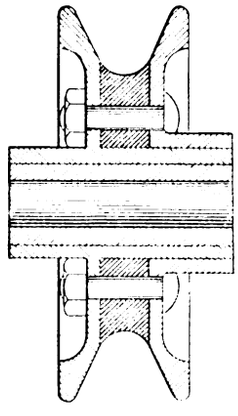


FIG. 3.—SECTION OF TROLLEY WHEEL WITH REVERSIBLE CENTRE.

flanges. The lower edge of each flange terminates in a number of lugs projecting inwards, the two sets of lugs interlacing with each other but separated by air gaps. To these lugs the wearing shoes are fastened. They consist of blocks of iron or steel shaped in such a way as to facilitate renewal and provide a strong rigid connection to the magnet. The magnet coil is completely enclosed in a watertight metallic cover. The terminals of the coil are insulated leads, brought out through stuffing boxes, and covered with flexible armouring, and arranged for connecting to the controller cables.

The 16 bogie cars have Newell track brakes, and the single-truck cars not fitted with the B.T.-H. brake have a mechanical slipper-brake, in addition to the ordinary hand and rheostatic brakes. On these hand track-brakes cast-iron shoes are being substituted for wooden shoes with excellent results, and they have also an adjustable bracket designed by Mr. W. Boot, the Works Superintendent, in conjunction with Mr. Aldworth, which enables the wear of the brake-shoe to be compensated for so that the full leverage is still obtained on the brake-shoe, even when considerably worn.

Twenty cars have been fitted with Dick-Kerr run-back preventers, which consist of an alteration in the connections of the controller by which the motors are short-circuited when the handle is in the off position, without the armature connections being reversed. It is found that a car will only run back down a steep grade at about one mile per hour under this arrangement when the controller is left in the off position.

Another interesting departure from standard design that members will be able to see when visiting the car-sheds is a type of trolley-wheel, with renewable centre and bushes. This is the joint invention of Mr. Aldworth and Mr. Boot, and is being manufactured by the Railway & General Engineering Co., of Nottingham. The renewable centre is simply a gun-metal disc, and solid graphite bushes are used. It is estimated that the sides of the wheel will last out some 20 centres or more. The life of the centres is about 5,000 miles, and of the graphite bushes about 8,000 miles. A section of the wheel is shown in Fig. 3.

In Nottingham, as elsewhere, trouble has occasionally been experienced with loose armature spiders, resulting sometimes in the conductors being torn off at the commutator lugs. As a means of tightening these, a useful workshop "kink" has been adopted, which, although it may appear a rough method, has, we are assured, been found thoroughly effective. The armature spindle upon which the spider has become loose is coated with hard solder, which is turned down in a lathe to a thickness of, say, $\frac{1}{64}$ in. The spider is pressed on to this, and keyed in the usual way, and a thoroughly tight fit is obtained.

There are three depôts. Two smaller ones have accommodation for 45 cars each, and the third at Trent Bridge, which is the one to be visited by the Association next week, has room for 88 cars, and is a good example of practical and useful design. The car-shed proper is about 90 yards long and 45 yards wide. Behind it is the main repair-shop, extending back another 40 yards, and occupying 23 yards of the width, and next to this is a shorter shop, in which the top covers are being fitted, taking up the remaining width. This latter shop contains a few wood-working tools, and the top covers are made and fitted there.

The main repair-shop has two 10-ton electric cranes, one over each of the two lines of repairing pits which occupy the centre, and along each side is a line of machine tools, each line of shafting being driven by an electric motor. There are three lathes, a double-bedded shaping machine, a radial drill, a boring machine, wheel-grinder, wheel-press, and other essential machines. A gas oven has been put in for baking out armatures, and a portion of the shop is partitioned off for armature winding. Practically all repairs to the cars are done in these shops, including metalling the bearings, but no actual car building, with the exception of the top covers already alluded to and the conversion of a motor-'bus into a tower-waggon, which is at present in progress in a smaller shop. Three motor-'buses were tried for a short time on a route not yet equipped for tramways, but these were found to require so much attention that, for the time being, they have been replaced by horse 'buses.

The car-shed contains eleven pits, and there is a traverser at the end by means of which a car can be transformed from any line of pits to any other. The shed is lighted with open arc lamps, a series of ten off the tramway circuit and two series of four off the lighting network. No sockets are provided for plugs for examination lamps for use in the pit, as these are taken off the car circuits when required.

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Among the cars in the shed is a combined snow-plough and store-waggon. This is mounted on an ordinary single truck with standard equipment, and is provided with salt hoppers large enough to hold 5 or 6 tons of salt, which is sufficient to salt the whole track of the town. By means of rollers worked by chain gear, the salt is brought down to each rail in just sufficient quantity to melt the snow on the rail.

At the back of the depôt building, comfortable recreation rooms have been provided for the men. There is a skittle alley, a large reading-room with a billiard-table and table skittles, and a music-room. This has been so much appreciated that it is proposed to have similar rooms on a smaller scale in the other two depôts for the men who are off duty for short periods.

THE GLASGOW TRAMWAY ACCIDENT

THE following is an abstract of the report of Col. H. A. Yorke to the Board of Trade on the accident that occurred on January 3rd to a tramcar belonging to the Glasgow Corporation while it was on the journey from Springburn to Mount Florida under circumstances reported in ELECTRICAL ENGINEERING, January 9th, p. 42.

As Car No. 986 was proceeding down the High Street with about 40 passengers on board, it appears to have got out of control on the hill called Bell of the Brae, between Rotten Row (or Drygate) and George Street (or Duke Street), and ran away for a distance of about 1,000 yards, until it came to rest in the Saltmarket, near the corner of Steele Street, where the gradient is almost flat. After passing Duke Street the car came into collision with eight lorries in succession, the first four collisions occurring between College Street and Ingram Street, and the remainder at intervals between Ingram Street and Glasgow Cross. The results of these collisions were disastrous, two persons being killed and about ten injured, in a few cases seriously. The leading end of the tramcar was demolished, the front platform and dashboard being smashed in, the staircase twisted out of shape, and the controller wrenched from its position and thrown backwards against the door of the car. The car was a four-wheeled double-deck car without top cover; it was fitted with the magnetic track brake, hand brake, trigger lifeguard, and two sanders, viz., one at each end.

The only place where the gradients are at all severe is on the portion of the route called Bell of the Brae Hill, between Rotten Row and George Street, where there are short lengths of 1 in 16, 1 in 18, and 1 in 20. On account of these gradients the speed down this portion of the route is limited by the Board of Trade regulations to eight miles an hour, and there are compulsory stops at the corner of Rotten Row (or Drygate), and at the corner of Duke Street, these being fixed in order to ensure as far as possible that the speed of cars shall be moderate.

The car left the Langside Depot at 5.17 a.m., and the three drivers who had charge of it before it was handed over to driver Dolan, who was in charge of the car at the time of the accident, all testified that the car was in perfect order during the whole time they had charge of it. Dolan received the car at Mount Florida, and drove it from there to Springburn, back to Mount Florida, and again to Springburn. On reaching Springburn on the last occasion, Dolan left the car for a few minutes, and asked a driver named R. McKenzie, who chanced to be there, to take the car across on to the other track ready for the return journey. In order to do this it was necessary to remove both the power handle and the reversing handle from the controller at the Springburn (or No. 1) end of the car, and put them on the controller at the Mount Florida (or No. 2) end. McKenzie found that he could not take off the reversing handle of No. 1 controller. While these men, together with Conductor Child, were trying to get the handle off, two other men arrived on the scene, viz. time-keeper Falconer and inspector Muirhead, who, in his anxiety to clear the road, decided to leave the reversing handle at No. 1 end of the car as it was, and to allow the car to return to Mount Florida without a reversing handle at No. 2 end, which then became the leading end of the car. Muirhead therefore gave Dolan instructions to this effect, at the same time telling him that the fact that the reversing handle was left in the forward position at No. 1 end would make no difference to the driving or braking of the car (by means of the electro-magnetic brake) at No. 2 end. The controller handle was then taken to No. 2 end, and Muirhead, having placed the reversing barrel at that end in the proper position for the journey to Mount Florida, by means of a pair of pliers, himself drove the car across from the north-bound track to the south-bound track, where, as everything appeared to work satisfactorily, he handed it over to Dolan.

All seems to have gone well until he reached the corner of Cathedral Street. From Cathedral Street to Rotten Row, which is the next stopping place, the distance is 200 yards, and the gradient 1 in 33·37. The evidence indicates that Dolan failed to stop at Rotten Row, where what is known as the Bell of the Brae hill commences, upon which there are short lengths of inclination of 1 in 16·72 and 1 in 18·54. At the bottom of this hill, namely, at the corner of Duke Street, which is rather more than 200 yards from Rotten Row, there is another compulsory stop, and again Dolan failed to stop his car. By this time the speed was high, being, according to the evidence, as much as 25 to 30 miles an hour. It was evident at that time that Dolan had entirely lost control of the car. Shortly after this the first and second collisions occurred, and Dolan fell into the roadway. After this the car proceeded on its journey unchecked, and collided with six other lorries in succession before reaching Glasgow Cross. Conductor Child realised that something had gone wrong, but was unaware that the motorman had been injured or that he had fallen from the car. He did not at that time apply his hand brake, because he did not receive the brake signal, viz., four rings on the electric bell, from the driver, and Col. Yorke is of opinion that, under the circumstances, he was right in not applying the hand brake, as he might have skidded the wheels and so have interfered with the action of the magnetic track brake in case this had been applied by the motorman. The car should have stopped at Glasgow Cross, where the tramway crosses two other tram lines, and where the traffic is usually very congested. Fortunately, it got across this busy spot without further mishap. As the gradient was getting flatter, the speed was being gradually reduced, and conductor Child, being by that time aware that something serious must have happened to the motorman, applied his hand brake and brought the car to a stand in the Saltmarket. It is a somewhat remarkable fact that the car did not leave the rails. Owing to the death of motorman Dolan and the absence of any direct evidence as to what happened at the front end of the car, it is impossible to say with certainty how it was that Dolan lost control of it, or why he failed to stop at the two important places, viz., Rotten Row and Duke Street. An examination of the gear of both the magnetic track brake and the hand brake after the accident indicated, so far as their damaged condition would permit, that no defect had existed in either of them prior to the accident.

Four methods of braking were, under normal circumstances, available on the car, as explained in the book of rules and regulations issued to their men by the Glasgow Corporation, viz., (1) By means of the hand brake; (2) by means of the magnetic track brake; (3) by reversing the motors: the reversing handle being placed in the backward position; (4) by short-circuiting the motors while acting as generators: the reversing handle being placed in the backward position, and the controller handle placed on the highest power notch. This method to be used only as a last resort. Of these, (3) and (4) were not available to Dolan, owing to the fact that he had no reversing handle at his end of the car. The rule in Glasgow is that on gradients such as those on the Bell of the Brae Hill cars should coast down with the magnetic track brake applied sufficiently to maintain the speed at eight miles an hour, but, assuming for a moment that something was wrong with the magnetic brake, there would have been no difficulty whatever in coasting down that hill by the use of the hand brake, had it been applied at the top of the hill at Rotten Row, and the speed never allowed to exceed the eight-mile limit. In either case the brake should be applied while the car is at rest at the top of the hill. Judging from evidence, Dolan was using both the magnetic brake and the hand brake at the time of the first collision. If the speed was then anything like 25 to 30 miles an hour, the hand brake would be practically useless, and the only result of applying it would be to interfere with the action of the magnetic track brake by causing the wheels to skid. And although the track brake, if properly used, would be able to stop a car travelling at that speed, given sufficient time or distance, it seems that the first collision occurred before any reduction of speed could have been effected. Had the reversing handle been available at the front end of the car, it is probable that Dolan, following the usual custom, would, if time had permitted, have made use of No. (4) method of braking, which, as already stated, is to be used only as a last resort. This method is in reality nothing more than another form of wheel brake, the power of which is limited by the coefficient of friction between the wheels and the rails, and it is not nearly so effective as No. (2). Under these circumstances, I do not think, writes Col. Yorke, that

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the fact that Dolan was unable to use No. (4) method of braking had any bearing upon the accident, inasmuch as this method would not have had time to take effect before the collisions occurred and Dolan received his fatal injuries. When the car came to rest, the hand brake was found to be off and the controller handle in the full braking position, the effect of which would be to apply the magnetic track brake with full force. But as the front of the car was very much damaged, and the hand brake spindle bent and the controller case broken and forced backwards out of its position, it is impossible to say definitely whether the handles were in these positions when Dolan fell off the car, though it is not improbable that they were.

It is difficult to explain why Dolan failed to stop his car in the usual manner at the top of the Bell of the Brae Hill, and allowed it to descend the incline at an excessive rate of speed so that by the time it reached the bottom of the hill it was entirely out of control. There seem to be only two ways of accounting for the occurrences. Either Dolan was driving carelessly or even recklessly, and allowed the speed of the car to increase too rapidly before he took any steps to check it, or else some portion of the magnetic track brake gear which he should have been using must have failed him. Dolan was an experienced motorman, and bore a good character for steadiness and sobriety.

Col. Yorke reports that he has gone very thoroughly into the construction of the controller in question, and the effect of leaving the reversing handle in the forward position at No. 1 end of the car, upon the driving and braking of the car by means of the controller at No. 2 end. No. 90 pattern of controller differs from other tramway controllers in that the movement of the reversing handle does not directly move the reverse drum itself, this not being actually rotated until the main handle is moved from the "off" position towards either the power or the brake notches. The ratio of the gear, by means of which the reverse drum is rotated by the movement of the main drum, is such that a very slight movement of the main (controller) handle causes the contacts of the reverse drum to make connection with their corresponding fingers. The placing of the reversing key of the controller in the forward position at one end of the car has, so long as the handle of the controller at that end is accurately in the "off" position, absolutely no effect upon the driving or braking of the car by means of the controller at the other end. But if by any chance the controller handle at the first end is displaced even to a small extent towards the brake notches, contact is made between the reversing drum and its corresponding fingers, with the result that when the controller handle at the other end is moved to the braking position the armatures of the motors are short-circuited, and the magnetic track brake cannot be applied. Similarly, if the main handle at one end of the car is slightly displaced towards the driving notches, the reversing key being as before, it would prevent the car from being started by means of the controller at the other end.

If, when Inspector Muirhead told Dolan to remove the controller handle from No. 1 end of his car to the other end, the pointer was exactly in the "off" position, he was right in saying that the reversing handle at No. 1 end of the car being left in the forward position would make no difference whatever to the driving or braking of the car by means of the controller at No. 2 end. But if, in removing the controller handle from No. 1 end, it was displaced even to a very slight degree in the direction of the braking notches, it would render it impossible to operate the magnetic brake from the controller at No. 2 end. Should anything of this sort have happened, it is possible that when Dolan came to apply his magnetic track brake on the Bell of the Brae hill, it did not operate, not on account of any defect in it, but simply because the electrical connections were wrongly made. This would take him by surprise, and, not knowing the reason for the failure of the brake, he might have made more than one attempt to apply it. By the time he realised that for some reason, which he did not understand, the magnetic track brake was out of use, the speed would have got beyond the power of the hand brake, and the car would then be out of control. It is impossible to say that the accident actually occurred in this manner, but it is undoubtedly a possible and not improbable explanation of the disaster.

Whether this is the correct explanation or not, Col. Yorke considers that inspector Muirhead committed a grave error of judgment in allowing the car to leave Springburn with the reversing handle in the forward position at the rear end of the car, and without any reversing handle at the driving end. For, disregarding altogether the suggestion made above, it is not to be disputed that Dolan was deprived of the third and fourth methods of braking the car which are specified in the Glasgow Tramway Rule Book. Muirhead's duty, and Dolan's duty if Muirhead had not happened to be present, was to cause the car to be taken to the nearest depot as soon as the difficulty with the reserving handle occurred, and, if the car had been sent there, there would have been no occasion for it to descend the hill until the defect had been put right.

It is quite easy to guard against the possibility of removing the controller handle when it is not absolutely in the "off" position by casting on the lid of the controller case an overhanging lip round the spindle of the main drum, with only one gap in it, viz., immediately opposite the "off" position, attaching at the same time to the handle a lug which would engage in the lip in such a way that the handle could only be put on or taken from the controller in the correct position. Such a lip is provided on controllers of other types, and the manufacturers (the British Westinghouse Co.) agreed to act upon this recommendation in future when manufacturing controllers of No. 90 pattern.

When the case of the controller was opened after the accident, the jamming of the reversing handle at No. 1 end of the car was found to be due to the screw pivot stud at the top of the reverse interlocking pawl having become unscrewed, thus allowing the pawl to get out of position and preventing it from passing through the slot in the sprocket wheel, the result being that the interlocking gear became jammed and the reverse handle could not be moved in either direction. The defect is easily remedied, either by inserting a small plug of wood or metal in the pivot hole on the top of the pivot stud, or, better still, by lengthening the pivot stud itself, and the manufacturers promised to attend to it.

In conclusion, Col. Yorke points out that the custom on the Glasgow Corporation Tramways of using the hand brake for ordinary stops, and of reserving the magnetic track brake for emergency stops and when coasting down hills, is not, in his opinion, the proper manner in which to employ the magnetic or any other form of "power" brake; it is a mistake in tramway practice to regard any brake as an "emergency" brake, and as one which is only to be used on rare occasions. When this custom is followed, there is a risk that the brake will either be wrongly applied, or for some reason or other will fail when the occasion for its use arises. In tramcar driving the "emergency" is ever present, and the motormen should be instructed to use at all times the most powerful braking device at their disposal. The tramcar to which this accident occurred, and most of the tramcars belonging to the Glasgow Corporation, are fitted with only two sand-boxes—viz., one at each end of the car. This means that sand can be applied to only one rail at a time, so that when the rails are greasy, and the efficiency of the braking appliances is of the utmost importance, it happens that the brakes, of whatever description, only do good work on one side of the car, which, in other words, means that when the rail conditions are at their worst, only half the brake power is available. This seems to be a very unsatisfactory arrangement, and I strongly recommend that the Glasgow Corporation should take early steps to fit all their cars with four sanders—viz., two at each end.

Electrification of the Bavarian Railways.—A large number of Bavarian manufacturing concerns have presented a memorial to the Bavarian Government, in which it is urged that the contracts for the supply of the electrical equipment necessary for the utilisation of the country's water-power and for the electrification of the railways, should be let out to the various firms specialising in the different classes of machinery, and should not be put in the hands of one or a few large firms. To entrust the whole of the work to one or a few large firms would, the memorial states, be injurious to the industry and to the country, on both economical and political grounds.

Manchester Electrical Exhibition.—A meeting of the General Committee was held in Manchester on Tuesday, the 16th inst. last, in the offices on the Exhibition site, Platt's Park, Fallowfield. Satisfaction was expressed at the progress which has been made in the erection of the huge building, the skeleton of which is now complete. The management reported that very satisfactory support was being received from all branches of the industry. Already over 100 spaces have been let, representing a total of between 140 and 150 individual exhibitors. That the importance of this exhibition is now generally recognised is evinced by the fact that Dr. Edward Hopkinson, of Messrs. Mather & Platt, Mr. Rushton, of Messrs. Dobson & Barlow, and Mr. W. T. Stubbs, of Messrs. Joseph Stubbs & Sons, have each accepted a seat on the General Committee, as representing the allied engineering trades. Schemes for the decorating ad lighting of the building inside and out were discussed, and the management were instructed to prepare plans and estimates for same. Special arrangements are being made with the railway companies all over the country for cheap fares and excursions to Manchester during the progress of the exhibition. A further General Committee meeting is fixed to be held in the exhibition offices on Tuesday, July 7th next, by which time it is hoped that the buildings generally would be in an advanced state. The management propose arranging for a demonstration of wireless telegraphy between the exhibition buildings and some important town within a radius of, say, 50 miles, of Manchester. Numerous other attractive demonstrations of electricity are also being arranged for, full details of which we shall hope to furnish our readers with later, and the members of the Gas and Oil Engine Manufacturers' Association, recognising the important bearing which the exhibition will have in the engineering world, have decided to arrange for a number of complete working exhibits of special plants as applied to the generation of electricity.

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ELECTRO-CHEMISTRY AND ELECTRO-METALLURGY

AT the last meeting of the Chemical Society, June 18th, Professor Tilden contributed an interesting Paper upon "The Rusting of Iron." It has frequently been stated that rusting only takes place when one has present iron, carbon dioxide, oxygen and water, although some investigators have contested this point, and said that it is possible to get rusting when you only have present iron, oxygen and water. In America, recently, W. H. Walker and collaborators (ELECTRICAL ENGINEERING, Vol. II., p. 576) consider that the rusting is an electrolytic action, and this they have proved in several ways. They think that owing to the impossibility of obtaining iron which is quite pure, that the composition of the metal is never uniform, that therefore owing to the impurities being unevenly distributed throughout its mass, the surface of the iron when in contact with water behaves as if it were a number of small electrolytic cells. There are consequent differences in potential, and therefore a portion of the metal will behave as cathode and another portion as anode. As a consequence, oxidation takes place and the metal rusts.

Prof. Tilden has carried out a long and laborious series of experiments, in which he has taken every precaution to prevent the presence of carbon dioxide in the oxygen he has employed. The iron was most carefully cleaned and placed in small silica boats contained in a glass tube, the whole apparatus was heated and connected up with a vacuum pump. Then water was introduced by heating crystallised barium hydrate; this will absolutely prevent carbon dioxide being present. Afterwards oxygen was introduced into the tubes, and it was noticed that in a short time the iron became tarnished, but generally speaking red rust was not produced. Professor Tilden has also proved that iron will dissolve to an analysable extent in pure distilled water, and he considers it invariably goes into solution in the form of ferrous hydroxide, and that red rust is afterwards produced by oxidation. He also referred to the well-known fact that washing the iron in a solution of chromic acid had the effect of preventing it being acted upon, and that not only did it temporarily effect it, but the effect appeared to be of a lasting character. It cannot, however, be said that the large amount of work which has recently been carried out in connection with the rusting of iron has led to any very tangible results. Most of the work which has been done of late has simply shown that under conditions which do not occur ordinarily, rusting will take place, but they have hardly yet told us how to prevent rusting taking place in iron exposed to ordinary atmospheric conditions.

In the *Chemiker Zeitung* of June 17th, Dr. W. Conrad contributes an article upon the "Advances in the employment of large electric furnaces for the manufacture of Calcium Carbide and high grade Ferrosilicon." Although the two processes are very different chemically, yet the same form of electric furnace can be used for the manufacture of both products. In the one case we have $CaO+3C=CaC_2+CO$, and in the other $SiO_2+2C=Si+2CO$, the latter reaction taking place in presence of iron or iron oxide. To produce 1,000 kilog. of chemically pure calcium carbide, 874 kilog. lime and 562 kilog. carbon are required, whereas to form 1,000 kilog. silicon, 2,140 kilog. of pure quartz and 860 kilog. carbon are necessary. The carbide process is in the main a melting one, but with ferrosilicon it is more in the character of a reducing process. The first forms of furnace employed consisted of a crucible forming one pole and a hanging electrode the other pole. But owing to the large amount of dust produced, and to the sudden bursting out of tongues of flame the process was troublesome and rather dangerous. Therefore, instead of withdrawing the charge as the reduction proceeded, the carbide was allowed to form until 300–400 kilog. had been produced; the furnace then cooled, and the blocks of carbide broken out. This intermittent process was carried on for a number of years, particularly in Norway, Austria, and Switzerland. It was then found that by employing two electrodes the yield could be increased by nearly 20 per cent. Series furnaces were then introduced, and with these blocks of carbide weighing more than 1 ton each could be obtained.

In order to build large furnaces for the production of ferrosilicon it is essential to so arrange the electrodes that they readily burn away, so that they become coated with a gas layer. A good furnace lining is of importance; the current also should not be led in by the floor of the furnace. The electrodes are formed of hard, burnt carbon, which is stamped and pressed into shape. The largest, which are made in Germany, are 18 cm. long and 33 cm. wide; consequently, in order to produce larger electrodes, they have to be clamped together. In France, some of the electrodes have a breadth of 50 cm. The raw material for the carbide manufacture consists of chalk or limestone, coke, anthracite, or wood charcoal. For ferrosilicon, quartz, anthracite, or wood charcoal and iron. 1 kilog. carbide requires 4 kilowatt hours, 1 kilog. silicon 12 kilowatt hours. Therefore, 1 kilowatt day would yield 6 kilog. carbide, or 4 kilog. 50 per cent. ferrosilicon. In the Alps and Norway, where water power is very cheap, the cost is 16s. to 40s. for 1 ton of carbide, and 24s. to 60s. for 1 ton of 50 per cent. ferrosilicon.

It has sometimes been asked why not manufacture carbide and ferrosilicon in the induction furnace. The reply is that steel may be produced with a temperature of not more than 2,000°; but it is another matter to work with 3,000°, which is the temperature required for the production of carbide in an induction furnace, because at 3,000° there is no heat-resisting substance which does not become a conductor. Ferrosilicon is extremely resistive against the action of acids, and it is suggested that it should be employed for making apparatus for use in the acid industry, *e.g.*, vessels and evaporators for boiling sulphuric acid.

In *Electrochemical and Metallurgical Industry* of June, attention is drawn to the uses to which aluminium may be put. It is used largely in the manufacture of motor-cars and of cooking utensils; the Japanese army was equipped during the Russo-Japanese war with aluminium mess kettles, which proved highly satisfactory. In the New York Subway some of the cars are lined with aluminium. It is also finding a largely increased use in chemical industries, as, for example, in acetic acid plants, for nitric acid condensers, ammonia concentrators, and in paper pulp mills. In America, in a few electric power stations aluminium bus-bars are employed, while for high-tension current transmission lines the employment of aluminium wire is largely increasing. "Bi-metallic" wires are also being introduced; these are steel wires coated with aluminium.

At the recent meeting of the American Electrochemical Society, Mr. E. E. F. Creighton described a method for studying the effect of temperature during annealing upon the magnetic properties of iron. The piece of metal to be tested is made the secondary of a transformer, so that it is possible, at the same time, to heat the iron by means of induction currents, and test it for its magnetic properties. As the temperature increases, the permeability increases. The magnetism, it was found, disappeared at 800° C. The temperature was then raised higher, and subsequently brought back, and it was found that the magnetism returned at exactly the same temperature at which it originally disappeared.

Telegraph Stations in Venezuela.—The telegraph stations of the Compagnie des Cables Télégraphiques at La Guaira, Pto. Cabello, Coro, and Maracaibo, have been closed by the Venezuelan Government since January 11th, 1906. According to a British Consular report, telegrams from Venezuela are sent by way of the island of Curaçoa, in consequence of which the income of the French Cable Co. has enormously increased, as the rates charged are very high.

Fishing by Electricity.—The Teltow Canal, which forms the cord to the loop of the river Spree, on which Berlin is built, is provided with a system of electric haulage, the barges being drawn by small locomotives which run on a track alongside the canal, and are supplied from an overhead wire. According to the Berlin correspondent of the *Daily Telegraph*, a man has been arrested for fishing in the canal on a wholesale scale with the aid of electricity. A wire connected to the overhead wire and thrown into the water is said to have so stupefied the fish within ten yards that they could be caught with hand nets.

Consolidated Electric Supply Co.—The case of the Consolidated Electric Co., Ltd., against the Consolidated Supply Co., Ltd., which was a debenture holder's action, came before Mr. Justice Swinfen Eady on Saturday last. Mr. Whitmore Richards asked for judgment in default of defence. Appearance had been entered, but the defendants did not now appear. A breach of condition took place by reason of the non-payment of interest for two months, and there was a notice calling in the money pursuant to the condition of the debenture. His lordship gave judgment accordingly.

Damage to Cables by Trawlers.—With reference to this matter (see ELECTRICAL ENGINEERING, June 4th, p. 842), the Chambers of Commerce, Exchanges, and Trade Associations throughout the United States are adopting resolutions, and forwarding memorials to the Government at Washington, appealing for the protection of submarine cables off the Irish coast. A memorial has been addressed to the President of the Board of Trade by the Liverpool Chamber of Commerce, suggesting an inquiry. The Bristol Chamber of Commerce has decided to act in concert with that of Liverpool.

Faraday House Old Students' Association.—The fourth annual dinner of this Association was held at the Queen's Hotel, Leicester Square, on Thursday, June 18th, with the President of the Association—Mr. Gerald W. Partridge, Engineer-in-Chief of the London Electric Supply Corporation—in the chair. The company included Mr. W. M. Mordey (President of the Institution of Electrical Engineers), Mr. Robert Hammond, Major O'Meara, Mr. Hugo Hirst, and Mr. Philip Dawson, who proposed the toast of the evening, "Faraday House and its Old Students." As is usual at these gatherings, beyond this toast there were no other speeches, the dinner being followed by a smoking concert.

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ELECTRICAL SCIENCE

British and American

Rectification Effect in Vacuum Tubes.—In the June number of the *American Journal of Science*, a novel experiment is described by H. A. Perkins. The author had noticed that a tube exhausted to a pressure of about half a millimetre of mercury glowed feebly when placed in an alternating electrostatic field. He examined the phenomenon more minutely by a special experiment. A conducting ring surrounding but not touching the vacuum tube was connected to one terminal of the secondary of a transformer excited from the public service, and the other terminal of the secondary was connected to earth. The tube was provided with a sealed-in electrode at each end, and the electrodes were connected outside through a switch and galvanometer. If now the primary circuit of the transformer was closed, the ionisation of the vacuous gas was made evident by a glow within the tube, and by a current through the galvanometer. These effects were very small unless the potential of the ring attached to the transformer secondary was greater than 550 volts, and the magnitude of the current through the gas varied with the position of the ring along the tube. With a tube 20 cm. long it was found that the current was zero if the ring were within 5 cm. of an electrode, was a maximum at about 8 cm., and was zero again at 10 cm., the middle of the tube. On moving the ring further the current changed sign, attained a maximum, and fell to zero at about 5 cm. from the second electrode. The gas current always left the tube at the electrode nearest to the ring. On the other hand, if the galvanometer were replaced by an electrostatic voltmeter the largest readings were obtained when the ring was near the electrodes. The curve representing the measurements made to connect gas current as ordinates with transformer E.M.F. as base starts suddenly upwards at 550 volts, and thereafter rises slowly as far as 2,000 volts, the limit of the experiments. The author gives a mathematical theory of the whole of the phenomena on the assumption that there is a uniform potential gradient between the ring and the sealed-in electrodes, and the calculated curves agree fairly well with the experimental curves.

Measurement of Current through an X-Ray Tube.—At the Röentgen Society's meeting on June 4th, the President, Mr. W. Duddell, F.R.S., gave a very interesting address on the measurement of the current through an X-ray tube. Many lantern slides of oscillograph tracings were shown to demonstrate the wave form of the discharges under varying conditions. When a spark gap was employed as a rectifier, the waves were very short and steep, and but little sign of inverse discharges could be detected. When the X-ray tube was removed and a water-resistance of about three megohms was substituted for it, the wave form was practically unchanged. An interesting side light upon the behaviour of the spark-gap was thrown by the tracings, and the lecturer mentioned that he had compared three forms of spark-gap, *i.e.*, point and ball, point and plate, and point and cup, the point being positive. Of these three varieties, the point and cup was the most effective. The ratio between the mean current through an X-ray tube and the instantaneous values was about as 1 : 30, that is to say, for a mean current of 0·5 milliampere the maximum value was 15·0, and for a mean of one milliampere it was 30 milliamperes. Curves to show the current waves through the tube when no rectifier was in circuit demonstrated a considerable inverse current, and finally, curves of the discharge of the coil on short circuit gave waves of a very different form. Measurements of the potentials at the terminals of the tube, and at the terminals of the coil, showed that the spark-gap rectifier caused a considerable voltage drop, from 60,000 to 30,000 volts in one instance. The indications of the milliamperemeter gave a very satisfactory measure of the mean current, but the instruments in common use for X-ray work were shunted by a condenser, and this the lecturer condemned.

A New Mercury Interrupter.—Mr. Wright afterwards showed a new form of mercury interrupter, which gave very powerful discharges in the secondary circuit of the coil. It consisted of a turbine arrangement for pumping up mercury into a narrow reservoir, where it met a revolving metal arm, which made and broke the circuit. The mercury being continually renewed in the reservoir, a clean surface was presented to the revolving blade, and very efficient contacts were obtained. By the overflowing of the reservoir the mercury was kept in constant circulation.

Royal Society Studentships.—The Council of the Royal Society have awarded the Mackinnon studentship in physics for the year 1908 to Mr. J. A. Crowther, of St. John's College, Cambridge, for an investigation of the passage through matter of the β-rays from radio-active substances.

Continental

Binant Electrometer.—The quadrant electrometer is governed by Maxwell's formula:

$$\alpha = C(Q_1 - Q_2)\left[N - \frac{Q_1 + Q_2}{2}\right]$$

where Q_1 Q_2 are the potentials of the quadrants, N is that of the needle, and α the deflection. This necessitates commutation if the deflection is to be proportional to the potential to be measured. Commutation is very difficult in working with saturation currents and automatic records. In the *Annalen der Physik*, No. 7, F. Dolezalek eliminates these difficulties by dividing the needle into two parts, the right-hand arm being as much above the potential of the chamber as the left-hand arm is below it. Instead of quadrants, the chamber consists of semicircles. Hence the new name, "binant electrometer." The principle was first proposed by Curie. The equation of the new instrument is

$$\alpha = C(N_1 - N_2)(Q_1 - Q_2).$$

The needle consists also of two semicircles. Both the needle and the chamber surface are concentric spherical surfaces, which give greater stability. The proportionality of deflection and p.d.'s $(Q_1 - Q_2)$ extends over an angle seven times as great as in the case of the quadrant electrometer, and, besides, the needle may be charged to higher potentials. Where the sensitiveness of a quadrant electrometer has a maximum at 250 volts, the binant electrometer is increasing in sensitiveness even at 900 volts. The range of the new instrument is very large, extending from 100 volts down to a few millivolts. The needle consists of thinnest aluminium foil. One semicircle is charged through the platinum wire suspension, and the other through a fine platinum spiral dipping into a liquid conductor. The usual charges are +65 and −65 volts.

Electrodynamical Mechanics.—A work of considerable interest to the student of the profounder theory of electricity is that published by H. Witte in the *Annalen der Physik*, No. 7. It is an elaborate investigation, covering 77 pages, of the rival attempts to explain electromagnetism by mechanics, and *vice-versa*. The author distinguishes two main classes of electromagnetic theories, those that postulate action at a distance, and those that postulate a continuous field. These, again, whether based upon emission or undulation, or both, may give rise to nine different types, and in some of these electromagnetic energy is all potential energy, in others it is kinetic, and in others again it is both. The author shows, first, that an interstellar ether is necessary. He then proves that it cannot be incompressible. For a moving electron would give a finite rotation, and then the rotation would cease to be proportional to the curve of the displacement. A continuous ether cannot be brought into harmony with mechanical principles. We must therefore fall back upon a discontinuous ether, and this is not indicated by any physical observation. It is against the principle of economy (or "parsimony") to assume any unnecessary complication when a simpler theory suffices. Therefore we must resign discontinuous ether, and renounce the attempt to construct a mechanical theory of electromagnetic phenomena. We are thus left with the dualism of mechanics and electromagnetism. To reduce this to a monism we must either find an electric theory of mechanics, a system which the author calls "electricism" as distinct from materialism, or we must reduce both mechanics and electromagnetism to a more fundamental system. The only attempt to do this is in the energetics of Ostwald. W. Wien has made some advance towards an electrical monism. The objection that nothing is gained by reducing mechanics to electricity as we are not acquainted with the "nature" of the latter, is easily answered by the plea that we know nothing of the nature of matter.

Faraday House.—A series of lectures on "The General Principles Involved in the Economical Production of Electrical Power" are being delivered by Mr. H. M. Hobart to the students of Faraday House. The course commenced on June 18th.

The Berlin Radiotelegraphic Convention.—It is announced that the British Government has notified Germany of its adherence to the Wireless Telegraph Convention, both on behalf of Great Britain and of all the British Colonies except Newfoundland and the Orange River Colony, the latter of which, being inland, has no direct interest in the matter.

Hampstead Tube Breakdown.—Considerable inconvenience was caused to passengers travelling on the Charing Cross, Euston & Hampstead Railway on Wednesday, June 17th, owing to the suspension of traffic on the south-running line between Mornington Crescent and Charing Cross after 5.50 p.m. The rear axle of the trailing bogie belonging to the motor-car of a three-car train broke soon after this train had left Mornington Crescent. The train, however, managed to reach Euston. The current was switched off from that section of the line, and traffic was maintained by a single six-car train, running between Mornington Crescent and Charing Cross on the north running line. The single journey, which was made without stops at Tottenham Court Road and Euston Road stations, occupied 7½ minutes, so that a 15-minute service from Charing Cross was kept up. From Mornington Crescent northwards the trains ran as usual. In the meantime, the workmen were attending to the damaged bogie, and by 1 o'clock on Thursday morning the south-running line was clear again.

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LOCAL NOTES

ACCRINGTON: *Electricity Supply.*—On June 18th Mr. North, the Local Government Board Inspector, conducted an inquiry at Accrington Town Hall respecting an application by the Corporation to borrow an additional sum of £7,500 for the electricity undertaking. The Chairman of the Electricity Committee, the Town Clerk, and Mr. Gray (Electrical Engineer) were present. Mr. Aitken said they asked 20 years for the repayment of the loan. The money was required owing to increased demand for electrical energy, both for lighting and power. The Board of Trade units supplied for the last quarter in December last were 642,500 against 265,639 for the corresponding quarter of 1906. A great part of the increase was due to one large firm taking an amount of the electricity for power. They had now purchased new works and enlarged them, and suddenly asked the Corporation to largely increase the supply. The firm was one of the largest in England for producing cotton-spinning machinery. In answer to the Inspector, the net loss on the electricity undertaking of £1,323 in 1903 was stated to have been gradually converted into a net profit of £604 last year, and it was estimated there would be a profit running into four figures for the current year. The total loans for the department had been £67,960, of which £12,202 had been paid off, leaving outstanding £55,758.

ACTON: *Electricity Accounts.*—The Electricity Committee reported at the last meeting of the District Council that the undertaking showed a gross profit for the year ended March, 1908, of £1,082 2s. 2d., but after providing for loans, instalments, interest, &c., there was a net deficiency of £2,934 18s. 3d. Mr. Lord remarked that a company in similar circumstances would be able to declare a profit.

AUSTRALIA: *Kalgoorlie.*—The Kalgoorlie Electric Power & Lighting Co. has shipped additional plant for its generating station, including what is said to be the largest engine and dynamo yet sent to Australia.

BELEEK FALLS (IRELAND): *Proposed Water Power Scheme.*—At the monthly meeting of the Lough Erne Drainage Board, held in Enniskillen last week, a letter was read from Mr. W. A. Lindsay, of Belfast, asking if the Board would be disposed to encourage the development of electrical energy at Beleek by the use of the Falls. He had been recently trying to induce some English and American friends to investigate the practicability of establishing a power station there, but naturally they wished to know, before taking any steps, on what terms the necessary rights could be obtained. Mr. Irwin said he would reply, stating that the Board were anxious to encourage them as much as possible, but that they would like to have some definite proposal as regards terms first. The Secretary mentioned that other electrical companies had approached him on the same subject, and he thought it would be better to take no definite action until they would see from whom they would get the best terms. It was decided to write to Mr. Lindsay, stating that the Board were in sympathy with the project for establishing an electrical power station at Beleek, but that they could take no action in the matter until more definite particulars and proposals were submitted to them.

BELFAST: *Tramway Agitation.*—A mass meeting was held in the Ulster Hall on the evening of the 16th inst., for the purpose of considering what has been described as the "present position of the Belfast tramways." Mr. D. J. Campbell, delegate to the Belfast Trades Council, presided, and the whole affair may be looked upon as a political and trades union agitation against the Corporation. Addresses were delivered, and a resolution was passed which declared that the meeting viewed with alarm the unsatisfactory state of the tramway undertaking, and called on the Corporation to have an accountant appointed to report on the financial standing of the undertaking.

BILBAO (SPAIN): *Tramways.*—The *Gaceta* of June 10th notifies that a concession has been granted to the Compañia del Tranvia Urbano de Bilbao for the construction of an electric tramway in the town of Bilbao.

BOSTON (AMERICA): *Water-power Plant.*—The Franklin Power Company have begun the construction of a 200-ft. log and concrete dam for the development of the power furnished by the falls known as Cleveland Rips, on the Carrabassett River, between the towns of Embden and North Anson. The dam will create a head of 25 ft., and the power obtained will be used in the generation of electricity for lighting and power in the towns of New Vineyard, Farmington, and Wilton. A line of poles and wires 16 miles long is now being erected to convey the current to Farmington.

BRENTFORD: *Tramways.*—The District Council has been in communication with the Board of Trade relative to the state of the tramway track through Brentford, and at the last meeting of the Council it was stated that the Board had written that the remedy for the condition of affairs complained of was in the hands of the clerk. The clerk reported that he had replied that the Council had no authority over the track itself, but the Board refused to order an inspection, and suggested that the Council had the power to compel the tramway company to keep the track in repair under the terms of the Tramway Act. The clerk decided to forward a copy of the correspondence to Dr. Rutherford, M.P., with a view to a question being asked in Parliament. In reply to a question, the Chairman (Mr. Evan Phillips, J.P.) said that the Council could not obtain an injunction to prevent the trams from running. It was only a question of a penalty, and they had to get the track properly inspected first, which would be an expensive proceeding.

BRIGHTON: *Electricity Accounts.*—The statement of account of the Electricity Department for the year ended March 31st shows a loss of £3,657, as compared with £10,253 for last year. The total receipts were £88,082, as against £85,684 for the previous year, and the expenditure was reduced from £51,713 to £40,753. Interest and sinking fund amounted to £44,987. The deficit is to be met from the reserve fund, which becomes reduced to £7,413. The total costs per unit sold were 1·26d., made up as follows:—Coal, 0·55d.; oil, waste, water, and engine-room stores, 0·01d.; wages, 0·17d.; repairs and maintenance, 0·16d.; rents, rates, and taxes, 0·13d.; management expenses and charges, 0·24d. The total units sold have increased from 7,849,194 to 8,002,376.

Tramways.—The scheme placed before the Corporation by Messrs. Stephen Sellon and Partners, consulting engineers, of London, referred to in our last issue, for running a service of tramways from Kemp Town through St. James's Street, North Street, and Western Road to Worthing, came before the Corporation on Thursday. As we announced last week, the scheme was recommended by the Tramways Committee, and in presenting the proposal to the Corporation, the Chairman said that the syndicate proposed to purchase the old horse tramways between Hove and Shoreham, and to electrify these, at the same time extending them to Kemp Town *via* Brighton. After a long discussion the scheme was rejected by 36 votes to 10.

CLECKHEATON: *Electricity Undertaking.*—The accounts of the electricity undertaking for the past year show a surplus of £99, compared with a deficit of £193 for the previous year.

COLCHESTER: *Street Lighting.*—It has been decided to gradually replace 316 Nernst and other incandescent street lamps by Osram lamps. The average cost of conversion is given at £1 3s. 6d per lamp. It is expected that the annual cost per lamp will be reduced from its present figure of £3 19s. 6d. to £3, reckoning the renewals at three pairs of Osram lamps per post per annum. A scheme was proposed for superseding the existing gas lamps by Osram lamps, but this was not agreed to.

DUNDEE: *Electricity Accounts.*—The accounts of the Electricity Department for the year ending April 30th, 1908, have just been issued, and show a very satisfactory state of affairs. The number of units generated is 4,719,085, an increase of 708,000 over last year, while the revenue is £34,973, an increase of £3,870. A very large item in this year's accounts is the increase in the coal account, which is fully £3,000 over last year. The gross profit amounted to £15,259, out of which has to be paid interest and sinking fund amounting to £9,578; while the Committee again adopted Mr. Richardson's recommendation to reduce the capital debt of the undertaking by transferring £5,380 from the capital account to revenue, the balance, with the balance from last year, leaving a net profit of £1,078. During the last four years the sum of almost £24,000 has been paid out of revenue account, a large part of which has gone to reduce the capital debt, while the balance has been for the large alteration at the power station. The Committee have adopted Mr. Richardson's suggestions with regard to the price to be charged to power-users, which in future will be on the sliding scale, with a maximum of 2½d. per unit, while large consumers with a very large load-factor can have power as low as 0·45d. per unit. The price of current for the tramways has also been reduced from 1¼d. to 1½d. per unit. The minimum charge has been abolished entirely, as Mr. Richardson considered it was more of an irritant to consumers than it was really worth. A new feature of the charges for next year is that for electric signs, which should tend to make this form of advertisement very popular. For the first 200 units the charge is 3½d. per unit. All above this amount 1½d. per unit. The work of erecting the new generating station is being pushed on with all speed, most of the contracts having now been placed, and it is hoped that everything will be completed and the station running in time for next winter's load.

DUDLEY: *Electricity Accounts.*—The report for the year ended March 31st records a steady growth of business, especially as regards motor-load. The year's working has resulted in a gross profit of £5,977, being an increase of £733 over that made last year. Financial charges for interest, repayment, and bank charges absorb £5,641, an increase of £465 over the previous year's requirements, the surplus for the year being £336. The load factor has risen from 13·96 per cent. last year to 14·65 per cent. this year. The works costs have decreased from 0·8555d. per unit sold last year to 0·81d. per unit sold this year, or a decrease of 6 per cent. in the works costs per unit sold, notwithstanding an increase of 11 per cent. in the cost of coal. It is not anticipated that the works costs per unit sold will fall

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much below 0·8d. until there is a larger increase in the load factor. The units sold during the year amounted to 2,022,207, made up as follows :—Private lighting, 422,333; power, 413,727; public lighting, 135,237; and tramways, 1,050,910. Last year's total was 1,812,193 units.

DUNFERMLINE: *Electric Lighting.*—A further report has been received from Sir Alexander Kennedy recommending the Council to lease its electric lighting Provisional Order to the Fife Electric Power Co., with the option of re-acquiring it 50 years hence. At the monthly meeting of the Council last week this report was adopted.

EALING: *Power Supply.*—It has been decided to reduce the charge for current for heating and power after this month from 2d. to 1½d. per unit.

Electricity Supply Accounts.—According to the report of the Borough Electrical Engineer (Mr. J. Douglas Knight) for the year ended March 31st last, which has just been issued, the business of the electricity undertaking during the twelve months was one of steady progression, satisfactory results having been achieved without any appreciable increase in expenses. Notwithstanding increased cost of fuel, increasing competition, and the introduction of the metal filament lamp, the working costs were again lowered in almost every direction, the reduction in the coal costs being most noticeable. The full effect of the last reduction in price of current was felt for the first time during the year, the average price per unit sold obtained from private consumers being 0·08d. less than the previous twelve months. The income would have been increased by £402 if the department had obtained the previous year's price on the output for the year ended March 31st. Units were sold to the number of 1,527,893, this being an increase of nearly 2¾ per cent. There was a decrease of 5 per cent. in the units used for public lighting; the increase on the supply to private consumers was 5 per cent. The income, totalling £26,947, showed an increase of 3·3 per cent. There was an increase of 11 per cent. in slot meter collections. The capital spent during the year totalled £2,628, the lowest on record in the history of the undertaking. The gross profit, after deducting charges for rent, rates, taxes, and cost of maintenance and management, amounted to £14,228, equivalent to 7·37 per cent. of the total capital expenditure to date. From this sum had to be taken the charges for interest and sinking fund, reserve for doubtful debts, Parliamentary charges, and audit fees, leaving a net profit of £2,013. This, added to the reserve fund, would raise the reserve to £8,654, equal to nearly 4½ per cent. on the capital expenditure, which to March 31st totalled £192,986. The assets exceeded the liabilities by £51,367, and the whole of the plant being maintained in efficiency out of revenue, the sum to reserve, says the Electrical Engineer, is sufficient to cover any depreciation of the value of the assets of the undertaking, representing 26·6 per cent. of the capital spent. During the year the cost of supplying each unit was lowered from 3·87d. to 3·849d. If the charges for interest and sinking fund be eliminated, the reduction was from 1·993d. to 1·390d. per unit sold—over 30 per cent. reduction. The total number of consumers on March 31st. was 3,620. An extension of plant and mains will be necessary in the immediate future. Condensing plant, transformers, and high-tension feeder mains are the items most urgently required.

ECCLES: *South Lancashire Tramways Co.*—It has been decided to seek an injunction preventing the South Lancashire Tramways Co. running its cars upon certain of the lines of the Council without consent.

EDINBURGH: *Redemption of Loan.*—At the last meeting of the Town Council the question of the equated period for the redemption of loans upon the electrical undertaking was considered, the Joint Committee of the Electric Light and Treasurer's Committee having recommended that the period should be reduced from 30 to 25 years. There were three proposals before the Council :—(1) That the shorter term should apply to future capital expenditure; (2) that it should apply to past expenditure; and (3) that it should apply to the last loan. After some discussion the first proposal was carried.

ERITH: *Tramway Position.*—At the last meeting of this Council a sub-committee appointed with a view to lessening the annual loss on the tramways undertaking and to make the system self-supporting, if not profitable, reported that the losses had rapidly increased year by year, and that Erith had the unenviable reputation of being the third from the lowest of 72 municipally-operated undertakings in regard to traffic earnings per car mile. The working expenses and administration of the department could not be reduced very materially, having regard to the safety and efficiency of the system, whilst having regard to the necessity for certain repairs, it was impossible to continue carrying on the system without a large increase in the working expenses. The net loss on last year's working (notwithstanding the low working expenses of 6·2d. per mile) was £4,449. Should the receipts continue to fall in the same ratio as last year—and they had every appearance of doing so—the current year's traffic receipts would show a decrease of 1d. per mile, and the Tramways Manager stated that the necessary repairs referred to would increase the working expenses by at least 1d. per car mile. The total loss, it was estimated, would be something over £7,000 to be provided for out of the rates. The Council agreed to the committee's recommendations to abolish ½d. fares, and to issue transfer tickets, to make certain changes in respect of workmen's tickets, and to abolish free riding by members of the Council, staff, and employees, except in the case of the uniformed staff (the last-named to be allowed to travel free to and from duty only).

GLASGOW: *Tramway Accounts.*—The financial statement for the tramways undertaking for the year ending May 21st shows a gross revenue of £916,566. The expenditure, including traffic, general, repairs, and power, amounted to £509,995, and there has been set aside for renewals and depreciation £188,603, leaving a balance of £217,968. From this has to be deducted the rent of the Govan lines, rent of the Paisley District Tramways, interest, sinking fund, income tax, Parliamentary expenses, and Common Good, amounting to £179,138. The balance of £38,830 has been appropriated as to £4,061 to special depreciation, and £34,769 to general reserve.

GRAYS: *Electric Supply Tariff.*—On and after July 1st, the rates charged for lighting will be reduced as follows :—The 5d. rate to 4d., 4¾d. to 4¼d., 4½d. to 4d., and 4d. to 3¾d.

GRIMSBY: *Electricity Finances.*—The Town Clerk reports that the electricity undertaking has a sum of £5,000 lying to its credit at its bank, which had been raised on mortgage of the rates and on property. He suggested that when the committee were next applying to the Local Government Board for a loan, the attention of the Board should be drawn to this sinking fund, and application made to use it as capital.

New Generating Plant.—Mr. W. A. Vignoles, the Borough Electrical Engineer, reported at the last meeting of the Corporation that he had been to Birmingham in connection with the tests of the new 500 kw. set which is to replace two small sets at present in the works. All the tests were satisfactory, with the exception of steam consumption, but this had again been tested and found satisfactory after certain adjustments had been made.

Electricity Works Staff.—An application by Mr. Channon, Chief Assistant Engineer at the Electricity Works, for an increase of salary from £150 to £175 per annum has been refused.

HASLINGDEN: *Tramways.*—The Corporation of Haslingden and Accrington have adjusted their difficulties with regard to electric trams. For nine months Accrington will supply Haslingden with cars and current over the two miles length. The cost to Haslingden will be 7d. per mile. The cars will run to and from Haslingden to Accrington, and the arrangement will re-establish traffic between the two boroughs.

HORNSEY: *Electricity Accounts.*—Submitting the financial statement for the half-year ended March 31st, at the last meeting of the Borough Council, Councillor Berrenger, Chairman of the Finance Committee, said that a year ago the electricity undertaking had to be subsidised to the extent of £1,421 to meet a deficit on the previous two years' working, but the hope held out when the subsidy was granted had been fully realised, viz., that should the undertaking increase its business at anything like the same rate as it did during the previous twelve months, the future call upon the rates ought to be very small, if any. The outcome of the Electricity Supply Committee's trading during the six months ended March 31st had been in every way encouraging, and it was the first time in the history of the undertaking that a profit over and above interest and instalments of loan had been shown. The balance carried to net revenue account as the result of the half-year's working was £6,253, being a net increase over the corresponding period of the previous year of £853, the income having increased by £1,366, and the expenditure by £513. The debit balance totalled £6,204, which, deducted from the amount transferred from revenue account, left a surplus of £49.

HOVE: *Electricity Omnibuses.*—It is stated that the service of electric omnibuses will be started very shortly.

ILFORD: *Tramways.*—At the last meeting of the Council it was stated that during the year ended March 31st, 1904, the trams carried 5,057,000 passengers, and the number increased year by year up to the twelve months ended March, 1907, when the total was 6,586,000, this figure being reduced last year to 6,385,000. However, one Easter and part of another were included in the 1907 returns, and this accounted for 120,000 of the decrease. The remaining 80,000 decrease had been lost by the cessation of inter-running with Barking, by disastrous holiday weather, and by two months' motor-'bus competition included in the period.

JAPAN: *Import of Electrical Appliances.*—The following figures as to the comparative value of imports of electrical appliances into Japan from the United States and other countries for the years 1905 and 1906 are given in an American consular report. Imports from the United States :—Electric light apparatus and instruments : 1905, $232,251; 1906, $170,203. Electric motors : 1905, $929,874; 1906, $430,964. Imports from other countries :—Electric light apparatus and instruments : 1905, $316,328; 1906, $247,785. Electric motors : 1905, $1,227,712; 1906, $704,158.

JARROW: *Tramways.*—A through service between Jarrow and South Shields was inaugurated on Thursday. The new service is the outcome of an arrangement between the Jarrow & District Electric Traction Co. and the South Shields Corporation.

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LEIGH: *Electricity Accounts.*—At the last meeting of the Corporation the Chairman of the Tramways and Lighting Committee, in reference to the Electrical Engineer's report, said that the loss was about £12, compared with £407 last year. There would have been a small profit this year but for the fact that the Lighting Committee had to pay a special rate amounting to £71, and also the cost of the current in connection with the opening of the Town Hall, amounting to about £20.

LONDON: *London County Council: Hammersmith-Harlesden Tramways.*—The Board of Trade has inspected the Hammersmith-Harlesden tramways, and has issued a report stating the speeds which are to be observed on the line.

Battersea.—The Finance Committee of the London County for a loan of £1,847, repayable in 20 years, for electric lighting, be granted. The loan is required for the provision of a Council recommend that the application of the Borough Council 200-kw. feeder booster, for which a tender has been accepted.

The Electrical Engineer has reported to the Electricity Committee with reference to a fault in the lighting mains which occurred near the Central Public Library, Lavender Hill, on May 26th. The fault was soon attended to, and there was no interruption in the supply, although for a time the pressure fluctuated. Callender's Cable & Construction Co., Ltd., have agreed, in accordance with the terms of their contract, to bear the cost of the repairs, estimated at about £60. The Electricity Committee has approved a scheme for public and private lighting on Battersea Rise House Estate, which provides for laying distributing mains in various thoroughfares, and a feeder from Northcote Road to the estate, and for erecting ten additional arc lamps along Clapham Common, west side, and 37 lamp columns fitted with brackets similar to those on Heathfield Estate, but with Osram metallic filament lamps of 100 c.p. each for the side streets. The estimated cost will be £5,362. Negotiations are in progress with the various builders who contemplate erecting houses on the estate, and one of them, Mr. George, has already undertaken to wire 60 houses for electric light. Mains will be laid in the various parts of the estate as they become developed, so that no expenditure will be incurred before a supply of current is required. The committee has approved, subject to the usual sanction, the purchase for £230 of an additional cross-over steam main, to be erected from one of the boilers to the main steam range. This will guard against breakdown and enable the three boilers to be used at the same time. An alternative connection will be available in case of emergency, and the arrangement will permit of a minimum amount of main being used during the greater part of the day.

Southwark.—The Electric Light and Finance Committees of the Borough Council reported on Monday having had under consideration the District Auditor's report on the accounts of the electricity undertaking for the year ended March 31st, 1907, in which he urged the advisability of adopting the recommendation of the Departmental Committee on the accounts of local authorities by including in the accounts proportions (calculated up to March 31st) of fixed charges (loans, interest, instalments, &c.), which fall due for payment after that date. He pointed out that if this course was adopted the result would be to show an adverse balance on the net revenue account, but the true profits for the year would not be affected. The Electric and Finance Committees have decided to adopt the recommendation of the Departmental Committee, but in order not to entirely deplete the reserve account they have agreed that £754, the full interest and half the instalment of principal accruing to the end of the financial year, be charged to the renewals reserve account, and placed in the accounts for the year ended March 31st, 1908, leaving the balance chargeable to the current year. The Electricity Committee has agreed that £36 of £90 expenditure incurred in opposing the L.C.C. Electric Supply Bill, London Electricity Supply Bill, and the Bermondsey Electric Lighting Order, be charged to the revenue account of the undertaking, but they protest against expenditure being incurred in respect of the undertaking without the Committee being consulted or having any voice in the matter.

St. Pancras.—The Borough Council had a late sitting on Wednesday, the 17th inst., the main subject for discussion being the proposed confirmation of the provisional decision of the Electricity Committee to wire houses in the borough through the medium of private contractors at accepted schedules of prices. Councillor Shearing, in opposing the recommendation, said that if the proposal were adopted, traders in the borough engaged in electrical works would suffer great injustice. The effect would be that contractors would be invited to schedule their prices, and the contractor offering the best discount would be accepted; presuming that the discount was 15 per cent., that would form a basis to govern practically the whole of the electrical work in the borough. The principle was a bad one, and the supply of fittings and the wiring of houses should be left to private individuals. Alderman Gauntlett said that by adopting the powers suggested, it would be possible to put on nine additional consumers to every mile of mains, in which they had a quarter of a million of money invested. At present only 3,000 of 24,000 houses in the borough were wired for electric light, because of the initial expenditure involved. Councillor James, as an electrical contractor, favoured the proposal, and hoped that before many years had passed, St. Pancras Council would have the complete control of the borough electrical undertaking. The Electricity Department should give the same facilities to householders as the Gas Light & Coke Co., who fitted up every requirement on the hire-purchase system. The reason the borough was badly off for electric light consumers was because of the cost. Councillor Paterson, as a contractor who was hardly hit by municipal trading, thought that the electric light undertaking should be municipalised, and thought the departure proposed would mean a great increase in work and profit for the electrical contractors in the borough. Alderman Davies severely criticised the hire-purchase system, and, hoping the Council would not undertake the scheme recommended, said that there was quite enough trouble with the Electricity Department, and quite enough extravagance. It having been suggested, in view of difference of opinion, that the whole matter should be referred back for further consideration and report, Alderman Matthews said the excuse for adopting the suggested powers under the L.C.C. (General Powers) Act, 1906, was that, under the present system, the poorer residents could not have electric light, but he held that electricity for an exclusive light was not suitable for poor people, for the expense of cooking and heating by electricity was such that even the King had not got it. The Council had had to cease electric supply to municipal dwellings because they could not let the rooms to the working classes without gas. Councillor Ingram, Chairman of the Electricity Committee, said that the undertaking was threatened with outside rivalry from electrical companies which wished to enter the district. The companies argued that they could produce current cheaper than the Council. This, on behalf of the Council, was denied, but when once these outside companies "got their foot in," it would mean ruin to the St. Pancras undertaking. Unless more consumers were obtained, the current could not be produced more economically by the Council. There were many thousands of houses in the borough where electric light might be used. It was cheap, and would be cheaper, but the one thing that stood in the way of the small consumer was the cost of wiring and fittings. The principle recommended had been adopted by the boroughs of Hackney, West Ham, Ealing, and at Wolverhampton, Norwich, and Brighton. By 36 votes to 14, it was decided to refer back the matter for further consideration and report.

Stepney.—At a meeting of the Thames Conservancy on Monday it was reported that application had been made by the Borough Council for permission to construct an embankment and place two 36-in. suction and discharge pipes in the river at their electricity generating station, Blyth's Wharf, Limehouse. Reports having been received from the engineer and Harbour Master on the matter, the permission asked for was granted, subject to protective conditions.

MALAGA (SPAIN): *Wireless Telegraph Station.*—A consular report states that a station for wireless telegraphy has recently been erected on the highest point of the Alcazaba, the old Moorish castle, overlooking the port, for the purpose of communicating with Melilla, on the African coast. This station has been erected by order of the Ministry of War, and will only be used by that department. It is stated that it will be working in the course of a month or two.

NOTTINGHAM: *Tramways.*—A ratepayers' meeting has been held approving the Bill of the Nottinghamshire and Derbyshire Tramways Co., by which the Corporation take over the powers of the latter with respect to certain tramways.

RUGBY: *Reduction of Power Charges.*—It has been decided to reduce the charge for power to 2⅛d. per unit for all customers having a consumption of 150 units per quarter for each horse-power installed.

SWANSEA: *Electricity Accounts.*—At the meeting of the Corporation last week, Colonel Sinclair, in presenting the report of the Tramways and Electric Lighting Committee, stated that there had been a profit for the year of £1,466, which enabled them to square off all outstanding accounts, and to still have a net balance over and above all the liabilities of the undertaking. But for the increase in the price of coal, the profits would have been another £400. Contrary to most other places, there had not been a decline in the revenue due to the use of metallic filament lamps, and he was pleased to say that the revenue was a growing one. The detailed accounts of the electricity department show a credit balance of £789, after providing for interest and sinking fund. The total revenue was £20,235, of which £11,861 was from private consumers, £1,806 from public lighting, and £6,567 from power supply.

TOTTENHAM: *Tramways.*—The Metropolitan Electric Tramways, Ltd., have asked the Urban District Council to carry out the widening of the High Road, opposite High Cross, in the same way as the road improvements in Seven Sisters Road and the High Road near Bruce Grove. The company are to be informed that the works will be put in hand as soon as the necessary deposit, viz., £620, is placed with the Council. The Metropolitan Electric Tramways, Ltd., further asked for permission to fix an automatic point controller at the junction of the High Road and Bruce Grove, and the request is to be acceded to. The Engineer is to meet the tramway company's Engineer and to fix a suitable site.

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WATFORD: *Electricity Supply.*—At the last meeting of the Urban District Council, Councillor W. F. Goodrich announced that the balance of income over expenditure in connection with the electricity undertaking for the past year ended March was £915, and it was proposed that this amount should be transferred to the relief of the general rate fund. Next year he believed there would be an even more substantial profit on the undertaking; the outlook for the future was exceedingly satisfactory. The Acting Electrical Engineer reported that there were 640 consumers connected. The Council decided to inform Messrs. Nicole & Co. that they would be in a position to cope with additional current for that firm next winter to the extent of 100 h.p.

WEST HAM: *Tramways.*—Negotiations are proceeding between the Borough Council and the East Ham and Ilford authorities with regard to through running on the Romford Road tramways route. In view of the fact that the development of land adjoining Prince Regent's Lane has not proceeded as rapidly as was anticipated, the Electric Lighting and Tramways Committee has decided that application be made to the Board of Trade for an extension for two years of the powers given by the Provisional Order for the construction of the Prince Regent's Lane tramway and the unfinished portion of the junction between Barking Road, Prince Regent's Lane, and Greengate Street.

YARMOUTH: *Electricity Accounts.*—The total receipts during the year have increased by £1,523 as against last year, but the works cost have increased from £10,225 to £12,442, entirely owing to the rise in the price of coal. Interest and sinking fund absorbed £6,190, and there is a final deficit of £14 on the year's working.

Tramway Accounts: The total receipts during the year have amounted to £24,777 and the expenses to £16,350; of the balance, £1,605 remained as surplus after payment of sinking fund, and interest of this sum, £1,500, has been transferred to the renewals fund and the remainder carried forward.

TENDERS INVITED AND PROSPECTIVE BUSINESS

AUSTRALIA: *Melbourne.*—The Council invite tenders for the supply of 5,060 yards insulated copper cables. Specifications, &c., from Messrs. McIlwraith, McEachern & Co. Proprietary, Ltd., agents for the Council, Billiter Square Building, London, E.C., to whom tenders by July 3rd.

BRAY.—At the last meeting of the Council a report of the Electric Light Committee recommending the expenditure of £5,000 upon extensions and improvements of the electric light works was adopted.

DUBLIN.—The Corporation invite tenders for a twelve months' supply of machinery oils for the Pigeon House Fort generating station. Particulars from the Town Clerk, and tenders to the Chairman, Supplies Committee, City Hall, Dublin, by June 29th.

Tenders are invited for the supply and erection of boiler plant at the Pigeon House Fort generating station. Particulars from the Electrical Engineer (fee, one guinea, returnable), and tenders to the Chairman of the Lighting Committee, Cork Hill, Dublin, by July 13th.

EDINBURGH.—Tenders are required for the installation of electric lighting and power in the new engineering laboratory at the Heriot-Watt College. Particulars from Mr. J. Anderson, Superintendent of Works. Tenders by July 3rd to Mr. P. Macnaughton, Clerk, Heriot Trust Office, 20 York Place, Edinburgh.

FARNWORTH.—The local District Council have applied to the Local Government Board for sanction to borrow £7,000 for purposes of electric lighting. An inquiry into their application has been fixed for July 7th, to be conducted by Mr. H. Shelford Bidwell.

FINCHLEY.—Extensions are to be carried out at the electricity works.

GRAVESEND.—The Electricity Committee invite tenders for the supply and erection of yellow-flame arc lamps, columns, &c. Particulars from the Electrical Engineer (fee two guineas, returnable), and tenders to the Town Clerk by June 27th.

LONDON: *London County Council.*—The Council invite tenders for the manufacture and delivery of high-tension main switchgear and low-tension auxiliary switchgear for the Greenwich generating station. Particulars from the Clerk, fee £2, returnable, and tenders by July 7th.

The Highways Committee recommend that capital expenditure to the extent of £1,900 be sanctioned for the purchase of tramway feeder pillars.

Fulham.—The Guardians invite tenders for a vertical high-speed engine and a 20-kw. dynamo, both British made. Full particulars from the Clerk, Guardians' Offices, 129 Fulham Palace Road, to whom tenders by July 2nd.

ODESSA.—The Town Council invites tenders for the installation and working, as a concession, of an electric station, with a capacity of not less than 6,000. Tenders to the Town Uprava (Executive Committee of the Town Council) by 12 o'clock noon of the 1-14 September of the present year, 1908. A deposit of a thousand roubles must be made as security for their proposal. Detailed particulars of the concession and other information may be obtained of the Building Department of the Town Uprava on working days (i.e., days when members are in attendance), from 1 to 3 o'clock.

PONTYPRIDD.—The Council invite tenders for the supply and delivery of six double-deck tramcars. Full particulars from the Tramways Engineer, Mr. T. Teasdel, fee £2 2s. returnable, and tenders to the Town Clerk by June 30th.

ROSSENDALE VALLEY.—The Rawtenstall Corporation are in negotiation with the Rossendale Valley Steam Tramways Co. for the purchase of their undertaking. Meanwhile, they have decided to construct an electric tramway from the existing line at Crawshawbooth to the borough boundary at Loveclough, and have empowered the Tramways Committee to accept tenders for converting the whole of the tramways of the borough to electric traction.

ROTHERHAM.—At the last meeting of the Board of Guardians the suggestion was made that the House and General Purposes Committee should take into consideration the advisability of substituting electricity for lighting the workhouse, and that tenders for electrical plant should be advertised for.

SALFORD.—Tenders are invited for re-wiring at the Royal Technical Institute. Particulars from Mr. V. A. H. M'Cowen, Borough Electrical Engineer, Electricity Works, Frederick Road, Pendleton. Tenders by July 1st. Fee one guinea.

SHEFFIELD.—A Local Government Board inquiry was held last week in connection with an application by the Corporation for a loan for £1,900 for the installation of an electric light plant at the Lodge Moor Hospital.

ST. ANNE'S-ON-SEA.—A feeder cable is required by the Council. Particulars from the Electrical Engineer (fee one guinea, returnable), and tenders to Town Clerk by June 27th.

SOUTH TOTTENHAM.—At the meeting of the Metropolitan Asylums Board on Saturday the Hospitals Committee brought forward a scheme for lighting the North-Eastern Hospital by electricity. The Engineer-in-Chief (Mr. Hatch) had prepared a statement of the actual cost of gas lighting for the last two years, from which he estimated that the total cost of electric light and gas (a small quantity being required for cooking, heating, and emergency) would be £700 per annum compared with the present expenditure of £1,200, or a saving of £500. The estimate was based on a quotation of the North Metropolitan Electric Power Supply Co., to supply the current required at "less than 2d. per unit." The Hospitals Committee pointed out that electric light had an advantage over gas in that it could be more favourably arranged in the wards, and was also more convenient, more hygienic, was attended with less risk from fire, and was generally accepted as the most suitable light for institution purposes. The Board unanimously approved the scheme. The cost of installation will be £4,500, the whole of the hospital, and not the permanent buildings only being included.

TENDERS RECEIVED AND ACCEPTED

EALING.—An order has been given to Oliver Arc Lamp, Ltd., for a number of "Oriflamme" flame arc lamps for street lighting.

GRAVESEND.—The two boilers on the training ship *Exmouth*, having proved inadequate for the work required in connection with the heating and lighting of the ship, and the cooking arrangements, the Metropolitan Asylums Board on Saturday approved the provision, at a cost of £275, of a battery of accumulators, with a small additional dynamo. The Engineer-in-Chief reported that the maintenance would cost £16 10s., and he estimated a net saving of £50 per annum at the lowest. The battery could be charged during light loads, and would be used to assist the dynamos at times of maximum demand.

LEYTON.—A large order for "Oriflamme" flame arc lamps for street lighting has been placed with Oliver Arc Lamp, Ltd.

LIVERPOOL.—A repeat order has been given to Messrs. Royce, Ltd., for one 5-ton three-motor electric overhead crane and steel gantry, 700 ft. long, for Messrs. Farnworth & Jardine, timber merchants, Seaforth, Liverpool.

LONDON: *London County Council.*—The Highways Committee recommend that a contract be entered into with Mr. W. Manders, of Leyton, for the road-work and platelaying in con-

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nection with the reconstruction of the Lea Bridge Road tramways, at an estimated cost of £3,990, which includes provisional sums of £250 and £340 for extra works, including the diversion of gas and water mains, &c. In this same connection, a contract with Messrs. Hadfield's Steel Foundry, Ltd., for special track work at £200 is also to be entered into. The offer of the Leyton District Council to supply, deliver, and erect the overhead equipment at cost price of material and labour, plus 10 per cent., is also recommended for acceptance.

The Highways Committee also recommend that the existing contract with Messrs. Dick, Kerr & Co., for the supply, delivery, and equipment of overhead equipment for the tramways from Beresford Square, Woolwich, to Wickham Lane, Plumstead, be extended to include the reconstruction of the Brixton-Camberwell Green tramways.

The tender of Messrs. Watlington & Co. and Messrs. Pfeil & Co., for certain switches and forge shop tools at the central car repair depôt on the Woolwich route, have been accepted.

The tenders of the British Electrical Transformer Co., Ltd., for a transformer, and Messrs. Spagnoletti for a distribution switchboard at the Bow car shed at £91 10s. and £53 respectively, have been accepted; also that of the Edison & Swan United Electric Light Co., for main switch-blocks and lighting materials at the Bow and Hammersmith car sheds at £212 12s.

The tender of Mr. W. A. Green for 50 five-ton tramcar jacks at 35s. 6d. each has been accepted.

The tender of Messrs. Mountain & Gibson for 400 anchor plates at 1s. per pound has been accepted.

The following tenders have been received for two electrically-driven centrifugal pumps to be erected at the Greenwich power station :—

	£	s.
Dick, Kerr & Co., Ltd. (accepted)	3,320	–
The General Electric Co., Ltd.	3,333	6
The British Electric Plant Co., Ltd. ...	3,335	10
Drysdale & Co., Ltd.	3,358	–
Worthington Pump Co., Ltd.	3,375	–
General Electric Co., Ltd. (alternative tender)	3,375	7
British Westinghouse Electric & Manufacturing Co. Ltd.	3,379	17
Worthington Pump Co., Ltd. (first alternative tender)	3,406	–
Dick, Kerr & Co., Ltd. (alternative tender)	3,415	–
Electric Construction Co., Ltd.	3,501	–
Worthington Pump Co., Ltd. (second alternative tender)	3,530	10
Thomas Parker, Ltd.	3,706	–
John Cochrane	3,757	10
Gwynnes, Ltd.	3,866	–
Greenwood & Batley, Ltd. (alternative tender)	4,004	10
,, ,, ...	4,074	10
Entwistle & Gass, Ltd.	4,342	–

The Highways Committee report that tenders have been obtained as follows for the supply of (i.) four single-phase static transformers, and (ii.) eight three-phase motors, and four auto-transformer starters, required in connection with the electric installation at the tramways central car-repair depot. Only one firm—namely, the British Electric Transformer Co., Ltd.—is in a position at the present time to supply the static transformers, and, as these are urgently required, the tender of this firm is recommended for acceptance. The tenders for the supply of the three-phase motors and auto-transformer starters were as follows :—

	£	s.
Electric Construction Co., Ltd. ...	427	10
British Westinghouse Electric & Manufacturing Co., Ltd.	468	–
General Electric Co., Ltd.	595	18
Dick, Kerr & Co., Ltd.	Incomplete tender.	

The following tenders have been received for the wiring and fitting for electric lighting of the Hackney car-shed. The tenders were as follows :—

	£	s.
Jenkins & Cawte	702	4
A. C. Smith	775	2
Perry & Co. (recommended)	911	–
S. J. Suter & Wood	961	–
W. G. Cannon & Sons	1,010	16
Pinching & Walton	1,014	19
Comyn, Ching & Co., Ltd.	1,099	8
G. Weston & Sons	1,158	8
G. E. Taylor & Co.	1,189	13
Cross & Cross	1,209	–
H. J. Cash & Co., Ltd.	1,245	–
Tilley Bros.	1,397	16

Metropolitan Asylums Board.—The tenders of the following firms for annual supplies of electrical accessories were accepted on Saturday :—General Electric Co., Pryke & Palmer, G. Braulik, Stirling Telephone & Electric Co., British Insulated and Helsby Cables, Ltd., W. T. Henley's Telegraph Works Co., Ltd., Edison & Swan United Electric Light Co., Ltd., Davies Kent & Stewart, Ltd., Callender's Cable and Construction Co., Ltd., Connolly Bros., India Rubber, Gutta Percha & Telegraph Works Co., Ltd., Goossens, Pope & Co., Sunbeam Lamp Co., Ltd., Cryselco, Ltd., H. G. Mayer & Co., A. P. Lundberg & Sons, Galsworthy, Ltd., J. H. Tucker & Co., London Electric Wire Co., Ltd., Siemens Bros. & Co., Ltd., Heap & Johnson, G. McLellan & Co., Macintosh & Co., Ltd. The Contracts Committee state that it is impracticable to give any reliable estimate of the probable total value of the supplies, as they are required almost entirely for replacements and renewals.

The Board has accepted the tender of Edmundson's Electricity Corporation, Ltd., at £194 (less 5 per cent. to the builder) for wiring and fitting for electric lighting the Belmont Laboratory, Sutton, Surrey.

MANCHESTER.—Messrs. Royce, Ltd., have received a repeat order from Messrs. Galloways, Ltd., Manchester, for two 40-ton three-motor electric overhead cranes and gantry for their boiler works, Ardwick.

WEST HAM.—The West Ham Borough Council Electric Lighting & Tramways Committee has received the following tenders for the supply of a 3,000 kilowatt turbo-generator :—

	£
Electrical Co.	11,400
Richardsons, Westgarth.—Brown Boveri ...	9,675
Richardsons, Westgarth-Parsons	9,400
Electric Construction Co., Richardsons, Westgarth	9,400
Richardsons, Westgarth-Electric Construction Co.	9,300
Willans & Robinson—Dick, Kerr	9,182
Howden-Dick, Kerr	8,865
Howden-Westinghouse	8,750
General Electric Co.-Richardsons, Westgarth ...	8,745
Richardsons, Westgarth-Dick, Kerr	8,520
Howden-Siemens	8,500
Parsons-Parsons	8,184
Richardsons, Westgarth-Siemens	8,175
Electric Construction Co.-Parsons	7,704
Parsons-Dick, Kerr	7,494
General Electric Co.-Parsons	7,349
British Westinghouse Co. (provisionally accepted)	6,100

The contract with the British Westinghouse Co. is to provide for delivery in five months, with two years' maintenance, and to contain clauses giving to the Council the option of purchasing a further similar turbo-generator within two years for £6,800. The Electrical Engineer's estimate for the first of these two turbo-generators amounted to £10,000.

MISCELLANEOUS CITY NOTES

ANGLO-ARGENTINE TRAMWAYS CO.—An extraordinary general meeting will be held at Winchester House, Old Broad Street, London, on Tuesday next.

BRUCE PEEBLES & CO.—In connection with the scheme of reconstruction, it is proposed that a new company shall be formed with a nominal capital of £250,000 in £1 shares. The holders of 5 per cent. debentures of the old company will exchange for 6 per cent. debentures in the new company for an equal amount, whilst ordinary creditors will receive ⅜ of the amount due in 6 per cent. unsecured debentures, and ⅝ in fully-paid shares. The holders of the 5 per cent. preference shares, as already announced, will have three shares of £1 each, 13s. 4d. paid for each preference share, and £5 ordinary shares will be exchanged £1 shares 10s. paid. It is understood that the scheme of reconstruction has received the approval of the committee of creditors and shareholders, and will come before the Court of Session in Edinburgh on July 10th.

HOBART ELECTRIC TRAMWAYS CO.—A dividend of 1s. per share free of tax is recommended.

PROVINCIAL TRAMWAYS CO.—An interim dividend of 3s. per share upon the ordinary shares is recommended.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO.—An issue of £900,000 5 per cent. bonds have been offered to the public by the Bank of Scotland and the Canadian Bank of Commerce at 80. The bonds are part of an authorised total of £3,500,000, and have a specific charge on the assessable and immovable property of the company subject to the prior claims of $25,000,000 first mortgage bonds.

SHAWINIGAN WATER & POWER CO.—A dividend of 1 per cent. for the quarter ending June 30th has been declared.

THE AMERICAN WESTINGHOUSE CO.—The special correspondent of the *Birmingham Daily Post* reports that the Westinghouse Electric & Manufacturing Co. has passed into the control of a syndicate associated with Mr. Pierpont Morgan. The purchase price is given at 40,000,000 dollars.

Electrical Laboratory at Oxford University.—The Drapers' Co. have granted a sum of £22,000 for the building and all the accessories of an electrical laboratory which is to be presented to Oxford University, and have instructed Mr. T. G. Jackson, the company's architect, to carry out the work. It is announced that in a Convocation to be held on October 20th next it will be proposed that the University accept the munificent offer and express its grateful appreciation of the company's generosity.

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COMPANIES' MEETINGS AND REPORTS

ALUMINIUM CORPORATION.—At the annual general meeting last week, the report and accounts given in our last issue were adopted. Sir James Sivewright, K.C.M.G., the chairman, who presided, said that since the beginning of the year the production of aluminium had been commenced, the first furnace having been worked in March. The number of furnaces had been added to since, and the quality of the aluminium was such that in no case had it fallen below 99 per cent. of pure metal. They were prepared to face competition, and in order to do so more effectively had decided to put up their own alumina works. In the past they had been buying their alumina in the open market, but the company had secured an extremely valuable bauxite property in the Var district of France, the material running to 60 per cent. alumina and 1 per cent. of silica. The chairman also stated that the company had taken authority to create £150,000 5 per cent. debentures, of which £100,000 would be issued very shortly.

BRITISH ELECTRIC TRACTION.—This company's report for 1907 will be found on page 985.

BUENOS AYRES ELECTRIC TRAMWAYS (1901).—The report for the fifteen months ended March 31st, 1908, states that, after allowing for debenture interest and transferring £2,530 to the sinking funds for redemption of debenture stock, and deducting the credit balance brought from the last balance-sheet, amounting to £2,639, there remains a debit balance of £1,931 to be carried forward, and when this balance has been wiped out, depreciation of rolling stock, plant, &c., will be duly provided for. The meeting is to-morrow.

BUENOS AYRES GRAND NATIONAL TRAMWAYS.—The annual report states that the gross receipts of the lines operated by the Buenos Ayres Grand National Tramways Co., Ltd. (consisting of the lines of this company and those of the Buenos Ayres New Tramways Co., Ltd.), have amounted to £380,969 6s., as compared with £321,256 9s. for the previous year. The working expenses amounted to £242,117 19s. 9d., as compared with £220,389 8s. 4d. The net receipts amounted to £138,851 6s. 3d., as compared with £100,867 0s. 8d. The Grand National Co.'s share of the above net receipts under the agreement has amounted to £91,446 18s. 8d., as compared with £68,405 14s. 4d. for the previous year. After payment of London administration expenses, interest on debentures, &c., there remained a balance of £37,840 15s. 11d., from which the sum of £3,502 has been transferred to debenture reserve funds and £3,726 3s. to income bondholders' interest account, and there has been paid on February 15th, 1908, £11,250, being the interim dividend of 2½ per cent. on the 5 per cent. cumulative preference shares, leaving £19,362 12s. 11d., which the directors recommend should be appropriated as to £11,250 to the payment of a further 2½ per cent., payable on August 1st, 1908, on the preference shares (making 5 per cent. for the year to March 31st, 1908), £3,293 8s. 11d. to contingency fund (bringing that fund up to £7,000), and that the balance, £4,819 4s., be carried forward. Since the last ordinary general meeting of the Company continued progress has been made with the work of converting for electric operation the joint system of this company and of the Buenos Ayres New Tramways Co., Ltd., and of constructing further lines authorised by concessions from the municipality of Buenos Ayres. At March 31st, 1908, there had been converted a total length of 85¾ miles, of which about 81 miles were being operated.

ELECTRICITY SUPPLY COMPANY FOR SPAIN.—The report for 1907 shows that after deducting debenture interest and expenses amounting to £11,139, administration expenses, income tax, and interest £2,148, there is a profit of £26,666. This, together with the debenture sinking fund of £46,250, and the carry over from 1906 of £12,034, has been applied in writing down the Company's assets in Madrid.

GLOBE TELEGRAPH & TRUST.—The report for the year to May 31st last states that the net revenue for the year, after deducting expenses, amounts to £210,294, and makes, with the balance of £26,565 brought forward, a total of £236,860. From this amount there has been distributed £131,769 in interim dividends, leaving an available balance of £105,090. The directors now recommend the payment of the following final dividends—namely, 3s. per share, less income-tax, on the preference shares, making with previous distributions a total dividend for the year on those shares at the rate of 6 per cent. per annum, less income-tax, and 5s. 9d. per share net on the ordinary shares, making, with previous distributions, a dividend on these shares at the rate of 5⅞ per cent. net for the year. These dividends will absorb £77,884 and leave a balance of £27,206 to be carried forward. The meeting is on the 30th inst.

INDIAN ELECTRIC SUPPLY & TRACTION.—The report for the year ended December 31st, 1907, states that up to June 30th, 1907, expenditure was debited to capital account, and on July 1st, 1907, the revenue account was opened. The capital expenditure has proved to be in excess of the estimates, partly owing to the plague, which delayed completion of the works, and partly because revenue has not come in to meet the debenture interest so soon as was expected. It will be necessary, in the early part of next year, to raise further capital to pay off the indebtedness incurred, and to provide for extensions of the company's mains, which are required for the development of the undertaking. The result of the first half-year's working has been a loss of £6,681, including payment of interest on construction debenture stock, amounting to £3,750. The working loss is mainly due to the tramway, the returns from which have fallen far short of the expectations formed of them. The meeting is on Monday.

J. G. WHITE.—The report for the year to February 29th, 1908, shows a net profit of £36,162. Profit has only been taken into the accounts on work actually completed at the date of the balance-sheet. Included in the completed works at that date was the tramways system for the town of Luton, which is now being operated successfully by the company under a leasing agreement. The company is now actively carrying out work in Buenos Aires, Montevideo, Para (Brazil), Dumbarton, and at other places. Since the date of the balance-sheet contracts have been secured for an electric supply installation at Arbroath, for the supervision of tramway works in Santos (Brazil), and for other tramway construction. With regard to the company's investments, since the date of the balance-sheet securities valued at £24,752 have been sold at a profit, which will come into the current year's accounts, leaving £119,496 as the valuation of the remaining securities. After bringing in £18,311 from the previous account, deducting the interim dividend paid on the preference shares at January 1st, 1908, and making provision for percentages due to directors and staff, there is a balance of £47,749. The directors recommend a dividend of 6 per cent. per annum on the cumulative preferred shares for the half-year to February 29th, 1908; a dividend of 6 per cent. per annum on the ordinary shares for the year to February 29th, 1908; and a bonus of 2 per cent. on the full amount of the preferred and ordinary share capital (making 8 per cent. for the year). £20,000 are placed to reserve, and £16,249 carried forward. The meeting is on Monday.

LEAMINGTON & WARRINGTON ELECTRICAL.—The report for the year ended December 31st, 1907, states that the capital expenditure during the year amounted to £2,295, of which £426 was incurred in connection with the reconstruction and equipment of the electric tramways and £1,866 in connection with the power station and equipment for the supply of electricity. The amount owing to the British Electric Traction Co. for advances in connection with the reconstruction and equipment of the tramways and power stations, &c., is £28,233, which it is proposed to repay as soon as arrangements have been made for issuing a portion of the authorised debenture stock. In the meantime interest at the rate of 4½ per cent. is being paid on the loan. The accounts show a net credit balance of £4,731 from tramways and electricity supply, and sundry receipts amount to £68. Deducting administration and general expenses, payments to the superannuation fund, interest on loans, and provision for renewals, there remains a balance of £2,356, to which has to be added £1,257 brought forward, making a total amount available for distribution of £3,613. The directors recommend increasing depreciation and reserve account to £4,300 by adding £300, a dividend of 4 per cent. on the ordinary shares for the year, leaving £139 to be carried forward. Before arriving at the profit, the directors have debited the profit and loss account with a sum of £350, which has been placed to a provision for renewals account. This, with the further sums of £650, which they now recommend should be placed to other reserves, is double the amount so provided last year. Owing to the inclement weather during the summer the tramway receipts show a falling off of £615. The expenses of operation, however, show a reduction of £407. The supply of electricity resulted in a loss of £240 on the year's working, but the expenses have been exceptionally heavy owing to trouble with the plant. At the meeting on Tuesday, the report and accounts were adopted.

MONTREAL LIGHT, HEAT & POWER.—For the year ended April, 1908, the net revenue amounted to $2,140,561, of which fixed charges absorbed $493,494. After paying $1,020,000 as dividends, there is a surplus of $627,466, and the amount to be carried forward, when added to the surplus from last accounts, amounts to $1,332,314. Since the company started operations seven years ago, the working expenses have been reduced from 53 per cent. to 43 per cent. of the revenue.

NEW GENERAL TRACTION.—The report for the year ended March 31st last states that the revenue amounts to £18,892, against £14,767 in the previous year. General expenses, including directors' fees and legal charges, amounted to £2,509, as against £2,485 in 1907. The amount paid for debenture interest remains the same as for the previous year—namely, £13,200—before deducting income-tax thereon. The item of "interest on loans, discount, and commission" figures as £3,292, against £1,836. The accounts for the year show a small profit of £264, thus reducing the balance of loss previously shown to £26,519.

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The Coventry Tramway Co.'s system has shown satisfactory results, enabling that company, besides paying an increased dividend, to reduce its indebtedness to this company by the sum of £4,000. The Norwich tramway traffic returns are disappointing. The returns from the Douglas property have again been satisfactory. The meeting is on the 30th inst.

OSWESTRY ELECTRIC LIGHTING & POWER.—At the annual general meeting held at Oswestry last week the report and accounts were adopted. The balance sheet shows a profit of £557, and after paying a dividend of 4 per cent., a sum of £150 is carried to reserve fund. During the year an automatic stoker has been added to the Lancashire boiler in the power station, which it is hoped will result in a considerable saving in fuel.

R. WAYGOOD.—At the annual general meeting last week the report and accounts were adopted. Mr. Henry C. Walker, the chairman and managing director, said the company's business was expanding at such a rate that the directors would soon have to decide whether the works should again be removed. The profit for the year was £61,527, which was a considerable advance on the previous year, but, of course, there had been extra expenses and general charges. A dividend of 7 per cent. on the ordinary shares, making 6 per cent. for the year, was approved.

MISCELLANEOUS BUSINESS NOTES

CHANGE OF ADDRESS.—We are informed by Messrs. Bramwell & Harris, consulting engineers, that owing to the Government authorities having purchased the lease of No. 5 Great George Street in accordance with the scheme of the Public Offices Sites (Extension) Act, 1908, they are about to move to new offices at No. 11 Great George Street, Westminster, S.W., which they hope to occupy by the end of this month.

G. M. BODDY & CO.—This firm asks us to state that they have now a scale of discounts in force applying to their "Metalik" lamps, which represents an allowance on an increasing scale, starting at 25 per cent. for 50 lamps. These discounts are offered to Corporations and the trade only. Full particulars will be sent on application to Messrs. Boddy's Newington Works, Liverpool, or their branch depôt, Castle Hill, Sheffield.

LIQUIDATIONS, BANKRUPTCIES, WINDINGS UP, &c.—A meeting of the Rand Central Electric Works, Ltd., will be held at the offices of Mr. H. Rogers, the liquidator, 120 Bishopsgate Street Within, London, on July 21st, at 12 noon, for the purpose of hearing the liquidator's account of the winding up.

F. Egginton, Electrical Engineer and Contractor, 11 Tempest Street, Wolverhampton, has been adjudicated bankrupt.

The first meeting of the creditors of Ernest Goacher, Gateford Road, Worksop, Nottinghamshire, electrical engineer, &c., was held last week at the Official Receiver's offices, Figtree Lane, Sheffield. It appeared that the debtor started business in 1901 without any capital. At the end of 1907 he opened a shop in Whitwell, and last April another at Cresswell, while in February last he disposed of another business which he had carried on for about two years. It was stated that no statement of affairs had been lodged, the debtor having gone away, but it had been estimated that the liabilities amounted to something like £600, while the assets had realised £78, but there were some outstanding book debts. The failure was alleged to be due to interest on borrowed money, bad trade, and illness. It was decided that the matter should remain with the Official Receiver, who, therefore, acts as trustee.

The first meeting in the bankruptcy of F. B. Eggington, Electrical Engineer and Contractor, 11 Tempest Street, Wolverhampton, will be held on July 2nd, at 11 a.m., at the Official Receiver's Offices, Wolverhampton, and the public examination will take place at the Wolverhampton County Court on July 22nd, at 11 a.m.

APPOINTMENTS AND PERSONAL NOTES

Mr. A. V. Mason, Manager of the Devonport & District Tramways Co., has been appointed General Manager of the South Metropolitan Electric Tramways & Lighting Co.

Mr. E. D. Long, Electrical Engineer to the Grays Urban District Council, has had his salary increased by £25 per annum.

Kelvin Lecture.—The Institution of Electrical Engineers have published a verbatim report of the Kelvin Lecture delivered by Prof. Silvanus P. Thompson, F.R.S., before the Institution on April 30th. Copies may be obtained from Messrs. E. & F. N. Spon, Ltd.

The Supply of Electricity Bill.—The Stepney Borough Council is circularising the other London Borough Councils, and also the local authorities of Greater London, asking that representatives be appointed to a deputation which it is proposed shall wait upon the President of the Board of Trade with a view to the re-introduction of the Supply of Electricity Bill as brought forward in the Session of 1906.

PARLIAMENTARY INTELLIGENCE

LONDON ELECTRIC POWER BILLS.—Our report of the proceedings before Lord Cromer's Committee will be found on pages 952 and 955 to 959.

AUDIT OF ELECTRIC LIGHTING COMPANIES' ACCOUNTS.—In the House of Commons on Thursday, Mr. Cleland asked the President of the Board of Trade whether the auditors employed by the South London Electric Supply Corporation had been appointed official auditors of the same accounts for the purposes of the Board of Trade audit; whether these auditors had failed to question the charging to capital account of certain proportions of the salaries of the company's permanent officials, a practice which the Local Government Board declined to allow local authorities to pursue; whether this company had also charged directors' fees to capital account, and had made an inadequate depreciation provision; and whether, in view of the fact that capital expenditure was always an important factor in determining the price a local authority had to pay for a company's undertaking, the Board of Trade would in future appoint independent official auditors other than those employed by the companies, and would make regulations under its statutory powers with the object of ensuring that the audit should be efficient and effective. Mr. Churchill, in reply, said that the auditors in question had been appointed by the Board of Trade in the manner suggested, and in their report stated that they saw no reason to question the principle upon which the proportion of salaries had been charged to capital account in respect of the time occupied by them on capital work. The auditors had called attention to the fact that the sum in respect of directors' fees charged to capital account in and before the year 1900 still remained. They also reported that they did not consider the provision made for depreciation by the company was inadequate. Whilst the Board of Trade had at various times endeavoured unsuccessfully to induce the company to remove the charge for directors' fees from capital account, he was bound to point out that they had no power to enforce the auditors' recommendation. As stated in a reply last week (ELECTRICAL ENGINEERING, June 18th, page 945), the arrangement made for the audit of electric lighting accounts for 1907 was being carefully watched in case it should need any changes. The Board of Trade had also issued instructions to auditors appointed by them with the object of ensuring that the audit should be efficient and effective.

PATENTS ACT.—In the House of Commons on Thursday, the President of the Board of Trade was asked whether representations had been received as to the effect of the Patent Act of 1907 upon United States manufactures, and what was the general purport of these representations, and the replies thereto. Mr. Churchill stated that representations had been received with regard to certain provisions of the Act affecting patents worked exclusively or mainly abroad. The United States Government appeared to be under some misapprehension in the matter, but correspondence with the United States Government was still proceeding.

PATENTS AND DESIGNS BILL.—In the House of Commons on Friday Mr. Hearley, on behalf of the Board of Trade, moved the second reading of this Bill, the object of which, he said, was to make clear the Patents and Designs Act of last year. Some doubt seemed to exist in the minds of some patent lawyers as to whether the appeal to the House of Lords in case of revocation of a patent by a lower court was safeguarded.

POST OFFICE ENGINEERING ESTIMATES.—In the House of Commons on Wednesday last week, Mr. Field asked whether the Postmaster-General would give directions that all future estimates for the Post Office Engineering Service shall show the expenditure in Ireland as distinct from Great Britain. The Postmaster-General, in reply, stated that he would consider the question before the estimates of 1909-10 were prepared, but the matter was not free from difficulty.

TRAWLERS AND SUBMARINE CABLES.—In reply to a question in the House of Commons on Thursday, Mr. Churchill said that he had seen a report to the effect that the cable steamer *Buccaneer* had hailed four steam trawlers off the south-west coast of Ireland, in which small area there were five cables belonging to two Atlantic companies, representing a value of over £2,000,000. He was considering the question of holding a small interdepartmental committee on the question.

UNOPPOSED BILLS.—The North-East London Railway Bill was before the Unopposed Committee of the House of Lords on Tuesday, and was ordered to be reported for third reading. The Bill amends the North-East London Railway Acts of 1905 and 1907, so that the period during which half the capital must be subscribed shall be four years instead of twelve months from 1905.

Electric Lighting Provisional Order Confirmation Bills Nos. 1, 2, and 3 were ordered to be reported for third reading by the Unopposed Committee of the House of Lords on Tuesday.

PROGRESS OF ELECTRICAL BILLS.—The Burnley Corporation Bill, and the Ayr Corporation Tramways Provisional Order Confirmation Bill, were read a third time and passed in the House of Commons last week.

Wolverhampton Corporation Bill and the Doncaster Corpora-

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tion Bill were read a second time in the House of Lords last week; the Great Northern, Piccadilly, and Brompton Railway Bill was read a third time, and the Central Ireland Electric Power, and Birmingham Corporation Bills a first time.

The Great Northern, Piccadilly, and Brompton Railway Bill, the Keighley Corporation Bill, and the Metropolitan District Railway Bill were read a first time in the House of Commons on Wednesday last week.

The Central Ireland Electric Power Bill, the Burnley Corporation and Electric Lighting Provisional Order Confirmation Bills, Nos. 1 and 2, were read a second time in the House of Lords on Thursday.

The North-East London Railway Bill, the Keighley Corporation Bill, and the Metropolitan District Railway Bill, were read a third time in the House of Lords on Wednesday.

ROYAL ASSENT.—Royal assent was given to the following Bills, last week, among others:—Edinburgh Corporation Tramways Order Confirmation; Loch Leven Water Power Order Confirmation; Tramways Order Confirmation No. 1, and the Rochdale Corporation.

NEW COMPANIES

BOURNE END ELECTRIC INSTALLATION CO.—This company was registered on June 19th, with a capital of £5,000 in £1 shares, to take over the business of suppliers of electric light and energy, engineers, and fitters, carried on at Bourne End, Bucks. The subscribers are:—F. C. Frye, H. S. Wilton, J. R. Collins, H. Wetton, H. C. Brannan, W. R. Chapman, E. R. Gibbs. No initial public issue. The number of directors is not to be less than two nor more than four; the first are F. C. Frye (chairman), H. S. Wilton, J. R. Collins, and W. P. Wilson. Qualification, £50.

ELECTRIC PREPAYMENT METERS.—This company was registered on June 5th, with a capital of £5,000 in £1 shares, to acquire from the Electrical Apparatus Co., Ltd., the benefit of certain existing inventions relating to improvements in meters for recording the supply of electricity, to adopt agreements: (1) with the said company, and (2) with the said company and others, and to carry on the business of manufacturers of electricity meters, suppliers of electric light and power, mechanical and electrical engineers, &c. The subscribers are:—P. R. Reeves, W. J. Park, W. Eacott, S. Jordan, W. J. McNelly, R. Bott, R. J. Hawkins. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are B. Bernheim, W. H. Fowler, and J. T. Jervis. Qualification £100. Remuneration £50 each in any year when 10 per cent. dividend is paid. Registered office: Caxton House, Tothill Street, Westminster.

ELECTROCAB DEVELOPMENT CO.—This company was registered on June 13th, with a capital of £100 in £1 shares, to carry on the business of electrical, mechanical, and general engineers, manufacturers of and dealers in electrocabs, electro-omnibuses, and other electric vehicles, tyres, wheels, motor-cars, motor-omnibuses, bicycles, carriages, and vehicles of all kinds, &c. The subscribers are J. Williams, R. James, D. Cony, C. Dew, A. Budd, R. H. Hammant, J. Booty. No initial public issue. Registered without articles of association.

ELECTRO-MECHANICAL BRAKE CO.—This company was registered on June 6th with a capital of £10,000 in £1 shares to acquire the benefit of certain existing inventions referred to in an agreement with J. B. Hamilton, A. W. Maley, G. Conaty, and G. Law, Jun., and to carry on the business of brake makers, electrical and mechanical engineers, manufacturers of and dealers in tramway carriages, trucks, motors, accumulators, and dynamos, &c. The subscribers are: J. B. Hamilton, general manager Leeds City Tramways; A. W. Maley, G. Conaty, G. Law, Jun., J. Hamblet, H. Denison, D. H. Wilmer. No initial public issue. The number of directors is not to be less than three, nor more than seven; the first are J. B. Hamilton, A. W. Maley, G. Conaty, G. Law, Jun., and J. Hamblet. Qualification, £250. Remuneration (except managing director), £100 per annum, dividend. Registered office: Eagle Works, Moor Street, West Bromwich.

LONDON ELECTROCAB CO.—This company was registered on June 13th with a capital of £100 in £1 shares. Other particulars as in Electrocab Development Co., Ltd. (q.v.)

REVY, PHILLIPS & CO.—This company was registered on June 18th, with a capital of £10,000 in 9,000 shares of £1 each, and 8,000 shares of 2s. 6d. each, to take over the business of electrical, telegraph, general, and sanitary engineers, contractors, manufacturers of cooking and other appliances, and heating and ventilating engineers, carried on by J. W. Revy and P. F. Besch, at 181 Queen Victoria Street, E.C., and at the Iliffe Iron Works, Amelia Street, Penton Place, Southwark, S.E., as "Revy, Phillips & Co." The subscribers are T. J. F. Bird, W. S. Roberts, A. P. Banting, F. Wilkinson, T. O. Wilkinson, F. Besch, T. Wilkinson. No initial public issue. The number of directors is not to be less than three, nor more than nine; the subscribers are to appoint the first. Qualification, £50. Remuneration as fixed by the company. Registered office, 181 Queen Victoria Street, E.C.

PAIGNTON ELECTRIC LIGHT AND POWER CO.—This company was registered on June 19th, with a capital of £15,000 in £1 shares, to acquire the benefits, rights, powers, authorities, obligations, and liabilities of J. A. Purves, D.Sc., and W. T. Purves, M.A., (trading as the Western Electricity Corporation), under a Provisional Order granted in 1907 to the said parties under the Electric Lighting Acts, 1882 and 1888, in respect of the urban district of Paignton, and confirmed by the Electric Lighting Orders Confirmation (No. 3) Act of 1907, and to carry on the business of suppliers of electricity in all its branches. The subscribers are:—W. J. Ham, J. A. Burland, W. Lambshead, J. N. Osborne, F. Sarson, T. H. Ward, R. Waycott. Minimum cash subscription, £6,000 shares. The number of directors is not to be less than four nor more than ten; the first are W. J. Ham, Major-General G. D'A. Jackson, T. H. Ward, M.D., J. A. Burland, L.R.C.P.I., R. Waycott, F. Sarson, W. A. Axworthy, and J. N. Osborne. Qualification, 100 shares. Remuneration as fixed by the company. Registered office: 5 Palace Avenue, Paignton.

NEW PUBLICATIONS

"Switchboard Measuring Instruments for Continuous Polyphase Systems." By John C. Connan. (London: E. & F. N. Spon.) Price 5s.

"Aldum's Pocket Folding Mathematical Tables," for the use of engineers, architects, students, &c. (London: E. and F. N. Spon.) Price 4d.

"Journal of the Institution of Electrical Engineers," June, including index to Vol. 40, also verbatim report of Kelvin Lecture. (London: E. & F. N. Spon.)

"Electrometallurgy." By John B. C. Kershaw. (London: Archibald Constable & Co.) Price 6s.

"Natural Sources of Power." By Robert S. Hall. (London: Archibald Constable & Co.) Price 6s.

Teaching Children to Cross the Road.—At Tuesday's meeting of the London County Council, in reply to a question from Mr. W. Reynolds as to whether, in view of the large increase of accidents to children through the use of motor vehicles and electric trams, he would arrange for teachers in the Council schools to give brief lessons daily, warning children of such dangers, Mr. Cyril Jackson, Chairman of the Education Committee, said that he would see if he could not arrange for teachers to warn children of the risks they ran in crossing busy thoroughfares.

Telegraph Traffic.—An interruption to telegraphic communication has occurred between Saigon and Bankok, but messages are being sent via Obone, subject to delay. The via Fao route has been restored. We shall, in future, not report interruptions and restorations of the Fao route. They occur very nearly daily, and need not be taken into account. The cable to Prince Edward Island is still down, and messages are being sent by mail via Pictou. The Cayenne-Salinas cable has also not yet been repaired, and the route to Brazil via Hayti is therefore still not available. The cable between Nantucket Island and Wood's Hole has been interrupted for some time, and it would appear that no attempt is being made to repair it. The break in the cable cuts off the wireless station at Siasconsett. The cable of the Direct United States Cable Co., interrupted by trawlers at the same time as those of the Commercial Cable Co., is still in the same condition.

Dispute as to Overhead Wires.—At Chorley County Court last Thursday an action was brought by William Holden, of Brinscall, against Thomas Barton, electrician, of Blackburn, for £14 damage alleged to have been sustained by reason of defendant's trespass in the erection of telephone wires. Plaintiff said in 1900 he found a telephone wire had been affixed to a chimney, for which he gave no permission. In August, 1907, workmen were on the roof fixing a second wire, and subsequently water came in, and he had had to pay various sums for damage to the roof and chimney. For the defence, Mr. J. W. Garsden, another Blackburn electrician, said in '99 he had control in the erection of a line from Brinscall to Manchester, and plaintiff verbally agreed to the bracket being fixed on the usual acknowledgment of 1s. per year. Defendant said he had laid 500 miles of telephone wires, and had never had litigation before. He had since had the wires removed from the property. His Honour gave a verdict for the defendant.

TRAVELLER.—Additional Traveller required for London for Arc Lamps, Transformers, and Accessories. Apply FOSTER ARC LAMP & ENGINEERING CO., Ltd., Wimbledon, S.W., by letter first, giving full details.—ADVT.

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BRITISH ELECTRIC TRACTION COMPANY'S REPORT

THE report for the year ended March 31st, 1908, in view of the fact that nearly the whole of the capital of the company is invested in a large number of associated companies, submits not only particulars of the company's interests in the associated companies, but also many particulars concerning the associated companies, the object being to enable the shareholders to form a correct view of the position of the company. The subscribed share and debenture capital of the company remains the same as at March 31st, 1907, viz., £4,949,969. The amount standing at the credit of reserve account is £567,420. In addition, reserves have been made out of profits against loss or depreciation of specific assets, of which reserves a balance of £41,117 is unappropriated. These, however, are not the only reserves, inasmuch as the various associated companies have created depreciation and reserve funds of their own, which amounted at December 31st, 1907, to £902,728. The associated companies have recently on the recommendation of the company adopted resolutions with a view to increase their provision against depreciation and also to define more clearly the purposes of their reserve funds. The resolutions are to the effect that the companies should make minimum provisions before payment of dividends, for (1) permanent way renewals, (2) redemption of capital, and (3) general depreciation purposes. The gross profits for the year 1907-8 amount to £250,539, and the expenses, including £73,682 interest on the 5 per cent. debenture stock and £23,802 interest on the 4½ per cent. debenture stock, for the year, amount to £144,829, leaving a balance of £105,709, to which is added the amount brought forward from preceding year, viz., £13,115, leaving to be dealt with £118,824. The gross profits include £49,954, profits on the Bombay undertaking, which have been fully explained in previous reports, and also £10,882 net profit on sale of investments. The expenses include £17,500, an amount reserved to meet depreciation of undertakings worked by the company (apart from investments), buildings, doubtful debts, and expenditure on undertakings not proceeded with.

The directors have given the question of the distribution of the balance of profit their earnest consideration, and are unanimously of opinion that, in advising the preference shareholders to agree to a postponement of a part of their dividend, they are recommending a course which will materially strengthen the position of the company, and which, by improving the prospects of increased profits, offers future compensation to both classes of shareholders for their present sacrifices. They therefore recommend that the full dividend on the preference shares at the rate of 6 per cent. per annum be paid for the six months ended September 30th, 1907, being at the rate of 3 per cent. for the financial year, which will absorb £48,431. They further recommend that there be added to general reserve (increasing the same to £602,420) the sum of £35,000, and that there be carried forward to next account £35,393.

The number of passengers carried last year upon the tramways and light railways was slightly less than in the year 1906, notwithstanding the increase in the number of miles worked. This reduction was due partly to the unfavourable weather and partly to the fact that several miles of tramways in the city of Birmingham reverted to the Corporation at the end of 1906, and that the new lines opened in various places do not as yet equal in density of traffic the routes which have been lost. The traffic on the lines which have been in operation for some time is, however, on the whole developing satisfactorily. Efforts have been made during the past year to improve the position of the undertakings by increasing the fares, by shortening the fare stages, and by eliminating unremunerative services. The increases of fares were not made till the second half of the year, and it will necessarily take some time before the full effects of these changes can be ascertained. Meanwhile, the directors regret the average fare for the past year has fallen to 1·21d. per passenger, compared with 1·22d. in 1906, and 1·38d. in 1901.

The expenses for the last nine months of the year have been discharged on a co-operative basis by the British Electrical Federation, but the directors are able to report a further reduction in the expenses. This reduction is not an advantage to the company in so far as it is a concomitant of reduced volume of business; it is satisfactory, however, that the management and general expenses are beng reduced in a larger ratio than the profits. In 1906-7 the gross profits were £267,757, and the management and general expenses £48,689, the proportion being 18·1 per cent., whilst in 1907-8 the gross profits were £250,539, and the expenses £27,446, a proportion of 10·9 per cent. Another matter which has been receiving attention is the price paid by the associated companies for the electrical energy for working the cars. This is a very large item in the working expenses, and in many cases, where the local authority owns an electricity supply station, an obligation has been placed upon the company to take current at what is now a high price, the local authority supplying other and much smaller consumers at considerably lower prices. The matter is receiving the attention of the directors with a view to securing better terms from the local authorities. With few exceptions the electricity supply undertakings owned by the subsidiary companies have now passed the pioneer stage, and are more than covering expenses, and their returns are steadily improving.

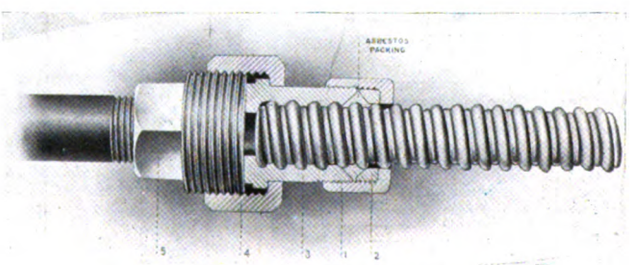
A federation of all the companies and undertakings associated with the company was formed in July, 1907 (in succession to the advisory committee for associated companies formed in 1902), for the purpose of co-operation and joint action in matters of common interest. About sixty undertakings have thus been federated for co-operative purposes, and a council has been constituted, consisting of the chairman or managing director of each of the federated undertakings. Among the more important matters dealt with by the federation are the following: Joint head offices and staffs, stores, insurances, &c. The council of the federation has also appointed expert officers to advise the companies in regard to rates and assessments, automobile matters, books and forms, and other like questions. The federation has been constituted on the basis of making no profit, and the expenses are distributed among the various companies in proportion to the services required by each. In the course of some general remarks as to the conditions under which the company is working in many places, the report states that the directors are giving consideration to some of the proposals for electrical enterprise submitted to them from countries where the conditions for the investment of capital are more favourable than in this country, and although such proposals require extensive examination before commitments can be made, the directors are hopeful that they will be able in the near future to employ the resources of the company to the further advantage of the shareholders in this direction. The meeting is to-day.

CATALOGUES AND PAMPHLETS RECEIVED

CARBON BRUSHES.—A list has been issued by Messrs. W. Geipel & Co., of the well-known graphitic carbon brushes, which are manufactured by the firm of Fabius Henrion, of Nancy (France). Particulars are given of several qualities of medium conductivity, high conductivity, and traction brushes, together with some useful notes as to their use. Messrs. Geipel are also agents in this country for Henrion arc lamp carbons and carbon incandescent lamps.

ELECTRIC GAS-LIGHTER.—A leaflet is to hand from Messrs. L. E. Wilson & Co., of 20 Cross Street, Manchester, describing the Thomson patent electric gas-lighter. The actual lighter consists of a glower of a special alloy, heated by current from a similar battery to that used in the firm's well-known pocket lamps. The special feature of the apparatus is, however, a small incandescent lamp worked off the same battery, which enables the apparatus to be used conveniently in the dark.

FLEXIBLE METALLIC TUBING.—A well illustrated catalogue is issued by the United Flexible Metallic Tubing Co., giving details of and describing the application of this firm's well-known metallic flexible tubing, which is rapidly superseding rubber hose, especially in cases where high pressures and temperatures have to be dealt with. Besides its application to steam at high pressures, the same form of tubing is largely



JOINT FOR FLEXIBLE METALLIC TUBING.

employed for conveying liquids, &c., in sizes up to 8 in. in diameter. A great deal of the success of such tubing depends upon the nature of the joint adopted, and especially where rigid and flexible tubes are connected together. The figure gives a section of the joint used by the company for this purpose; 1 is an octagon back nut, and 2 a bevelled ring. The sleeve 3 is screwed to the pitch of the tubing, 4 is hexagon nut, and 5 a plug for screwing into standard steam barrel. Asbestos thread or similar material is twisted round two corrugations of the tubing in the space left at the bottom of the sleeve, and the space in the corrugations of the tubing is completely filled up with alternate layers of red-lead and packing.

METAL FILAMENT LAMPS AND SHADES.—A price sheet from Simplex Conduits, Ltd., deals with a series of metal filament lamps with an efficiency of 1¼ watts per candle, and an average useful life given as 1,000 hours. The sizes listed are 25 c.p. at 50 volts; 32, 50, and 100 c.p. at 70 to 130 volts; and 50 and 100 c.p. at 200 to 250 volts. The company take all risk of breakage in consignment of not less than 50 or 100 lamps, if the damaged lamps are returned immediately. Several patterns of adaptor and pendant fitting for two lamps in series are illustrated, together with special designs of long shades.

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STOCK AND SHARE LIST

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. * = Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
ELECTRIC SUPPLY.	£	%	%		
Bournemouth & Poole E. S. Co. Ltd.	10	7	7%	10½—11	
Do. 4½% Cum. Pref.	10	4½	4½%	9⅝—10⅜	
Do. 6% Cum. Second Pref.	10	6	6%	10½—11	
Do. 4½% Debenture, Red.	Stock	4½	4½%	102—105	
Bromley (Kent) E.L.& Power Co.,Ltd.	5	5⅛	5⅛%	4⅜—5	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	94—97	
Brompton & Kensington E. S. Co.,Ltd.	5	10	10%	6¾—7¾	
Do. 7% Cum. Pref.	5	7	7%	6¾—7¾	
Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%	98—101	
Ch. Cross, W. E. & City E. S. Co.	5	5	5%	3⅜—4½	
Do. 4½% Cum. Pref.	5	4½	2¼%	4⅛—4⅝	
Do. 4% Deb. Red	Stock	4	4%	95—98 xd	
Do. "City Undertaking," 4½% Cm. Pf.	5	4½	4½%	3⅜—4⅝	
Chelsea Electric Supply Co., Ltd.	5	4½	4½%	3—3½	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9½—10½	
Do. 6% Cum. Pref.	10	6	6%	12—13	
Do. 5% Deb. Red	Stock	5	5%	124—127	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	102—105	
City of Durham E. P. Dis. Co.	5	4	2%	2½—3	
Do. 5% Pref.	5	5	5%	3⅜—4¼	
County of London Elect. Sup. Co. Ltd.	10	5	5%	7⅝—8⅝	
Do. 6% Cum. Pref.	10	6	6%	10¾—10⅞	-⅛
Do. 4½% Deb. Red	Stock	4½	4½%	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	98—101	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	½—1	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	63—73	
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4¾—5¼	
Do. 5% Cum. Pref.	5	5	5%	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½%	6—6½	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	90—93	
Kensington & Knightsbridge E.L.Co.	5	10	10%	7—8	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N'tng Hill E.L. Cos. Db.Rd.	Stock	4	4%	97—101	
London Electric Supply Corporation	3	4	2¾%	⅞—1⅛	
Do. 6% Pref.	5	6	6%	4½—4¾	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	89—92 xd	
Metropolitan Elec. Supply Co., Ltd.	5	6	6¾%	⅞—5	
Do. 4½% Cum. Pref.	5	4½	4½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E.Corp.for P.Dist.1stMt.D.	100 & 500	4½	4½%	95—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	7¾—8½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	8	8%	5½—6	
Do. £2 Pm.	5	8	8%	5½—6	
Do. 5% Pref. (fully paid)	5	5	5%	5¼—5½	
Do. 10/- Pm.	5	5	5%	5⅛—5⅜	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11½—12½	+¼
Oxford Electric Co., Ltd.	5	7	7%	5¾—6¼	
Do. 4% Deb. Red.	Stock	4	4%	94—98	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7½—8½	
Do. 7% Non-Cum. Pref.	5	7	7%	6½—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	⅛—¾	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4%	2¾—2¾	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅝—⅞	
Do. 7% Cum. Pref.	1	7	7%	1⅛—1⅛	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5%	1—2	
Do. 5% Cum. Pref.	5	5	5%	1⅝—2⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7½—8	
Do. 4½% Cum. Pref.	5	4½	4½%	5⅜—5⅝	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	90—92	
Central London	Stock	4	3%	74—77	-6
Do. 4% Preferred	Stock	4	4%	90—92	
Do. Deferred	Stock	4	2%	56—59	-5
Do. 4% Debentures	Stock	4	4%	103— 6	+3
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	2—5	
City and South London Cons.	Stock	2⅝	4¼%	39—41	
Do. 4% Perp. Deb.	Stock	4	4%	100—103	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1896	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11 3d.	¾—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4%	6—6½	
Do. 4% Perp. Deb.	Stock	4	4%	89—92	
Mersey Cons.	Stock	nil	—	1—3	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	¼%	40½—41½	-1
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	75—78	
Do. 3½% Convertible Pref.	Stock	3½	3½%	73—76	
Metropolitan District	Stock	nil	—	13—14	
Do. 6% Perp. Deb.	Stock	6	6%	120—125	
Do. 4% Deb.	Stock	4	4%	73—78	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	23—28	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	39—43	
Whitechapel and Bow 4% Deb.	Stock	4	4%	103—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-*	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	⅛—⅜	
Do. 4½% Deb. Red.	Stock	4½	4½%	85—90	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1⅜—1⅝	+⅛
Do. 6% Cum. Pref.	10	6	6%*	4⅜—4⅝	+¼
Do. 5% Perp. Deb.	Stock	5	5%	92—97	
Do. 4½% 2nd Deb.	Stock	4½	4½%	75—79	
City of Birmingham Trs. Co., Cm. Pf.	5	5	5%	4¼—4⅜	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	97—100	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. * = Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%	%		
Dublin United Trams Co.	10	6	6%*	12¼—13½	
Do. 6% Pref.	10	6	6%	12⅝—13⅝	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	93—96	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅞—1⅜	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	1⅝—1⅞	
London United Trs., Ld., Cm. Pf.	10	5	5%	7¼—8½	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—86	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅛—⅜	
Do. 5% Cum. Pref.	1	5	5%	1⅛—1⅜	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	95—98	
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—½	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	⅛—⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—½	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	4%	⅛—¼	
Do. 5% Cum. Pref.	1	5	5%	⅛—⅜	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3¾	4%	4⅜—5⅛	
Do. 6% Cum. Pref.	10	6	6%	9¼—10½	
South Met. Elec. Trams & Ltg. Co. Ltd. 6% Cm. Pf. (fully paid)	1	—	6%	¾—1	
Do. 4% Deb. Red.	Stock	—	4%	77—81	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	76—81	
Yorkshire (West Riding) Elec. Trams	5	nil	—	¾—1⅜	
Do. 6% Cum. Pref.	5	nil	—	3¼—3⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	59—62	
Do. 6% Pref. Crd.	Stock	6	30/-*	104—105	
Do. Def. Ord.	Stock	1¾	1¾	16½—17	
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3—3½	
Do. 10% Cum. Pref.	5	10	10%	8—9	
Do. 4½% Debs.	50	4½	4½%	100—103	
Direct United States Cable Co. Ltd.	20	4¼	4/-*	13⅜—14½	+⅛
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red	100	4½	4½%	100½—102½	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	101—103	+½
Do. do. (Mauritius Sub.)	25	4	4%	100—102	+½
Eastern Ext. Australasia & China	10	7	7/6	12⅜—13½	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	100½—102½	
Eastern Telegraph Co.	Stock	5⅜	7%	131—136	
Do. 3½% Pref.	Stock	3½	3½%	84½—86½	
Do. 4% Mort. Deb.	Stock	4	4%	100½—102½	
G. N. Tel. Co. (Copenhagen)	10	20	20%	28—30	
Indo-European Telegraph Co. Ltd.	25	13	65/-	54—57	+1½
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅞—1⅛	-1/16
National Telephone Co., Ltd., Pref.	Stock	6	6%	108½—110½	
Do. Deferred	Stock	5½	6%	113—115	
Do. 6% Cum. 1st Pref.	10	6	6%	10½—12½	
Do. 6% Cum. 2nd Pref.	10	6	6%	10½—12½	
Do. 5% 3rd Pref.	5	5	5%	5⅛—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	99½—101½	
Do. 4% Deb. Red.	Stock	4	4%	102½—104½	
Western Telegraph Co., Ltd.	10	7	7%	13⅜—13⅝	
Do. 4% Deb.	Stock	4	4%	101—103	+½
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	1/16—⅛	
Do. 6% Cum. Pref.	1	6	6%	1/16—⅛	
Babcock & Wilcox, Ord.	1	20	1/7½*	3⅛—3⅜	+1/16
Do. 6% Pref.	1	6	7½d	1⅜—1⅝	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	5¾—6¼	
Do. 6% Cum. Pref.	5	6	6%	5¾—6¼	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	93—98	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	1/16—1⅛	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	1/16—1/8	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	70—75	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	55—60	
Callender's Cable and Const. Co., Ld.	5	15	15/-	9¼—10⅛	-¼
Do. 5% Cum. Pref.	5	5	5%	5¼—5⅜	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	107—109	
Consolidated Electrical Co., Ltd.	1	3	3½%	⅜—½	
Crompton & Co., Ltd.	3	5	5%	1⅜—1⅝	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1¼—1⅜	+1/16
Do. 6% Cum. Pref.	1	6	6%	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
Edison & Swan United "A," £3 paid	5	4½	2/6	⅜—½	
Do. do. (fully paid)	5	4½	4/2	1¼—2⅛	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	¼—½	
Do. 7% Cum. Pref.	2	7	—	1¼—1⅝	
Do. 4% 1st Mort. Deb.	Stock	4	4%	63—67	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8¼	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10¾—11½	
Do. 4½% Cum. Pref.	5	4½	4½%	5—5⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	104—106	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	30½—32½	+⅜
Do. 4% Deb. Bds. Red	100	4	4%	102—104	+½
Willans & Robinson, Ord. Shres	1	nil	5%	⅜—1⅛	
Do. 6% Cum. Pref.	5	nil	6%	3½—3⅝	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	70—74	

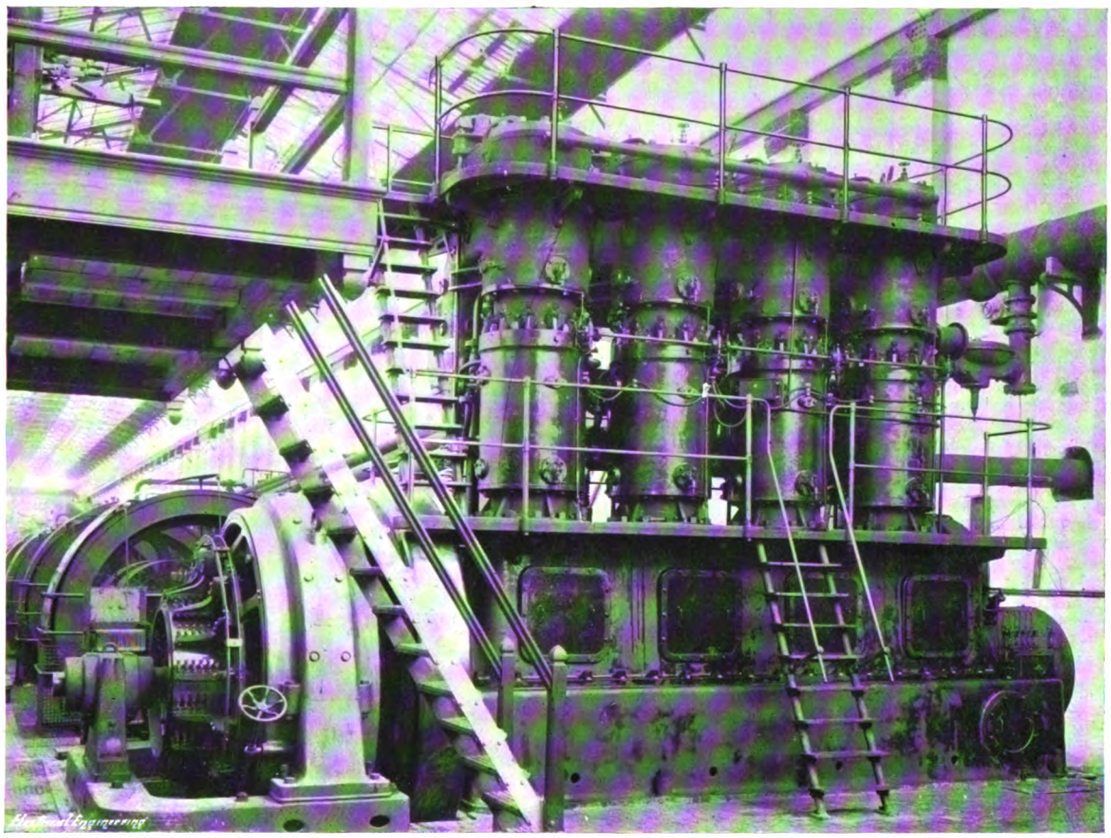
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A LARGE VERTICAL WESTINGHOUSE GAS ENGINE

THE accompanying illustration represents a 1,000-h.p. vertical eight-cylinder four-crank tandem vertical gas engine, which has just been erected at the works of the Castner-Kellner Alkali Co., Ltd., Runcorn, and was started up by Mr. Percy Allen, engineer to the company, on June 6th. The engine, which is of the latest standard vertical type, was supplied by the British Westinghouse Co., and is connected to a direct-current generator, supplied by the same makers. It forms an extension to the existing installation at Runcorn, where four 750-B.H.P. engines of the same make have been in operation for some considerable time in connection with the electrolytic process of the above firm. The cylinders, in pairs, are placed over four cranks, by which arrangement the makers claim that they can give the most even turning moment of any gas engine on the market. In these engines, with several cylinders of small size, water cooling is not required for the pistons, valves, or other moving parts, and the danger of breakage of pistons, which is occasionally a source of trouble in connection with large horizontal engines, is avoided. Forced lubrication is used throughout. The oil-pumps are in duplicate, and are so arranged that they can be examined and the oil-sieves changed whilst the engine is in operation. The valve-gear is very simple. All valves are positively operated by means of straight push-rods actuated directly from the camshaft. These are also arranged with adjustable screws, so that any play or wear can be taken up on these valves whilst the engine is in operation.

It is pointed out by the makers that this particular engine marks an epoch in the gas-engine industry, as it is the largest vertical gas engine yet manufactured and put into successful operation.

In addition to the five Westinghuose engines of this type now installed at the Castner-Kellner works, three of 750-B.H.P. capacity have been supplied to Messrs. Pilkington Bros., St. Helens, for their glass works, one of 750 B.H.P. to the Hollis Mill Co., Marple, which has been working for some considerable time, and visitors to the Franco-British Exhibition will have noticed one of these large engines in the right-hand corner of the Machinery Hall. Those who are interested in gas-engine work should take advantage of the opportunity thus afforded of inspecting an example of a type entirely British both in design and manufacture, presenting several features worthy of study which distinguish it from other designs of gas engine.



1,000-H.P. WESTINGHOUSE GAS ENGINE AT THE WORKS OF THE CASTNER-KELLNER ALKALI CO. AT RUNCORN.

THE KENT COLLIERIES PUMPING PLANT DISPUTE: JUDGMENT

ON Tuesday last, in the Official Referee's Court, Mr. Muir Mackenzie delivered judgment in the claim brought by Messrs. Ernest Scott & Mountain, Ltd, against the Kent Collieries, Ltd., for £3,249, the balance of the contract price of £5,780 for electrical plant supplied, besides money paid by the plaintiffs for wages. The defendants alleged that the plant was not in accordance with the contract, and counterclaimed for £48,000 (see ELECTRICAL ENGINEERING, April 16th, p. 601; May 7th, p. 684; May 21st, p. 798). The Official Referee, in delivering judgment, said that the defendants resisted payment of the greater part of the plaintiffs' claim, because the machinery was not in accordance with the specifications. With regard to the counterclaim, the defendants, he said, were not ready to receive the plant, and that the delay was due to the fact that the appliances provided for dealing with the plant were not strong enough. No claim for damages due to delay could therefore be considered. As the defendants had decided to work one pump at a time instead of two alternatively as the plaintiffs had advised, they could not recover losses due to breakdown unless the breakdown was due to the plaintiffs. The motors were, according to the specification, designed for giving the stated output for six hours continuously, and not indefinitely. The generators, he found, were not according to the specifications. They had an output of 255 kw. instead of 300 kw., and consumed 38 lb. of steam per kw. hr. instead of 28 lb. For this the defendants were entitled to compensation. He could not make the extra cost of fuel a basis for the compensation, but would take as a basis the difference between the value of the machinery as delivered and that specified. He awarded the plaintiffs £2,943 as the balance of the contract price. On defendants' counterclaim he found that they were entitled to £417 on account of the failure of the machines to comply with the specifications, and a further sum of £700 for damages, making a total of £1,117. Deducting this from £2,943, he gave judgment for the plaintiffs for £1,826. As the defendants had succeeded in some of the issues, the costs would be divided.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published June 18th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

9,397, S. DE PONT. A hard, non-inflammable, water- and oil-resisting insulating material, consisting of 50 per cent. plaster of Paris, 30 per cent. wood pulp, 15 per cent. copal, 15 per cent. pitch, 13 per cent. lampblack, 8 per cent. clay, and smaller percentages of cowrie or lac, wax, aniline, and mica. The mixture is dried, treated with bisulphide of carbon, or benzoline, and then rolled between steam rollers at a temperature of 120° to 180° F. The product is moulded at a temperature of from 250° to 300° F., and then subjected to a pressure of from 3 to 4 tons per cubic inch of the material. The final product is quite hard, and can be sawn or turned like vulcanite. One claim.

13,285, G. ELLISON. A combined starting rheostat (for the rotor circuit), overload cut-out, and no-voltage release for three-phase induction motors. The solenoid of the overload cut-out is in one phase of the rotor circuit, and the solenoid of the no-voltage release is in one phase of the stator circuit. The overload cut-out operates by opening the circuit of the no-voltage release solenoid, which in turn releases the starting handle, which is pulled round to the off position by a spring. In the case of high voltages the no-voltage release solenoid would be operated from a small transformer. The arrangement is applicable to single-phase motors. Five claims, three figures.

18,245, R. B. RANSFORD (*Compagnie Parisienne des Voitures Electriques, procédés Krieger*). A method of control for petrol-electric vehicles. A compound generator is used, which has only a weak shunt excitation sufficient to keep the machine excited when the engine is running slowly. A series winding is provided, and also a demagnetising series winding, which, during normal running, is short-circuited. When this last winding is in circuit it more than neutralises the ordinary series winding, and the voltage of the generator is so much reduced that the motors receive practically no current. This affords a means of stopping the motors without breaking the main circuit. The motors can be pure series motors, or can also be supplied with a shunt winding across the armature brushes. Five claims, three figures.

1908 Patents

66, G. M. LITTLE. A magnetite arc-lamp electrode for use with alternating current, and consisting of 60 parts magnetic oxide of iron (Fe_3O_4) to form the main conducting material, 27 parts of titanium oxide (TiO_2), 6 parts of ferrous chromite (Cr_2O_3, FeO) for preventing rapid consumption of the electrode, 20 parts of potassium silicate (K_2SiO_3) for obviating the unsteadiness and flickering of the arc, and 5 parts of calcium fluoride (CaF_2) for increasing the luminosity of the arc. For this last purpose, salts of strontium, barium, or magnesium can also be used. Six claims.

665, A. P. STROHMENGER. A material for separating or enclosing the plates of secondary batteries. A cellulose fabric, such as ordinary muslin, is coated with pulp cellulose, and the resulting porous sheet is nitrated to a sufficient degree to be unaffected by the acid electrolyte. The finished material, which is porous and sufficiently strong to resist cracking, tearing, or abrasion in actual use, is either wrapped round the plates or merely interposed between them, effectually preventing short circuits through dislodgment of the active material. One claim.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1907 Patents

10,072, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric motor control systems.
10,293, COLLINS, HAYES & WATSON. Trolley heads.
12,353, AUSTIN. Receivers for wireless telegraphy.
12,406, SEDGWICK. Signalling apparatus.
12,407, GRANT (*Haggarty*). Ships' telegraphic apparatus.
12,578, HEYLAND. Self-regulating machines for alternating or direct current.
12,857, TONRY. Ball and socket joints for electric light fittings.
12,969, HELLMANN. Synchronous working of apparatus.
13,032, EASTWOOD. Systems for electric railways.
14,572, HAYWOOD, AND MCKENZIE & HOLLAND, Ltd. Electrically detecting the position of the switch tongues and locking bolts of railway points.
18,013A, KESSLER & JELICH. Contact arrangement and stand for electric lamps.
18,308, ELLISON & JACOBS. Telephonic apparatus.
19,073, FUSSER. Supports for electric lamps.
19,447, MOORE. Automatic time switch mechanism.
19,734, GROSS. Arc lamps.
20,119, MARCONI & MARCONI'S WIRELESS TELEGRAPH CO. Transmitters.
24,753, SIEMENS BROS. & CO. (*Siemens & Halske Akt.-Ges.*). Means for rectifying alternate currents.
25,206, HARRISON (*Electric Railway Improvement Co.*). Welding.
25,350, ARENAS Y GARCIA. Dynamo-electric machines of the homopolar type.
26,621, CUMONT & COMPAGNIE DE SIGNAUX ELECTRIQUES POUR CHEMINS DE FER. Signal and point mechanism.
27,379, AMALGAMATED RADIO-TELEGRAPH CO. (*Scibt*). Radio-telephony.
28,516, JOHNSON (*Felten & Guilleaume Lahmeyerwerke Akt.-Ges.*). Electrical driving gear for motor vehicles.

1908 Patents

2,488, WOLHAUPTER. Insulated joints for rails.
3,701, POLYPHOS ELEKTRIZITÄTS-GES. Method of transmitting photographs.
4,444, DOWSING. Electrical radiators.
4,621, FRIEDHEIM. Manufacture of heat interchangers by an electrolytic process.
5,225, ALLGEMEINE ELEKTRICITÄTS-GES. Electrodes for arc lamps.
5,610, ALLGEMEINE ELEKTRICITÄTS-GES. Incandescent lamps.
6,050, SIEMENS & HALSKE AKT.-GES. Process for hardening tantalum.
7,910, SIEMENS BROS. & CO. (*Siemens & Halske Akt.-Ges.*). Pyrometers and thermometers.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patents

15,798, KUZEL. Metal filament lamp.
27,608, GEISSINGER. Electric thermostat.

1908 Patents

11,415, NORSK HYDRO-ELEKTRISK KVOELSTOFAKTIESELSKAB. Production of pure sodium nitrite.
11,633, ALLGEMEINE ELEKTRICITÄTS-GES. Alternating-current commutator machines.
11,870, HARTMANN-KEMPF. Apparatus for indicating the frequency of electrical oscillations.

Applications for Amendment

Further particulars and instructions as to procedure in opposition to amendment will be found in the Official Journal of the Patent Office of June 17th, 1908.

23,899 of 1904. THE WOLFRAM (TUNGSTEN) METAL FILAMENT LAMPS, LTD., seek leave to amend this specification, granted to ALEX. JUST and FRANZ HANAMAN, for "Improvements relating to the manufacture of incandescent lamps," on the ground of doubtful validity of some of the claims. The amendments consist in striking out all reference to molybdenum and limiting the invention to tungsten.

11,949 and 20,175A of 1905; also 3,225, 3,684, and 4,081 of 1906. THE WOLFRAM (TUNGSTEN) METAL FILAMENT LAMPS, LTD., seek leave to amend these specifications, granted to Alex. Just, F. Hanaman, and others, for the same reason as stated above with reference to No. 23,899 of 1904.

Expiring Patents

The following patents expire during the current week, after a life of fourteen years :—

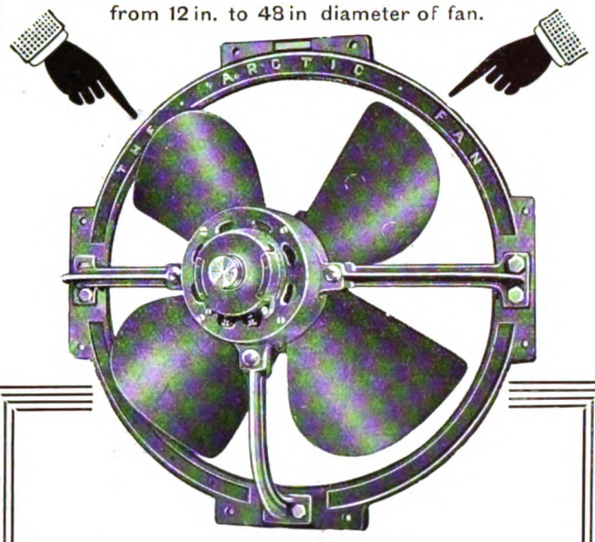
12,407 of June 26, 1894. H. A. TAYLOR. An improved form of Wheatstone automatic transmitter for submarine telegraphy. The battery contact is prolonged relatively to the earth contact and the durations of these contacts are adjustable.

12,552 of June 28th, 1894. G. H. NISBETT. Sealing and junction boxes for lead-covered cables, for preventing access of moisture to the open ends of the cables. The cables enter the inner chamber of the box through solder glands. The inner chamber is filled with ozokerite or similar material, and the outer chamber contains terminals and fuses.

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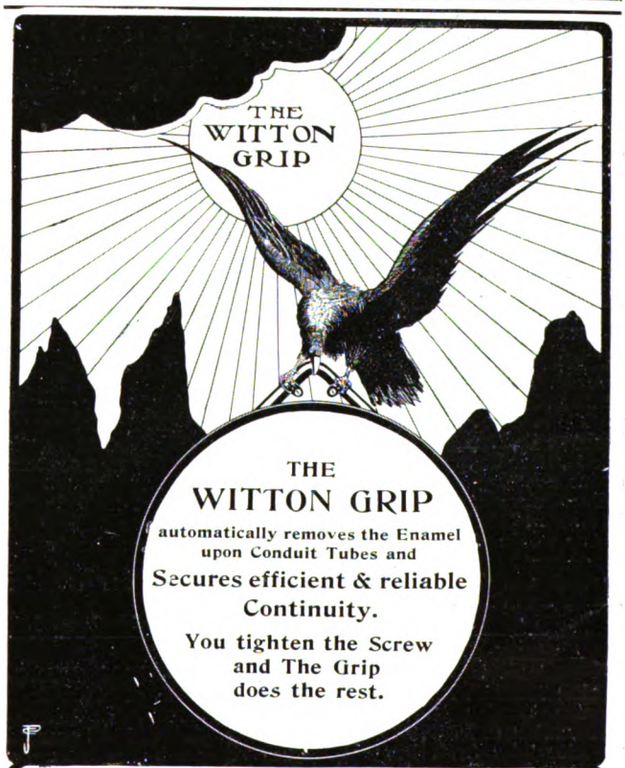
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Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on June 17th, 1908.

Any person, or persons, may give Notice of Opposition to the Amendment (on Patents Form No. 18), at the Patent Office, 25 Southampton Buildings, London, W.C., within one calendar month from the date of the said Journal.

C. N. DALTON, Comptroller-General.

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Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on June 17th, 1908.

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Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on June 17th, 1908.

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Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on June 17th, 1908.

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Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on June 17th, 1908.

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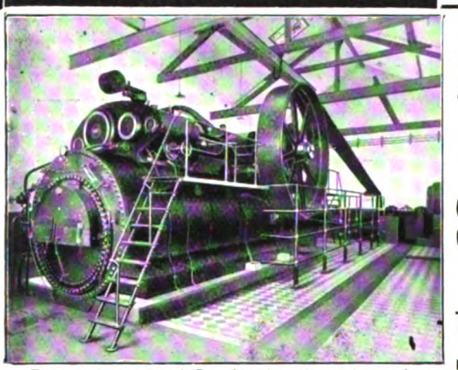
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Corporation Electricity Works,
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Liverpool.

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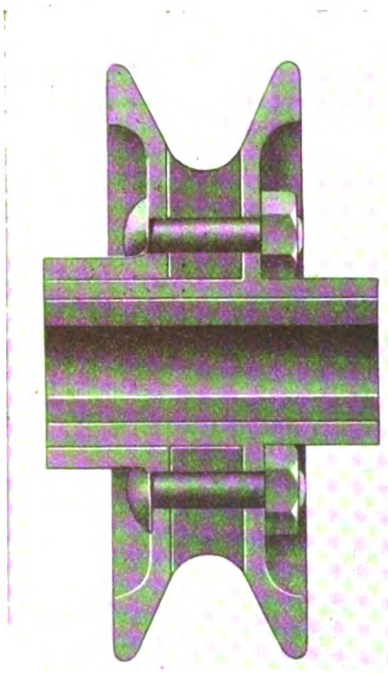
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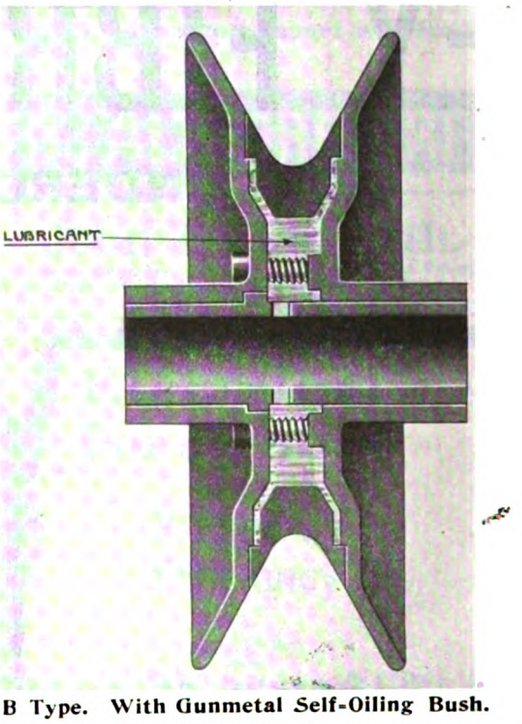
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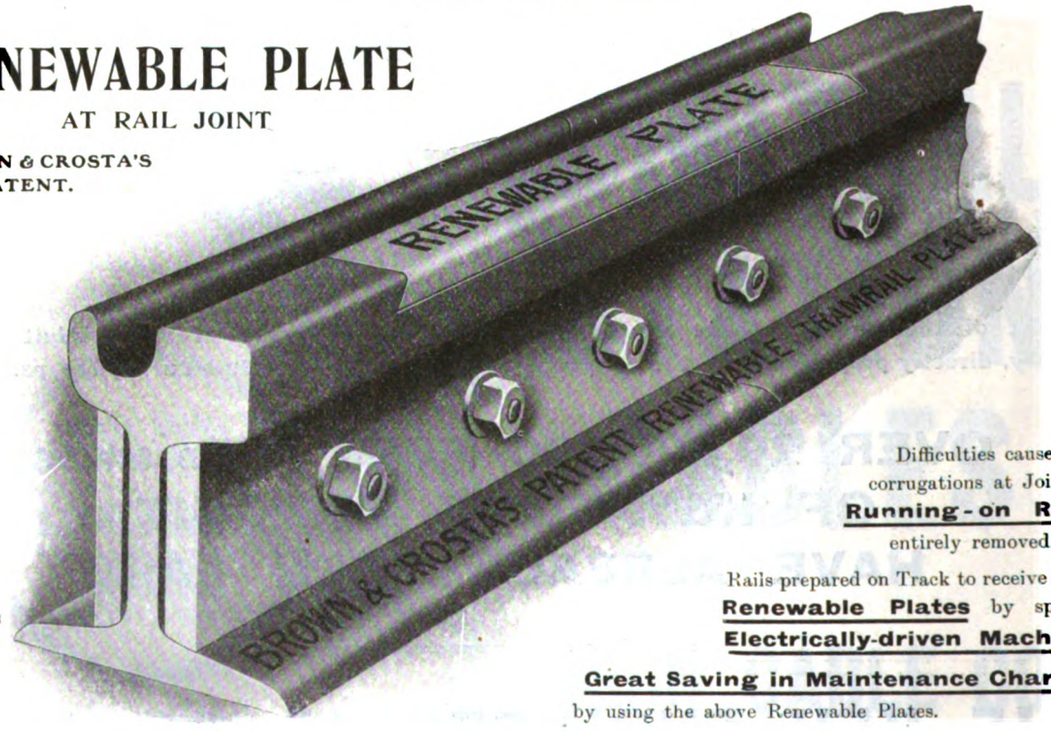
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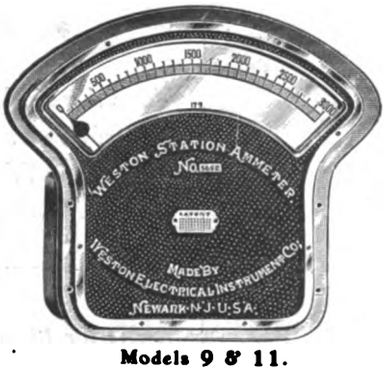
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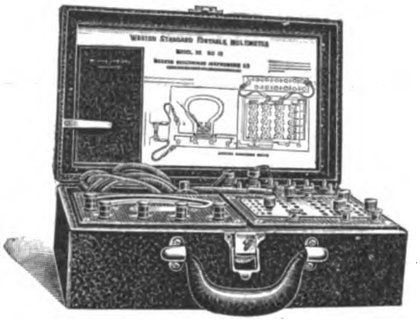
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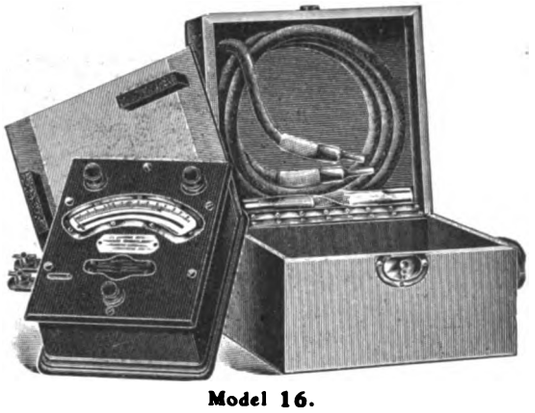
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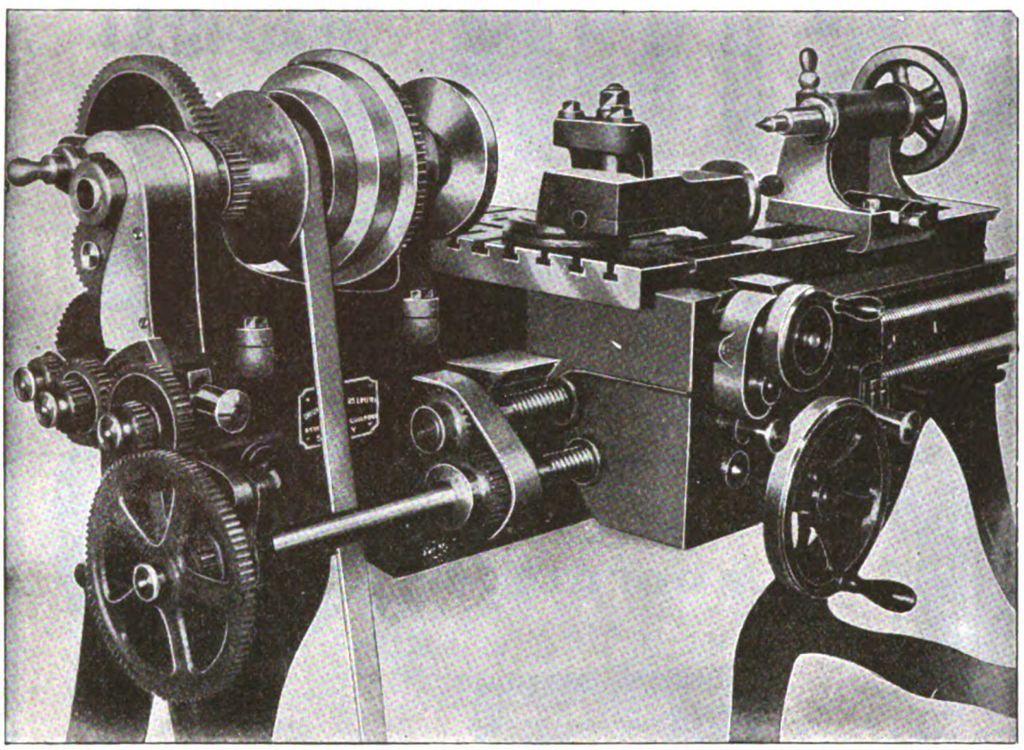
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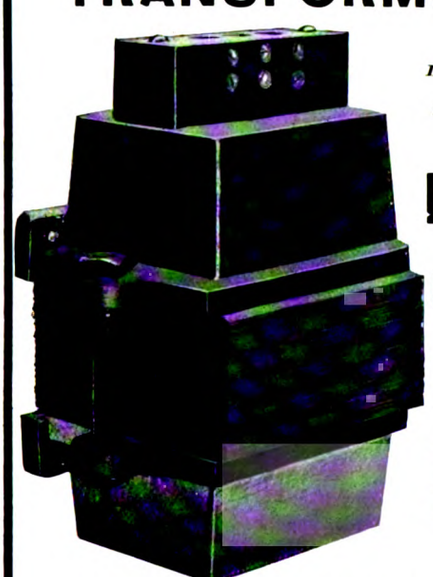
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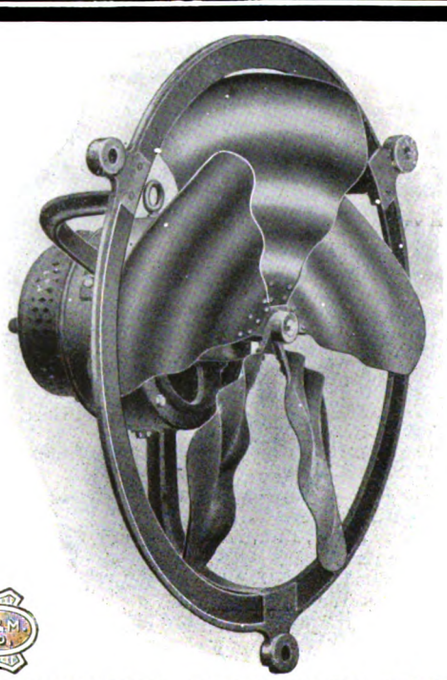
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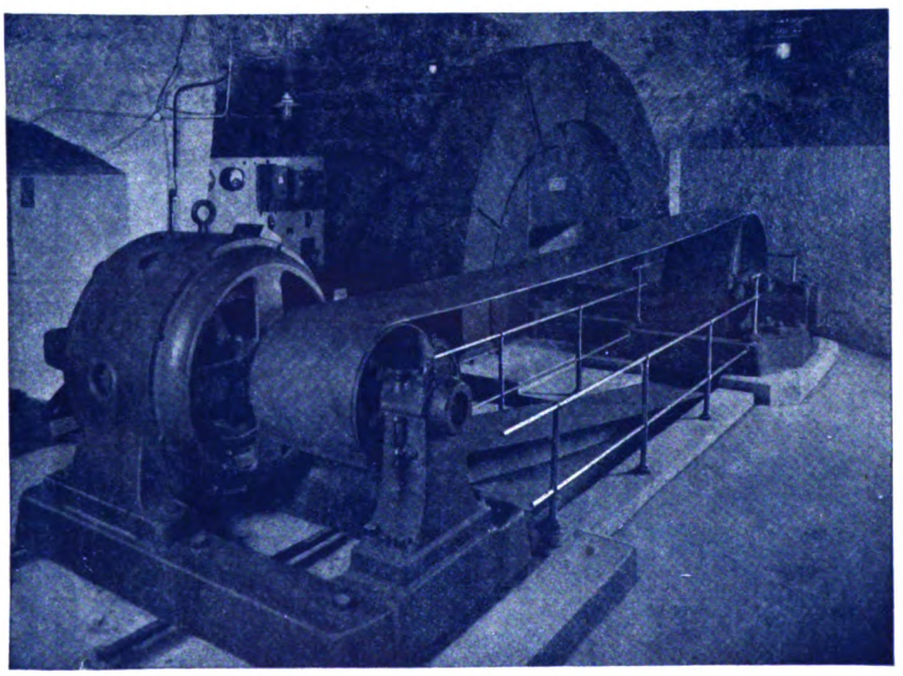
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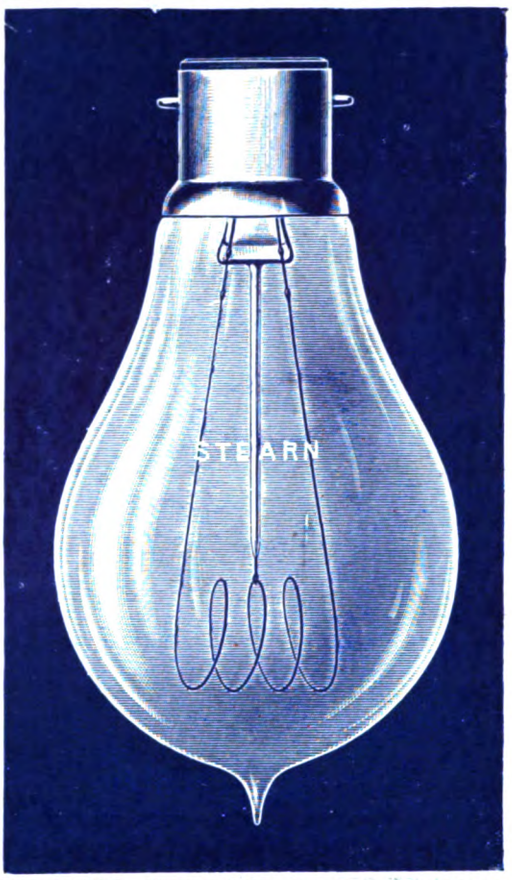
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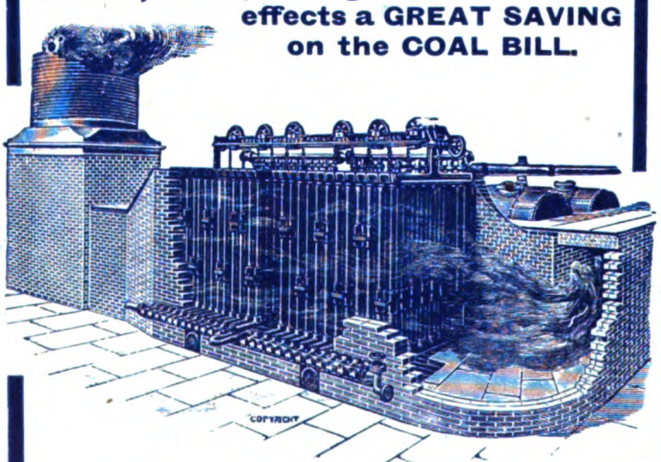
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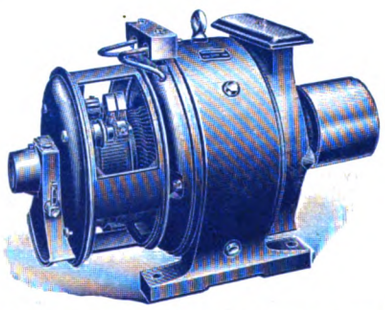
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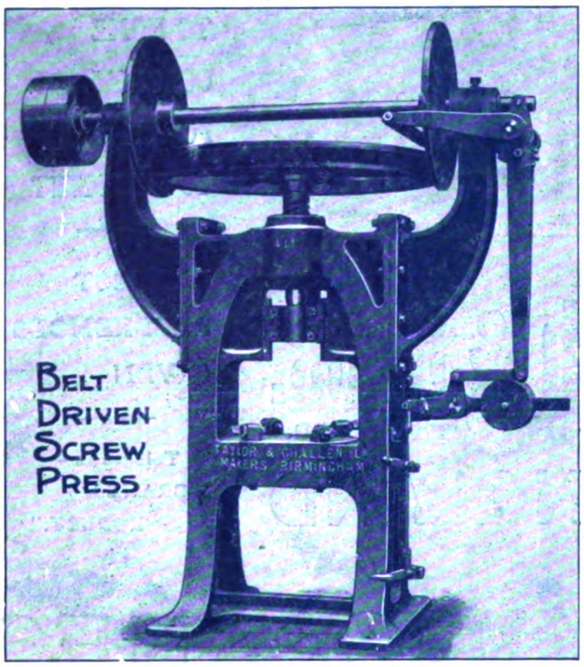
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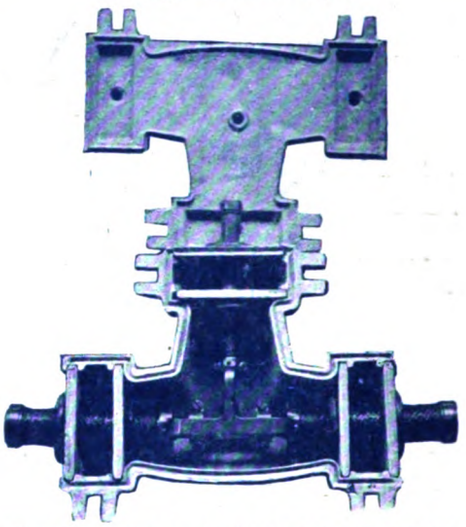
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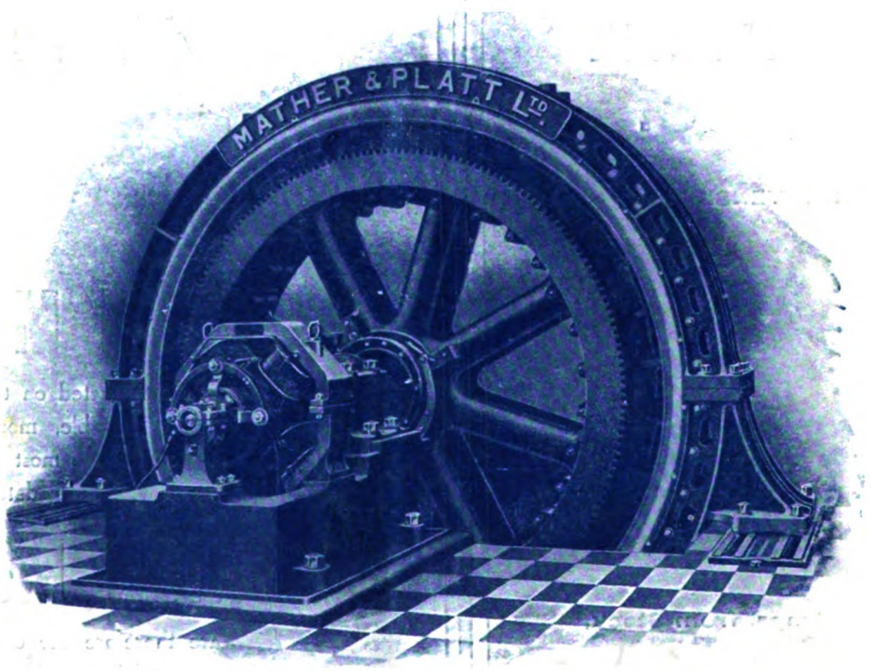
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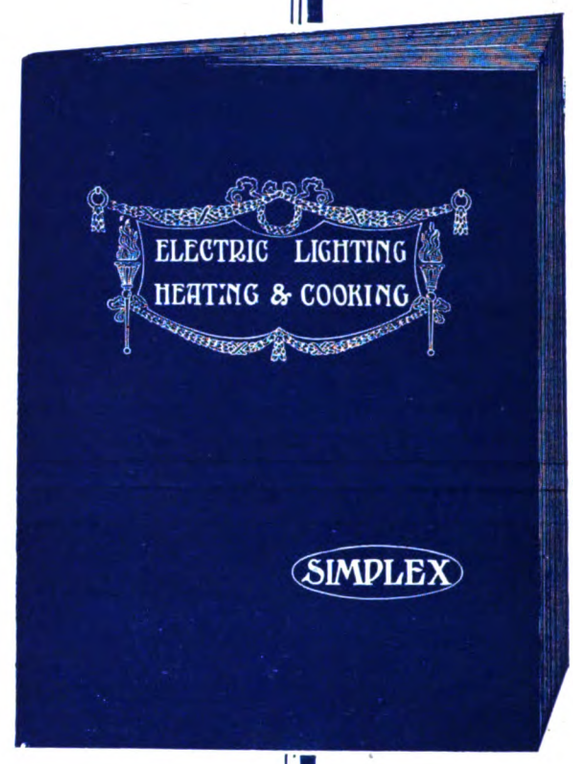
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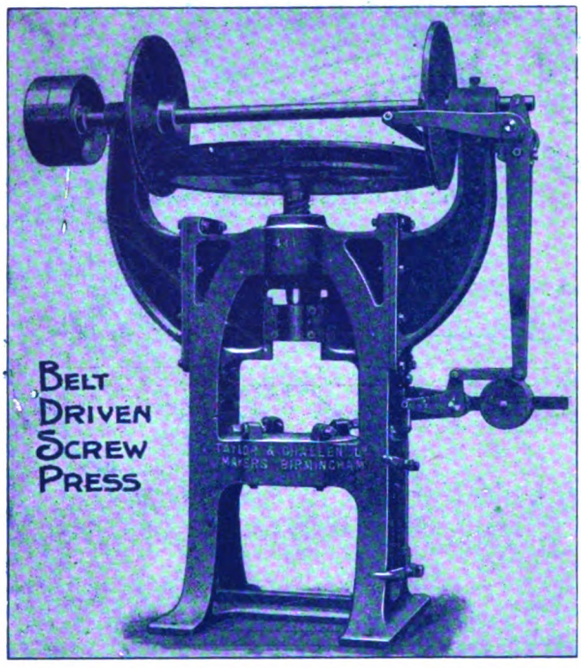
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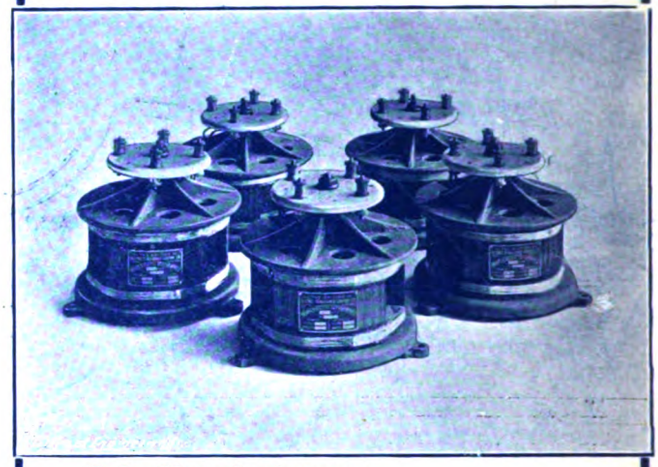
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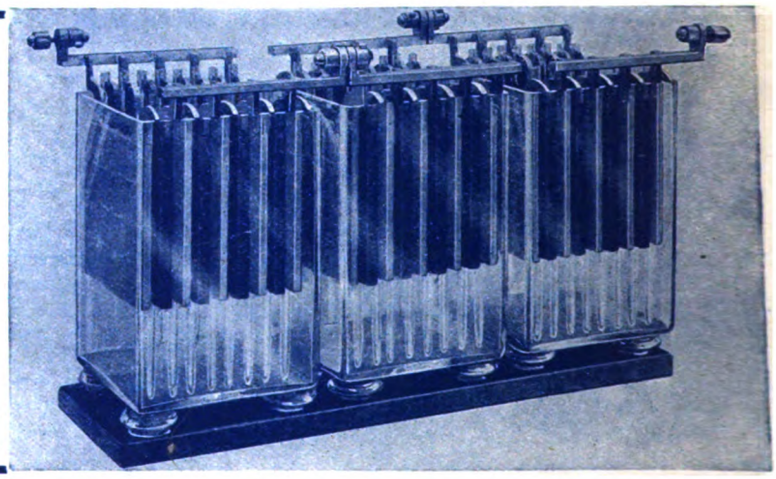
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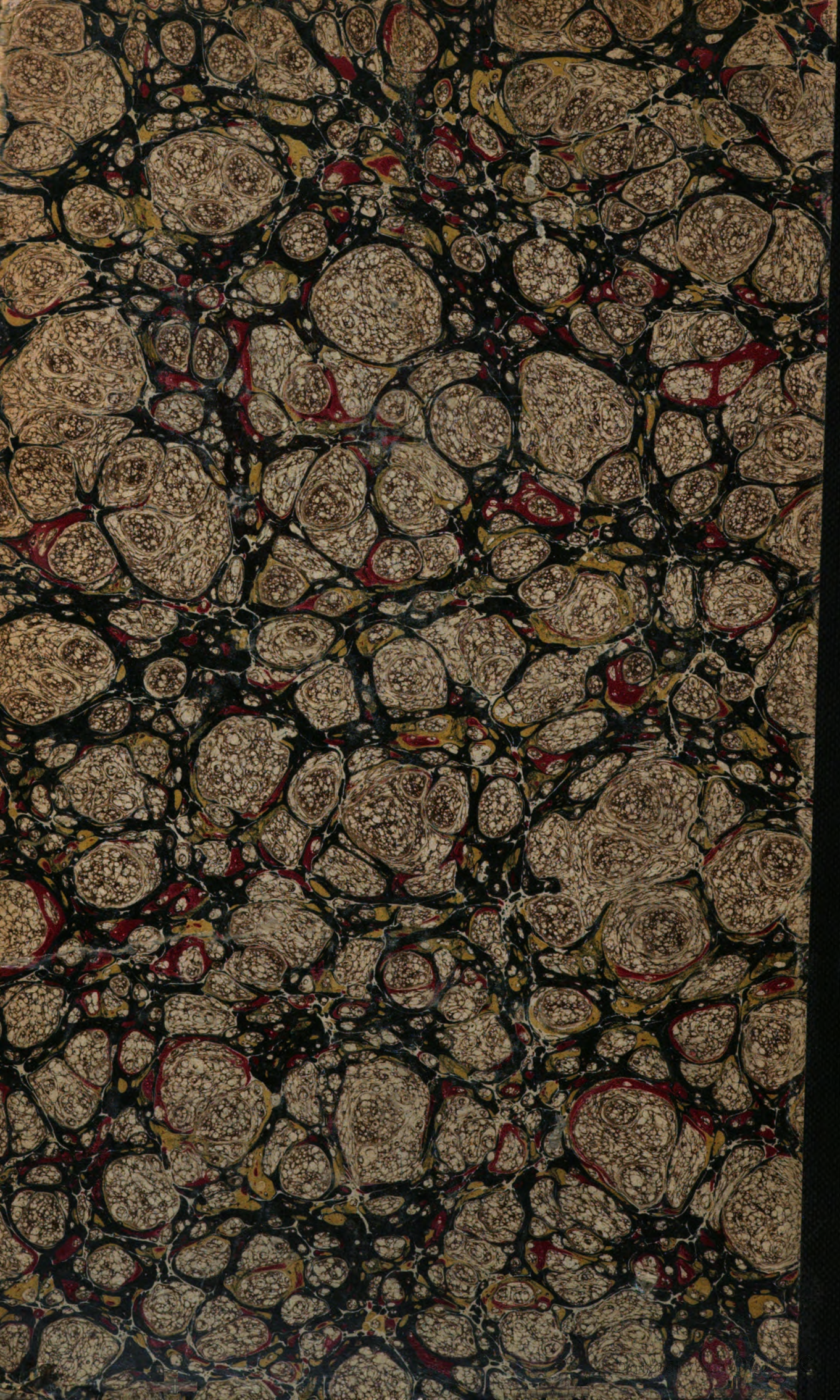
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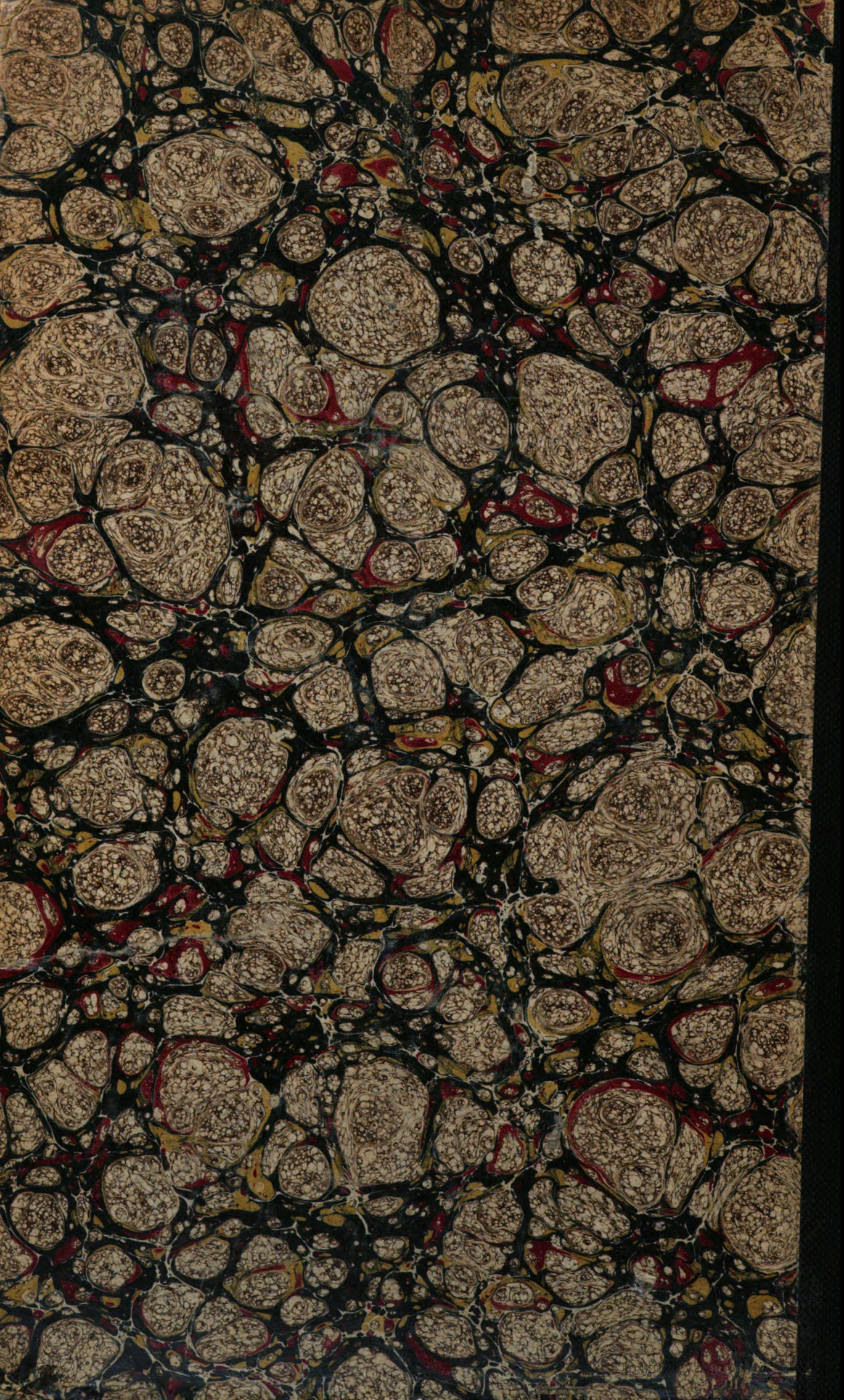
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The Annual Staff Dinner.
The Main Object of a Telephone Society. By C. E. Fenton.
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Dear Sirs,

In reply to your letter of the 4th inst., we beg to inform you that we tested three "METALIK" lamps 220 volt, 50 c.p. in a sloping position burning with alternating current. These lamps were burning continually without switching in and out more than about once every 100 hours. The life of the first lamp was 970 hours, of the second 1856 hours, while the third lamp is already burning 2,775 hours, and is *still in good condition*. The light of the lamps is not materially less than as they were new. The blackening of these lamps is practically so slight that we may say there is no blackening.

We also tested five lamps in our laboratory on direct current. These lamps showed the same behaviour as the above mentioned three lamps; they have not yet burned more than about 300 hours. The candle power was, new, 40 Heffner [35 British C.P.], and is steadily increasing, so that it is now 49 Heffner [43 British C.P.] after 250 hours; the consumption is constant 58 watt. These lamps are switched in and out about every 10 hours.

Electricity Offices .....

Messrs. G. M. Boddy & Co.,
Liverpool. *March 9th*, 1908.

Dear Sirs,

Some time ago we had two sample 50 c.p. "METALIK" Lamps from you for testing purposes. These lamps had an average life of 1407 hours, and would have run longer had not the filaments become shorted by twisting.

It is our opinion that the supporting arrangements of all lamps of this class should have more consideration, as in all the lamps tested by us failure has generally been the result of partial shorting of the filament in the first case.

We shall be glad to have your best price for the supply and delivery carriage paid at our .....Stores of "METALIK" lamps in the 32 c.p. size suitable for series burning on a 230 volt direct current circuit.

Yours faithfully,

.... *City Electrical Engineer.*

Corporation Electricity Works,

Messrs. G. M. Boddy & Co.,
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Dear Sirs,

In reply to yours of the 27th inst., so far your "METALIK" lamps have been burning very satisfactorily and shall be obliged if you will quote me your best price for 100 lamps, as we shall probably be wanting some more before long.

Yours faithfully,

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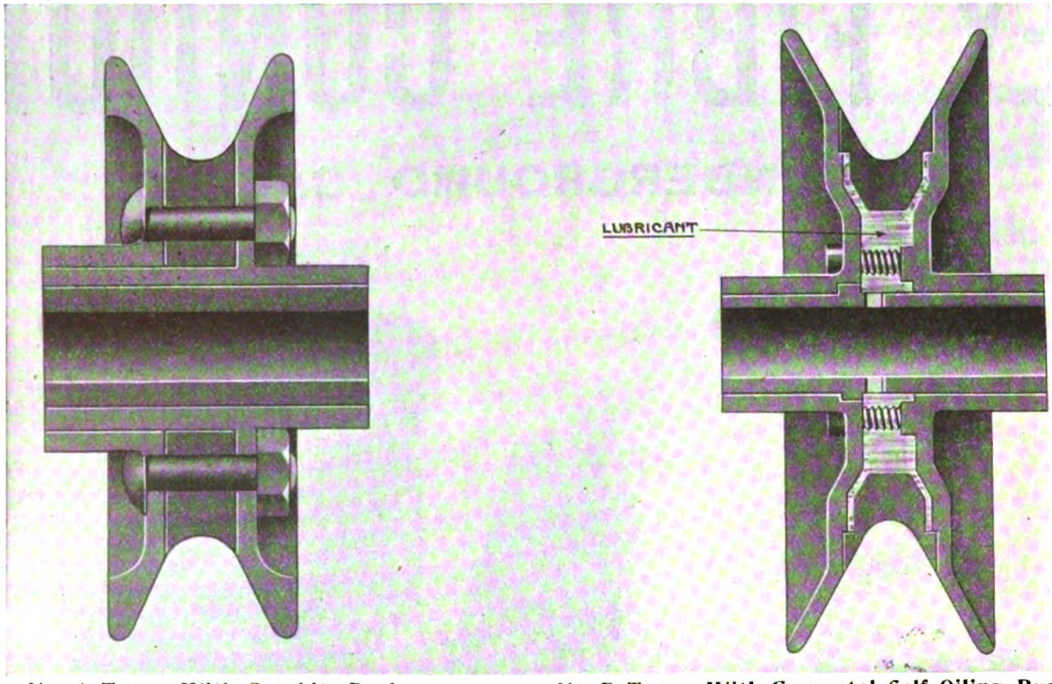
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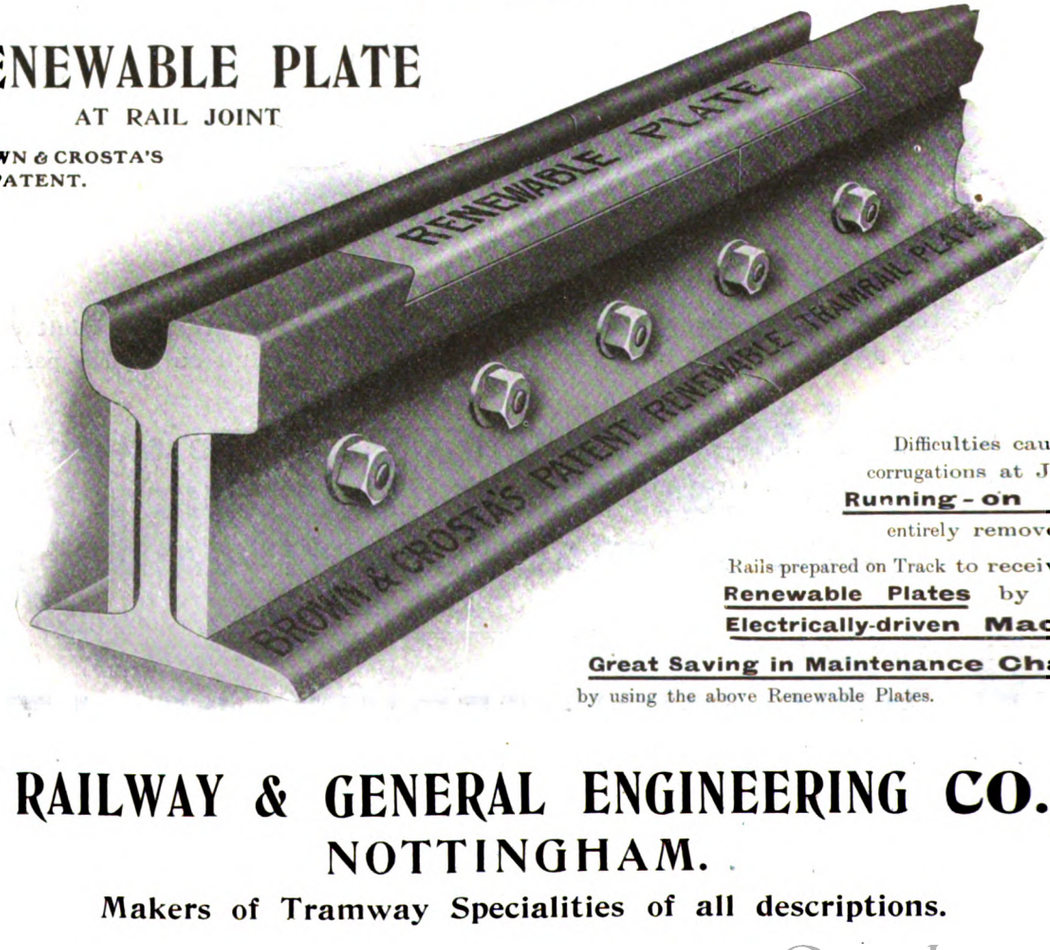
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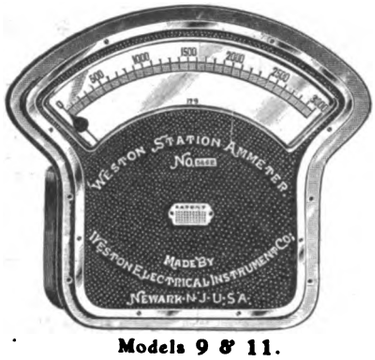
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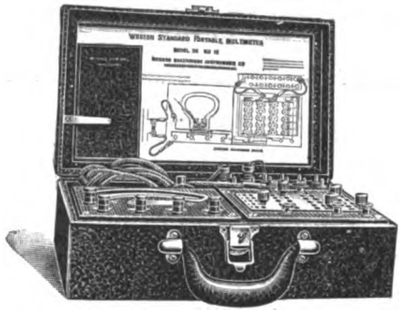
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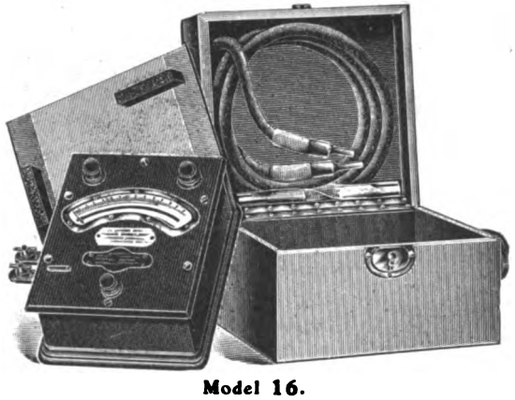
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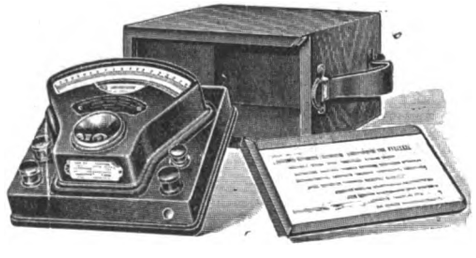


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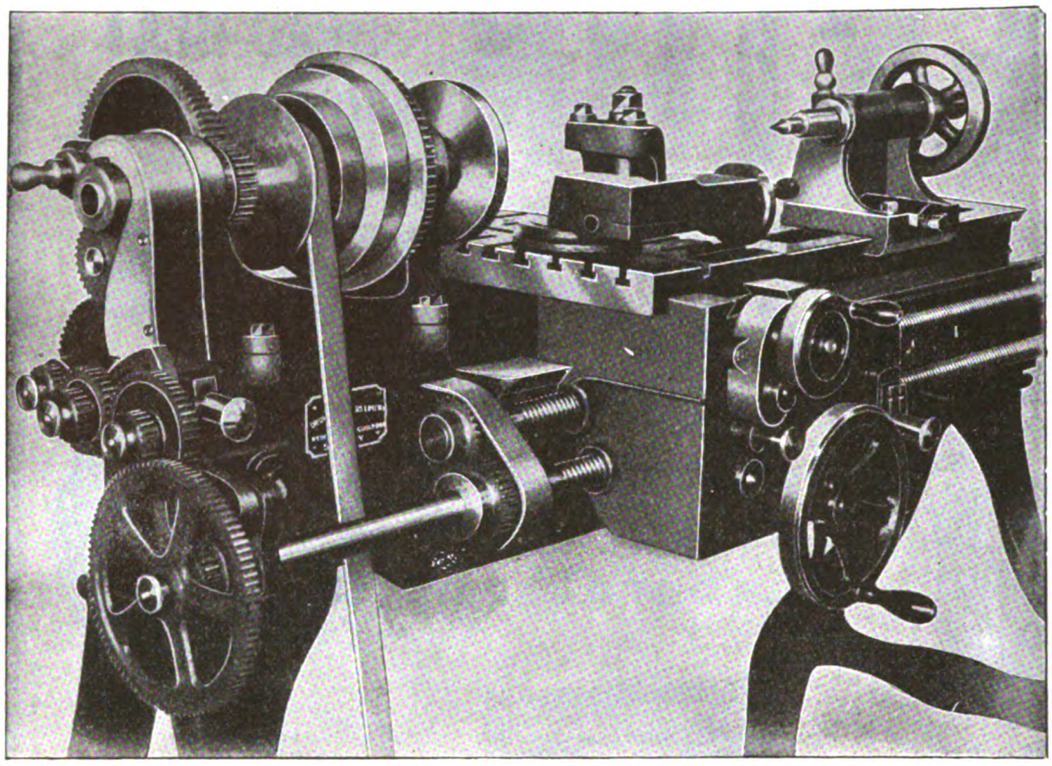
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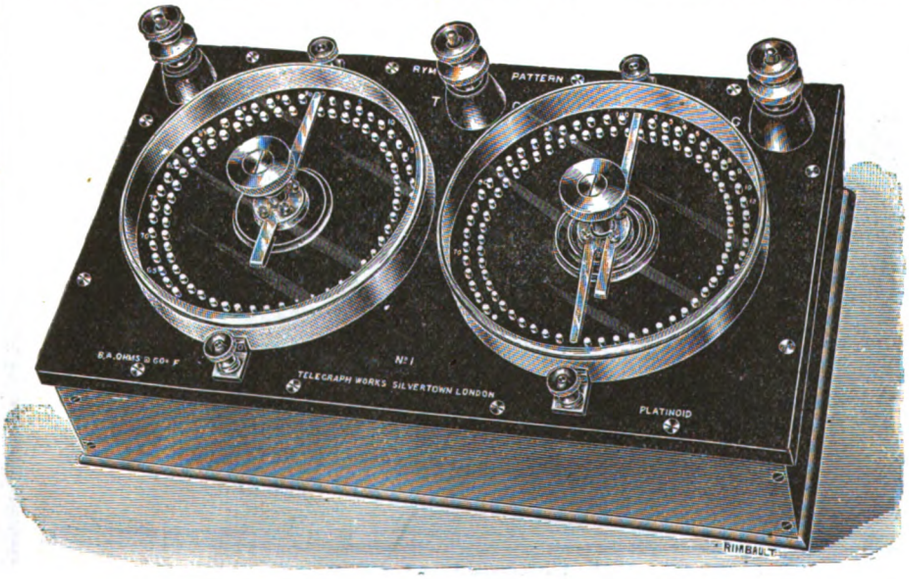
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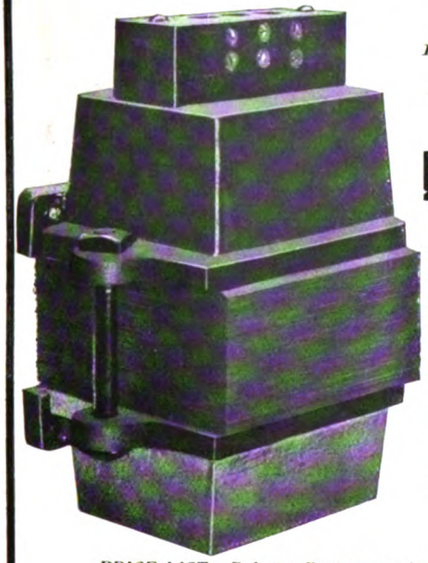
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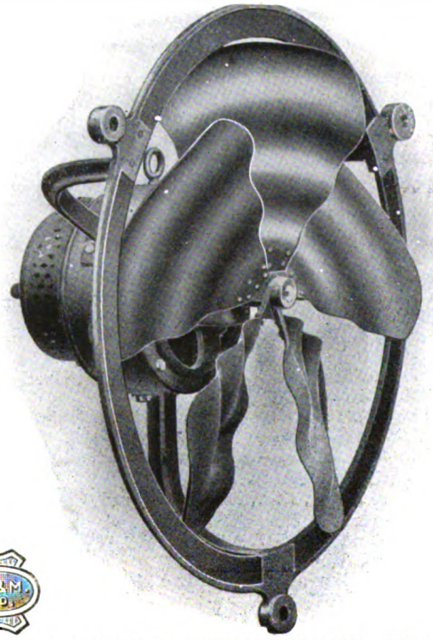
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Do. 4½% Debenture, Red.	Stock	4½	4½%	102—105	
Bromley (Kent) E. L. & Power Co., Ltd.	5	5⅛	5½%	4⅛—5	
Do. 4½% 1st Deb. Red.	Stock	4½	4½%	94—97	
Brompton & Kensington E. S. Co., Ltd.	5	10	10%	6⅜—7¼	
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Central E. S. Co., Ltd., 4% Guar. Db.	Stock	4	4%	98—101	
Ch. Cross, W. E. & City E. S. Co.	5	5	5%	3⅜—4⅛	
Do. 4½% Cum. Pref.	5	4½	2½%	4⅛—4⅜	
Do. 4% Deb. Red	Stock	4	4%	95—98 xd	
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Chelsea Electric Supply Co., Ltd.	5	4½	4½%	3—3½	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
City of London Elec. Lt. Co., Ltd.	10	6	6%	9½—10½	
Do. 6% Cum. Pref.	10	6	6%	12—13	
Do. 5% Deb. Red	Stock	5	5%	124—127	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	102—105	
City of Durham E. P. Dis. Co.	5	4	2%	2½—3	
Do. 5% Pref.	5	5	5%	3¾—4¼	
County of London Elect. Sup. Co. Ld.	10	5	5%	7⅜—8¼	
Do. 6% Cum. Pref.	10	6	6%	10⅜—10⅝	-⅛
Do. 4½% Deb. Red	Stock	4½	4½%	107—110	
Do. 4½% 2nd Deb. Red	Stock	4½	4½%	98—101	
Edmunson's Electricity Corp., Ltd.	5	4	1/6*	⅛—⅜	
Do. 6% Cum. Pref.	5	3½	—	¾—1	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	63—73	
Folkestone Elec. Supply Co., Ltd.	5	5½	5½%	4¾—5¼	
Do. 5% Cum. Pref.	5	5	5%	5—5½	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	94—97	
Hove Electric Lighting Co., Ltd.	5	9	8½%	6—6½	
I. of Wight E. L. & P. Co., Db. Rd.	Stock	4½	4½%	90—93	
Kensington & Knightsbridge E. L. Co.	5	10	10%	7—8	
Do. 4% Deb. Red	Stock	4	4%	96—99	
Kens. & N'tng Hill E. L. Cos. Db. Rd.	Stock	4	4%	97—101	
London Electric Supply Corporation	3	4	2⅔%	⅞—1⅜	
Do. 6% Pref.	5	6	6%	4½—4⅝	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	89—92 xd	
Metropolitan Elec. Supply Co., Ltd.	5	5	6⅔%	4⅝—5	
Do. 4½% Cum. Pref.	5	4½	4½%	4½—5	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	107—111	
Do. 3½% Mort. Deb. Red	Stock	3½	3½%	85—90	
Midland E. Corp. for P. Dist. 1st Mt. D.	100 & 500	4½	4½%	95—99	
Newcastle & Dist. E. L. Co., £9 paid	10	5	4%	7⅜ 8½	
Do. 4½% Mort. Deb. Red	Stock	4½	4½%	96—99	
Newcastle-upon-Tyne Elec. Supply.	5	5	5%	5½—6	
Do. £2 Pm.	5	8	8%	5½—6	
Do. 5% Pref. (fully paid)	5	5	5%	5¼—5½	
Do. 10/- Pm.	5	5	5%	5¼—5½	
Notting Hill Elec. Ltg. Co., Ltd.	10	7½	7%	11½—12½	+¼
Oxford Electric Co., Ltd.	5	7	7%	5¾—6¼	
Do. 4% Deb. Red.	Stock	4	4%	94—98	
St. James and Pall Mall E. L. Co. Ltd.	5	10	10%	7¼—8¼	
Do. 7% Non-Cum. Pref.	5	7	7%	6¾—7¼	
Do. 3½% Deb. Red.	Stock	3½	3½%	85—90	
Smithfield Mkt. Elec. Sup. Co., Ltd.	5	nil	—	1¼—3	
Do. 4% Deb. Red	Stock	4	4%	70—74	
South London Elec. Sup. Corp. Ltd.	5	3	4%	2¼—2¾	
South Metropolitan E. L. & P. Co.	1	2½	1/-	⅝—⅝	
Do. 7% Cum. Pref.	1	7	7%	1⅛—1⅝	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	99—102	
Urban Elec. Supply Co., Ltd.	5	5	5%	1—2	
Do. 5% Cum. Pref.	5	5	5%	1⅝—2⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	87—90	
Westminster Elec. Sup. Corp., Ltd.	5	12	10%	7⅛—8	
Do. 4½% Cum. Pref.	5	4½	4½%	5⅜—5⅝	
ELECTRIC RAILWAYS.					
Baker St. & Waterloo 4% Perp. Deb.	Stock	4	4%	90—92	
Central London	Stock	4	3%	74—77	-6
Do. 4% Preferred	Stock	4	4%	90—92	
Do. Deferred	Stock	4	2%	56—59	-5
Do. 4% Debentures	Stock	4	4%	103—106	+3
Ch. Cross, Eust. & Hamp. Pp. Db.	Stock	4	4%	2—5	
City and South London Cons.	Stock	2½	4¼%	39—41	
Do. 4% Perp. Deb.	Stock	4	4%	100—103	
Do. 5% Perp. Pref. 1891	Stock	5	5%	113—116	
Do. 5% Perp. Pref. 1893	Stock	5	5%	112—115	
Do. 5% Perp. Pref. 1901	Stock	5	5%	110—113	
Great Northern & City Pref. "A"	10	4	11sd.	¾—1¼	
Gt. Northern, Piccadilly & Brompton	10	4	4%	6—6½	
Do. 4% Perp. Deb.	Stock	4	4%	89—92	
Mersey Cons.	Stock	nil	—	1—3	
Do. 3% Perp. Pref. Red.	Stock	nil	—	3—6	
Metropolitan Cons.	Stock	1	¾%	40½—41½	-1
Do. 3½% Preference	Stock	3½	3½%	86—89	
Do. 3½% "A" Pref.	Stock	3½	3½%	75—78	
Do. 3½% Convertible Pref.	Stock	3½	3½%	73—76	
Metropolitan District	Stock	nil	—	13—14	
Do. 6% Perp. Deb.	Stock	6	6%	120—125	
Do. 4% Deb.	Stock	4	4%	73—78	
Do. Perp. Extension Pref. (5%)	Stock	nil	—	23—28	
Ass. Ext. Pf. Guar. by U. E. Rs. Co.	Stock	3	3½%	44—48	
Underground Elec. Railways Co. of London 5% Profit Shg. Sec. Notes	Various	5	5%	39—43	
Whitechapel and Bow 4% Deb.	Stock	4	4%	103—106	
ELECTRIC TRAMWAYS.					
Bath Electric Tramways, Ltd.	1	5	1/-	½—¾	
Do. 5% Cum. Pref.	1	5	5%	⅝—¾	
Do. 4½% Deb. Red.	Stock	4½	4½%	85—90	
Birm. & Mid. Trs., Ld. 1st Db. Rd.	Stock	4½	4½%	93—96	
British Electric Traction Co., Ltd.	10	—	—	1⅜—1⅝	+⅛
Do. 6% Cum. Pref.	10	6	6%*	4⅜—4¾	+¼
Do. 5% Perp. Deb.	Stock	5	5%	92—97	
Do. 4½% 2nd Deb.	Stock	4½	4½%	75—79	
City of Birmingham Trs. Co., Cm. Pf.	5	5	5%	4¼—4¾	
City of Birmingham Trs. Co. 4% 1st Mort. Deb.	100	4	4%	97—100	

NAME.	AMOUNT OF SHARE.	DIVIDEND PAID. * = Interim. 1906	1907	STOCK EXCHANGE QUOTATION.	RISE OR FALL SINCE LAST WEEK.
	£	%			
Dublin United Trams Co.	10	6	6%*	12¾—13¼	
Do. 6% Pref.	10	6	6%	12¾—13¼	
Hastings & District E. Tr. Co. Db.	Stock	4½	4½%	93—96	
I. of Thanet E. Tr. & L. Co. Cm. Pf.	5	1¼	—	⅝—1⅛	
Do. 4% Deb.	Stock	4	4%	58—63	
Lancs. Un. Trs., Pr. Lien Db.	Stock	5	5%	91—94	
London Street Tramways Co.	4	4/9	4/6	⅝—¾	
London United Trs., Ld., Cm. Pf.	10	5	5%	7¾—8¼	
Do. 4% 1st Mort. Deb. Red	Stock	4	4%	81—86	
Metropolitan Elec. Trams, Ltd., Def.	1	nil	—	⅜—⅝	
Do. 5% Cum. Pref.	1	5	5%	1⅛—1⅜	
Do. 4½% Deb. Stk. Red.	Stock	4½	4½%	95—98	
National Elec. Construction Co. Ltd.	1	10	2/-	⅜—½	
New General Tr. Co., 6% Cm. Pf.	5	nil	—	¼—⅜	
North Metropolitan Trams Co.	£4 10s.	1/-	1/-*	⅜—½	
Do. 3½% Mort. Deb.	100	3½	3½%	89—92	
Potteries Electric Traction Co. Ltd.	1	4	4%	1¾—2	
Do. 5% Cum. Pref.	1	5	5%	1¾—2	
Do. 4½% Deb. Red	Stock	4½	4½%*	93—96	
Provincial Tramways Co. Ltd.	10	3½	4%	4½—5¼	
Do. 6% Cum. Pref.	10	6	6%	9½—10½	
South Met. Elec. Trams & Ltg. Co. Ld. 6% Cm. Pf. (fully paid)	1	—	6%	¾—1	
Do. 4% Deb. Red.	Stock	—	4%	77—81	
Sunderland Dst. E. Trs. 1st Mt. Db. Rd.	100	5	5%	76—81	
Yorkshire (West Riding) Elec. Trams	5	nil	—	⅞—1⅜	
Do. 6% Cum. Pref.	5	nil	—	3⅝—3¾	
Do. 4½% 1st Deb. Red	Stock	4½	4½%	84—87	
TELEGRAPH AND TELEPHONE					
Anglo-American Telegraph Co. Ltd.	Stock	3⅝	15/-*	59—62	
Do. 6% Pref. Crd.	Stock	6	30/-*	104—105	
Do. Def. Ord.	Stock	1⅜	1%	16½—17	
Commercial Cable Co., 4% Deb. Red.	Stock	4	4%	84—87	
Direct Spanish Telegraph Co. Ltd.	5	4	4%	3—3½	
Do. 10% Cum. Pref.	5	10	10%	8—9	
Do. 4½% Debs.	50	4½	4½%	100—103	
Direct United States Cable Co. Ltd.	20	4½	4/-*	13⅝—14½	+½
Direct West India Cable Co. Ltd., 4½% Reg. Debs. Red.	100	4½	4½%	100½—102½	
Eastern & S. African Ltd., 4% Mt. Deb.	100	4	4%	101—103	+½
Do. do. (Mauritius Sub.)	25	4	4%	100—102	+½
Eastern Ext. Australasia & China	10	7	7/6	12½—13½	
Do. 4% Mort. Deb. Perp.	Stock	4	4%	100½—102½	
Eastern Telegraph Co.	Stock	5⅜	7%	131—136	
Do. 3½% Pref.	Stock	3½	3½%	84½—86½	
Do. 4% Mort. Deb.	Stock	4	4%	100½—102½	
G. N. Tel. Co. (Copenhagen)	10	20	20%	28—30	
Indo-European Telegraph Co. Ltd.	25	13	65/-	54—57	+1½
Marconi Wireless Telegraph Co. Ltd.	1	nil	—	⅞—1⅛	-⅛
National Telephone Co., Ltd., Pref.	Stock	6	6%	108½—110½	
Do. Deferred	Stock	5½	6%	113—115	
Do. 6% Cum. 1st Pref.	10	6	6%	10½—12½	
Do. 6% Cum. 2nd Pref.	10	6	6%	10½—12½	
Do. 5% 3rd Pref.	5	5	5%	5½—5⅝	
Do. 3½% Deb. Red	Stock	3½	3½%	99½—101½	
Do. 4% Deb. Red.	Stock	4	4%	102½—104½	
Western Telegraph Co., Ltd.	10	7	7%	13⅜—13¾	
Do. 4% Deb.	Stock	4	4%	101—103	+½
MANUFACTURING					
Aron Electricity Meter Co., Ltd.	1	nil	—	⅜—⅝	
Do. 6% Cum. Pref.	1	6	6%	⅝—¾	
Babcock & Wilcox, Ord.	1	20	1/7½*	31⅜—31⅝	+⅛
Do. 6% Pref.	1	6	7½d	1⅞—1⅞	
British Insulated & Helsby Cables, Ld.	5	10	10% & bonus	5¾—6¼	
Do. 6% Cum. Pref.	5	6	6%	5¾—6¼	
Do. 4½% 1st Mort. Deb. Red.	Stock	4½	4½%	102—105	
British Thomson-Houston Co., Ltd. 4½% 1st Mort. Deb. Red.	Stock	—	4½%	93—98	
British Westinghouse Electric Mnfg. Co., Ltd., 6% Pref.	5	nil	—	⅛—⅜	
Do. 4% Mort. Deb. Red.	Stock	4	4%	45—50	
Brush Electrical Engineering Co.	2	nil	—	0—⅛	
Do. 6% Pref.	2	nil	—	⅛—⅛	
Do. 4½% Perp. 1st Deb.	Stock	4½	4½%	70—75	
Do. 4½% Perp. 2nd Deb.	Stock	4½	4½%	55—60	
Callender's Cable and Const. Co., Ld.	5	15	15/-	9¾—10½	-¼
Do. 5% Cum. Pref.	5	5	5%	5¼—5½	
Do. 4½% 1st Mort. Deb.	Stock	4½	4½%	107—109	
Consolidated Electrical Co., Ltd.	1	3	3½%	⅝—¾	
Crompton & Co., Ltd.	3	5	5%	1⅝—1¾	
Do. 5% 1st Mort. Reg. Deb.	50 & 100	5	5%	92—95	
Dick, Kerr & Co., Ltd.	1	10	10%	1½—1⅝	+⅛
Do. 6% Cum. Pref.	1	6	6%	1—1¼	
Do. 4½% Deb. Red	Stock	4½	4½%	101—104	
Edison & Swan United "A," £3 paid	5	4½	2/6	⅝—¾	
Do. do. (fully paid)	5	4½	4/2	1½—2⅛	
Do. 4% Deb. Red.	Stock	4	4%	78—81	
Do. 5% 2nd Deb. Red.	Stock	5	5%	85—87	
Electric Construction Co., Ltd.	2	—	—	½—⅝	
Do. 7% Cum. Pref.	2	7	—	1½—1⅝	
Do. 4½% 1st Mort. Deb.	Stock	4	4%	63—67	
General Elec. Co., Ltd., 5% Cum. Pref.	10	5	5%	7⅜—8¼	
Do. 4% 1st Mort. Deb. Red.	Stock	4	4%	87—90	
Henley's (W. T.) Tel. Works Co., Ltd.	5	15	15%	10¾—11½	
Do. 4½% Cum. Pref.	5	4½	4½%	5—5⅜	
Do. 4½% 1st Mort. Deb. Red	Stock	4½	4½%	104—106	
I. R. & G. P. Co., Ltd.	10	10	10%	15½—16½	
Do. 4% Deb. Red.	100	4	4%	98—100	
Tel. Const. & Maintenance Co.	12	15	17½%	30½—32½	+½
Do. 4% Deb. Bds. Red	100	4	4%	102—104	+½
Willans & Robinson, Ord. Shres	1	nil	5%	⅜—½	
Do. 6% Cum. Pref.	5	nil	6%	3½—3¾	
Do. 1st Mtg. Deb. 4% Red.	100	4%	4%	70—74	

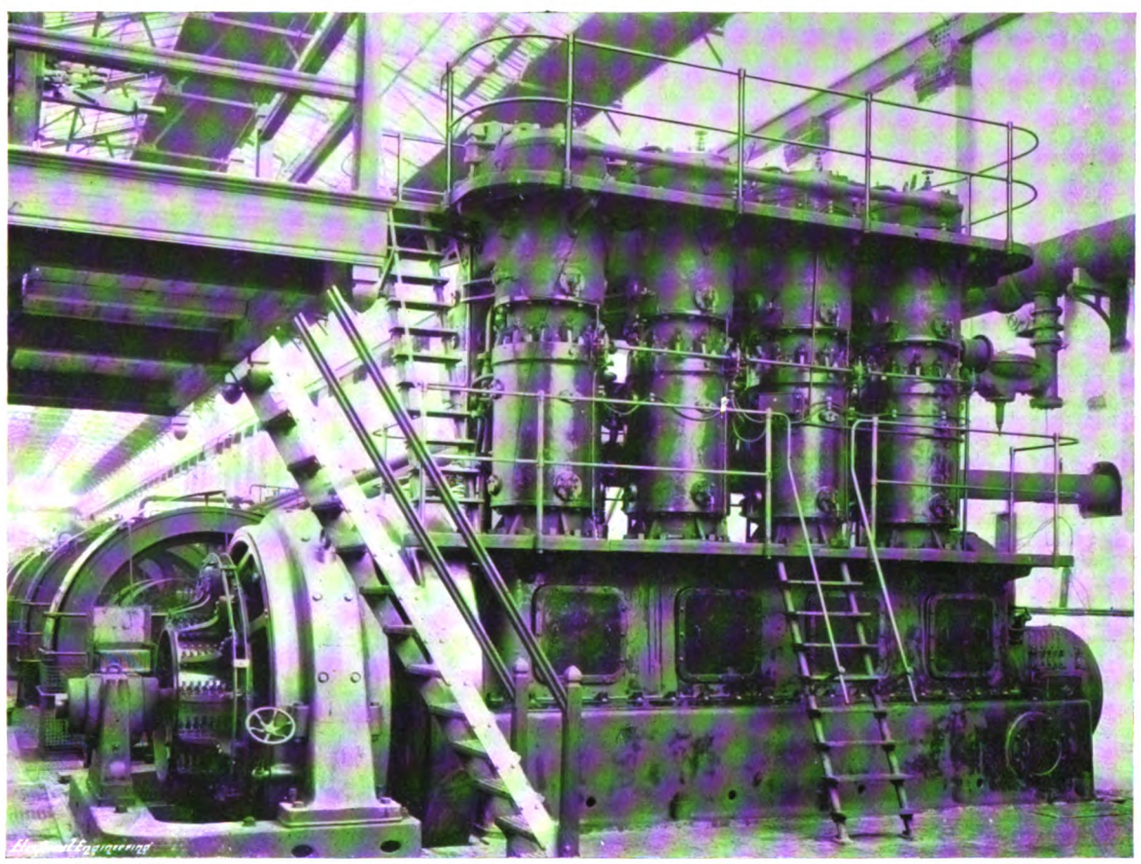
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A LARGE VERTICAL WESTINGHOUSE GAS ENGINE

THE accompanying illustration represents a 1,000-h.p. vertical eight-cylinder four-crank tandem vertical gas engine, which has just been erected at the works of the Castner-Kellner Alkali Co., Ltd., Runcorn, and was started up by Mr. Percy Allen, engineer to the company, on June 6th. The engine, which is of the latest standard vertical type, was supplied by the British Westinghouse Co., and is connected to a direct-current generator, supplied by the same makers. It forms an extension to the existing installation at Runcorn, where four 750-B.H.P. engines of the same make have been in operation for some considerable time in connection with the electrolytic process of the above firm. The cylinders, in pairs, are placed over four cranks, by which arrangement the makers claim that they can give the most even turning moment of any gas engine on the market. In these engines, with several cylinders of small size, water cooling is not required for the pistons, valves, or other moving parts, and the danger of breakage of pistons, which is occasionally a source of trouble in connection with large horizontal engines, is avoided. Forced lubrication is used throughout. The oil-pumps are in duplicate, and are so arranged that they can be examined and the oil-sieves changed whilst the engine is in operation. The valve-gear is very simple. All valves are positively operated by means of straight push-rods actuated directly from the camshaft. These are also arranged with adjustable screws, so that any play or wear can be taken up on these valves whilst the engine is in operation.

It is pointed out by the makers that this particular engine marks an epoch in the gas-engine industry, as it is the largest vertical gas engine yet manufactured and put into successful operation.

In addition to the five Westinghuose engines of this type now installed at the Castner-Kellner works, three of 750-B.H.P. capacity have been supplied to Messrs. Pilkington Bros., St. Helens, for their glass works, one of 750 B.H.P. to the Hollis Mill Co., Marple, which has been working for some considerable time, and visitors to the Franco-British Exhibition will have noticed one of these large engines in the right-hand corner of the Machinery Hall. Those who are interested in gas-engine work should take advantage of the opportunity thus afforded of inspecting an example of a type entirely British both in design and manufacture, presenting several features worthy of study which distinguish it from other designs of gas engine.



1,000-H.P. WESTINGHOUSE GAS ENGINE AT THE WORKS OF THE CASTNER-KELLNER ALKALI CO. AT RUNCORN.

THE KENT COLLIERIES PUMPING PLANT DISPUTE: JUDGMENT

ON Tuesday last, in the Official Referee's Court, Mr. Muir Mackenzie delivered judgment in the claim brought by Messrs. Ernest Scott & Mountain, Ltd, against the Kent Collieries, Ltd., for £3,249, the balance of the contract price of £5,780 for electrical plant supplied, besides money paid by the plaintiffs for wages. The defendants alleged that the plant was not in accordance with the contract, and counterclaimed for £48,000 (see ELECTRICAL ENGINEERING, April 16th, p. 601; May 7th, p. 684; May 21st, p. 798). The Official Referee, in delivering judgment, said that the defendants resisted payment of the greater part of the plaintiffs' claim, because the machinery was not in accordance with the specifications. With regard to the counterclaim, the defendants, he said, were not ready to receive the plant, and that the delay was due to the fact that the appliances provided for dealing with the plant were not strong enough. No claim for damages due to delay could therefore be considered. As the defendants had decided to work one pump at a time instead of two alternatively as the plaintiffs had advised, they could not recover losses due to breakdown unless the breakdown was due to the plaintiffs. The motors were, according to the specification, designed for giving the stated output for six hours continuously, and not indefinitely. The generators, he found, were not according to the specifications. They had an output of 255 kw. instead of 300 kw., and consumed 38 lb. of steam per kw. hr. instead of 28 lb. For this the defendants were entitled to compensation. He could not make the extra cost of fuel a basis for the compensation, but would take as a basis the difference between the value of the machinery as delivered and that specified. He awarded the plaintiffs £2,943 as the balance of the contract price. On defendants' counterclaim he found that they were entitled to £417 on account of the failure of the machines to comply with the specifications, and a further sum of £700 for damages, making a total of £1,117. Deducting this from £2,943, he gave judgment for the plaintiffs for £1,826. As the defendants had succeeded in some of the issues, the costs would be divided.

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"ELECTRICAL ENGINEERING" PATENT RECORD

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Specifications Published June 18th, 1908

A full list of these was published in our last issue. The following are abstracts of the more important specifications.
Names in brackets indicate communicators of inventions from abroad.

1907 Patents

9,397, S. DE PONT. A hard, non-inflammable, water- and oil-resisting insulating material, consisting of 50 per cent. plaster of Paris, 30 per cent. wood pulp, 15 per cent. copal, 15 per cent. pitch, 13 per cent. lampblack, 8 per cent. clay, and smaller percentages of cowrie or lac, wax, aniline, and mica. The mixture is dried, treated with bisulphide of carbon, or benzoline, and then rolled between steam rollers at a temperature of 120° to 180° F. The product is moulded at a temperature of from 250° to 300° F., and then subjected to a pressure of from 3 to 4 tons per cubic inch of the material. The final product is quite hard, and can be sawn or turned like vulcanite. One claim.

13,285, G. ELLISON. A combined starting rheostat (for the rotor circuit), overload cut-out, and no-voltage release for three-phase induction motors. The solenoid of the overload cut-out is in one phase of the rotor circuit, and the solenoid of the no-voltage release is in one phase of the stator circuit. The overload cut-out operates by opening the circuit of the no-voltage release solenoid, which in turn releases the starting handle, which is pulled round to the off position by a spring. In the case of high voltages the no-voltage release solenoid would be operated from a small transformer. The arrangement is applicable to single-phase motors. Five claims, three figures.

18,245, R. B. RANSFORD (*Compagnie Parisienne des Voitures Electriques, procédés Krieger*). A method of control for petrol-electric vehicles. A compound generator is used, which has only a weak shunt excitation sufficient to keep the machine excited when the engine is running slowly. A series winding is provided, and also a demagnetising series winding, which, during normal running, is short-circuited. When this last winding is in circuit it more than neutralises the ordinary series winding, and the voltage of the generator is so much reduced that the motors receive practically no current. This affords a means of stopping the motors without breaking the main circuit. The motors can be pure series motors, or can also be supplied with a shunt winding across the armature brushes. Five claims, three figures.

1908 Patents

66, G. M. LITTLE. A magnetite arc-lamp electrode for use with alternating current, and consisting of 60 parts magnetic oxide of iron (Fe_3O_4) to form the main conducting material, 27 parts of titanium oxide (TiO_2), 6 parts of ferrous chromite (Cr_2O_3, FeO) for preventing rapid consumption of the electrode, 20 parts of potassium silicate (K_2SiO_3) for obviating the unsteadiness and flickering of the arc, and 5 parts of calcium fluoride (CaF_2) for increasing the luminosity of the arc. For this last purpose, salts of strontium, barium, or magnesium can also be used. Six claims.

665, A. P. STROHMENGER. A material for separating or enclosing the plates of secondary batteries. A cellulose fabric, such as ordinary muslin, is coated with pulp cellulose, and the resulting porous sheet is nitrated to a sufficient degree to be unaffected by the acid electrolyte. The finished material, which is porous and sufficiently strong to resist cracking, tearing, or abrasion in actual use, is either wrapped round the plates or merely interposed between them, effectually preventing short circuits through dislodgment of the active material. One claim.

Specifications Published To-day

The following Patent Specifications will be published to-day, and will be on sale at the Patent Office Sales Branch, 25 Southampton Buildings, London, E.C., at the price of 8d. each, post free. The number and year of the patent should be quoted on the order.
Summaries of the more important of these patents will appear in our next issue.

1907 Patents

10,072, BRITISH THOMSON-HOUSTON CO. (*General Electric Co.*). Electric motor control systems.
10,293, COLLINS, HAYES & WATSON. Trolley heads.
12,353, AUSTIN. Receivers for wireless telegraphy.
12,406, SEDGWICK. Signalling apparatus.
12,407, GRANT (*Haggarty*). Ships' telegraphic apparatus.
12,578, HEYLAND. Self-regulating machines for alternating or direct current.
12,857, TONRY. Ball and socket joints for electric light fittings.
12,969, HELLMANN. Synchronous working of apparatus.
13,032, EASTWOOD. Systems for electric railways.
14,572, HAYWOOD, AND MCKENZIE & HOLLAND, Ltd. Electrically detecting the position of the switch tongues and locking bolts of railway points.
18,013A, KESSLER & JELICH. Contact arrangement and stand for electric lamps.
18,308, ELLISON & JACOBS. Telephonic apparatus.
19,073, FUSSER. Supports for electric lamps.
19,447, MOORE. Automatic time switch mechanism.
19,734, GROSS. Arc lamps.
20,119, MARCONI & MARCONI'S WIRELESS TELEGRAPH CO. Transmitters.
24,753, SIEMENS BROS. & CO. (*Siemens & Halske Akt.-Ges.*). Means for rectifying alternate currents.
25,206, HARRISON (*Electric Railway Improvement Co.*). Welding.
25,350, ARENAS Y GARCIA. Dynamo-electric machines of the homopolar type.
26,621, CUMONT & COMPAGNIE DE SIGNAUX ELECTRIQUES POUR CHEMINS DE FER. Signal and point mechanism.
27,379, AMALGAMATED RADIO-TELEGRAPH CO. (*Scibt*). Radio-telephony.
28,516, JOHNSON (*Felten & Guilleaume Lahmeyerwerke Akt.-Ges.*). Electrical driving gear for motor vehicles.

1908 Patents

2,488, WOLHAUPTER. Insulated joints for rails.
3,701, POLYPHOS ELEKTRIZITÄTS-GES. Method of transmitting photographs.
4,444, DOWSING. Electrical radiators.
4,621, FRIEDHEIM. Manufacture of heat interchangers by an electrolytic process.
5,225, ALLGEMEINE ELEKTRICITÄTS-GES. Electrodes for arc lamps.
5,610, ALLGEMEINE ELEKTRICITÄTS-GES. Incandescent lamps.
6,050, SIEMENS & HALSKE AKT.-GES. Process for hardening tantalum.
7,910, SIEMENS BROS. & CO. (*Siemens & Halske Akt.-Ges.*). Pyrometers and thermometers.

Complete Specifications open to Public Inspection before Acceptance.

1907 Patents

15,798, KUZEL. Metal filament lamp.
27,608, GEISSINGER. Electric thermostat.

1908 Patents

11,415, NORSK HYDRO-ELEKTRISK KVOELSTOFAKTIESELSKAB. Production of pure sodium nitrite.
11,633, ALLGEMEINE ELEKTRICITÄTS-GES. Alternating-current commutator machines.
11,870, HARTMANN-KEMPF. Apparatus for indicating the frequency of electrical oscillations.

Applications for Amendment

Further particulars and instructions as to procedure in opposition to amendment will be found in the Official Journal of the Patent Office of June 17th, 1908.

23,899 of 1904. THE WOLFRAM (TUNGSTEN) METAL FILAMENT LAMPS, LTD., seek leave to amend this specification, granted to ALEX. JUST and FRANZ HANAMAN, for "Improvements relating to the manufacture of incandescent lamps," on the ground of doubtful validity of some of the claims. The amendments consist in striking out all reference to molybdenum and limiting the invention to tungsten.

11,949 and 20,175A of 1905; also 3,225, 3,684, and 4,681 of 1906. THE WOLFRAM (TUNGSTEN) METAL FILAMENT LAMPS, LTD., seek leave to amend these specifications, granted to Alex. Just F. Hanaman, and others, for the same reason as stated above with reference to No. 23,899 of 1904.

Expiring Patents

The following patents expire during the current week, after a life of fourteen years :—

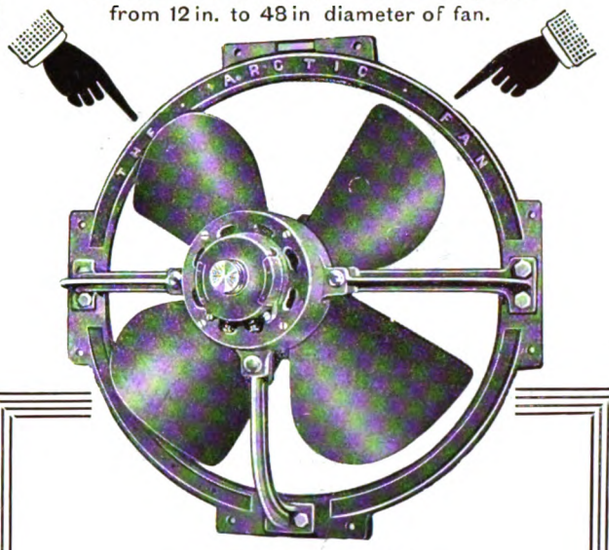
12,407 of June 26, 1894. H. A. TAYLOR. An improved form of Wheatstone automatic transmitter for submarine telegraphy. The battery contact is prolonged relatively to the earth contact and the durations of these contacts are adjustable.

12,552 of June 28th, 1894. G. H. NISBETT. Sealing and junction boxes for lead-covered cables, for preventing access of moisture to the open ends of the cables. The cables enter the inner chamber of the box through solder glands. The inner chamber is filled with ozokerite or similar material, and the outer chamber contains terminals and fuses.

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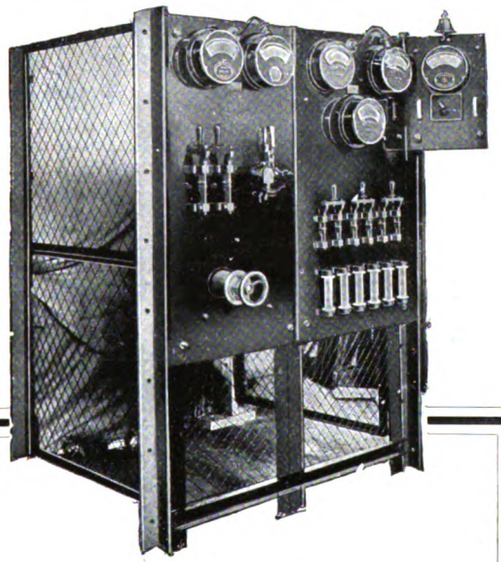
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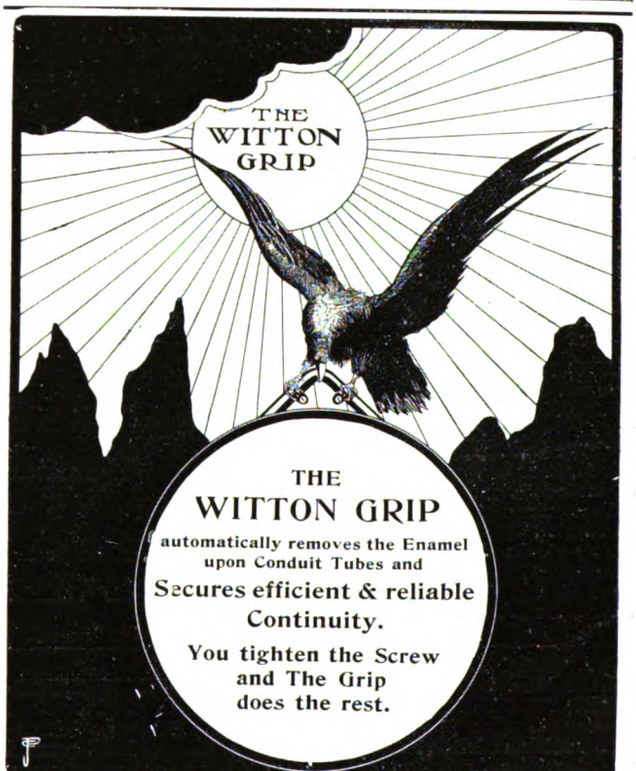
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Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), issued on June 17th, 1908.

Any person, or persons, may give Notice of Opposition to the Amendment (on Patents Form No. 18), at the Patent Office, 25 Southampton Buildings, London, W.C., within one calendar month from the date of the said Journal.

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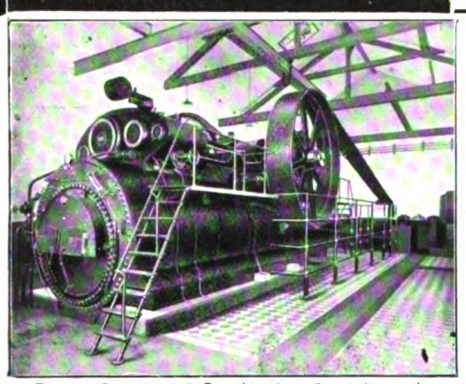
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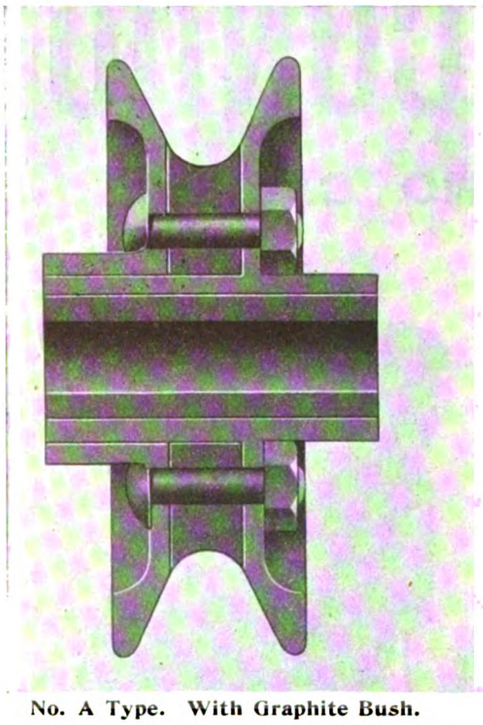
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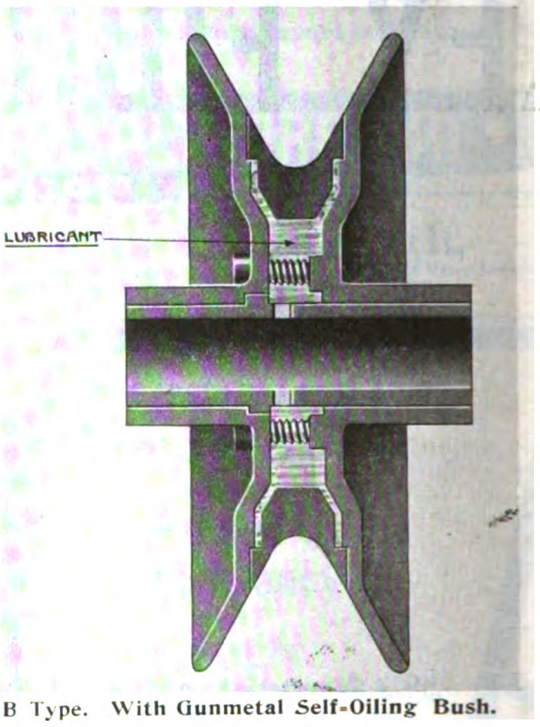
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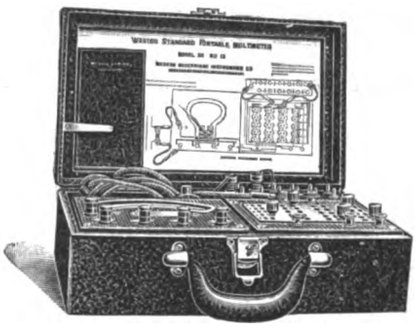
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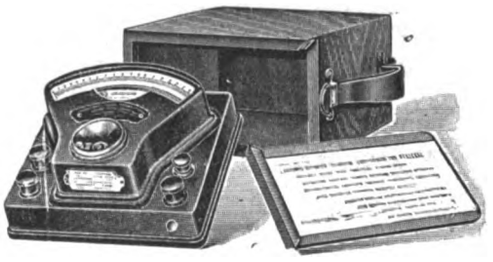


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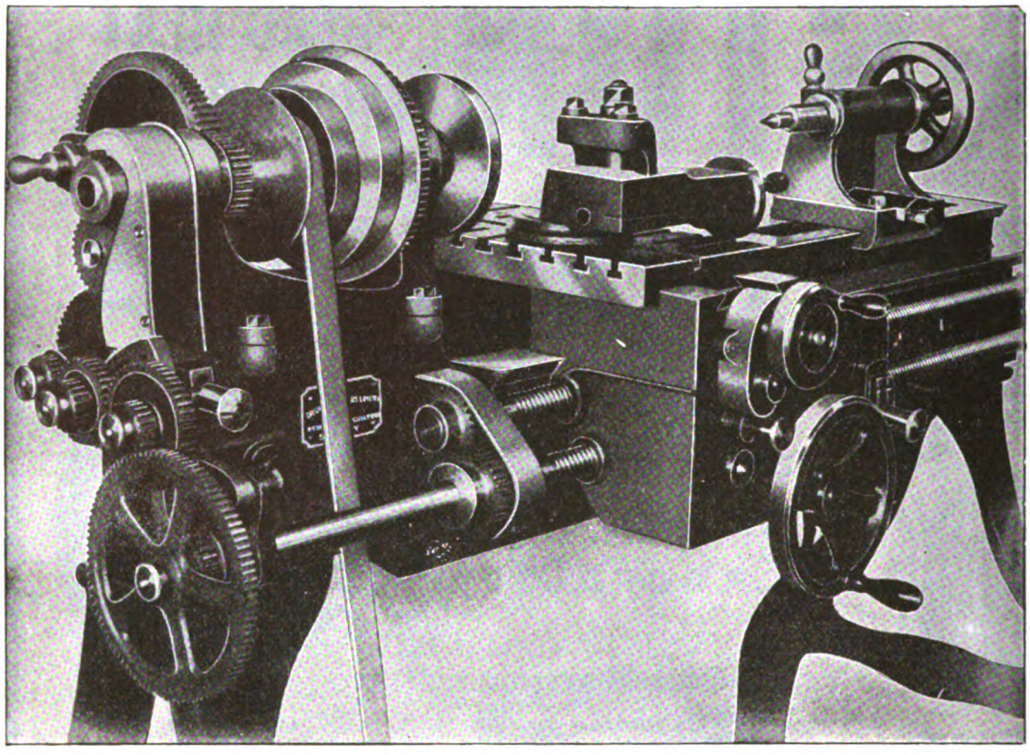
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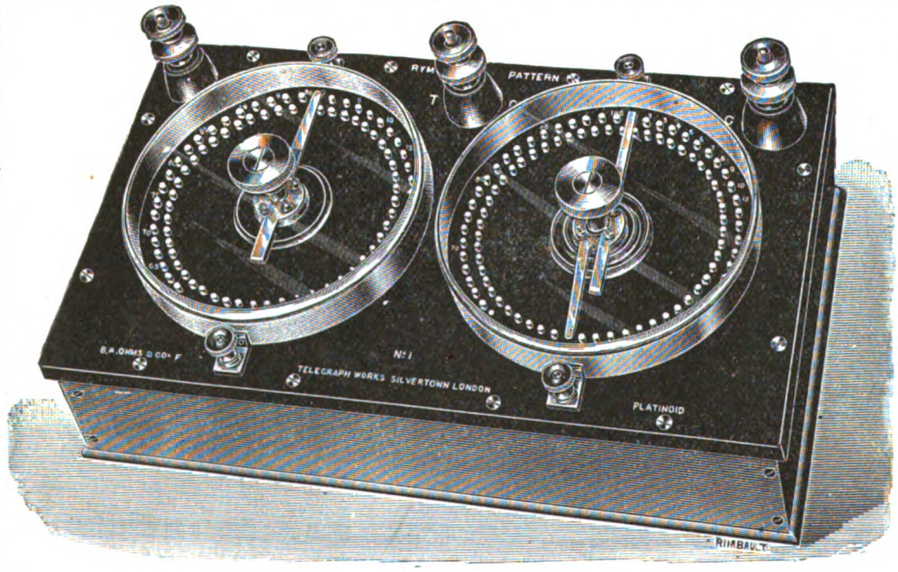
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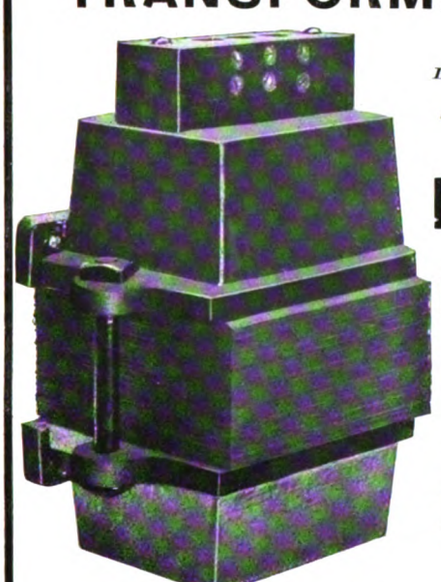
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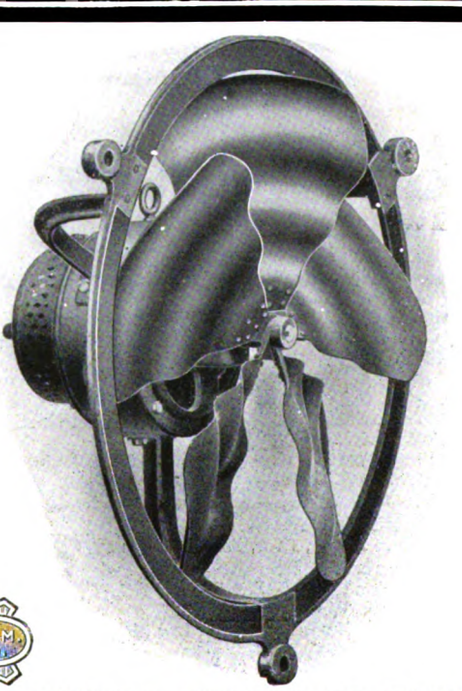
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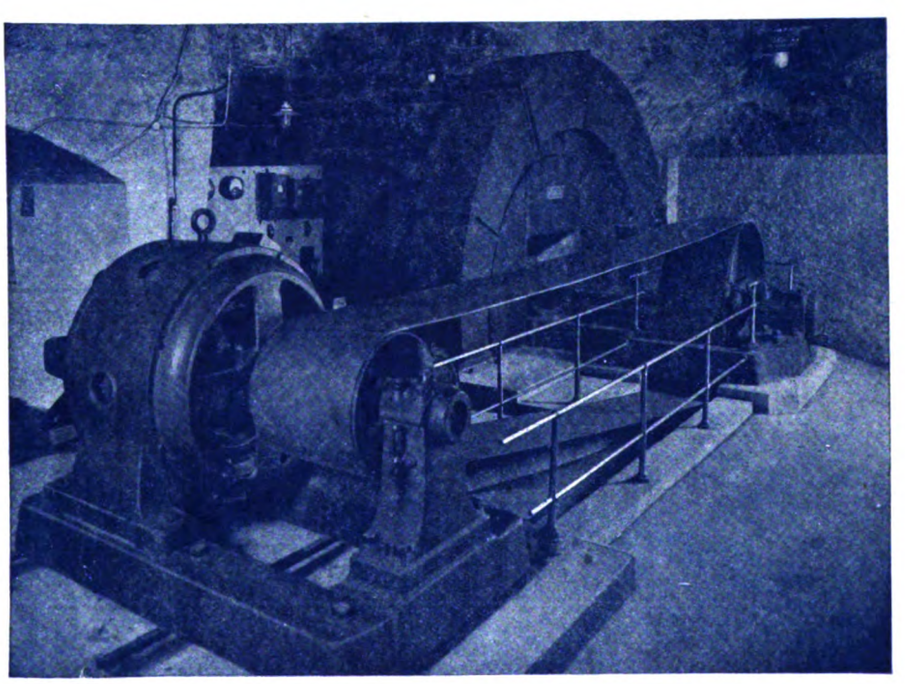
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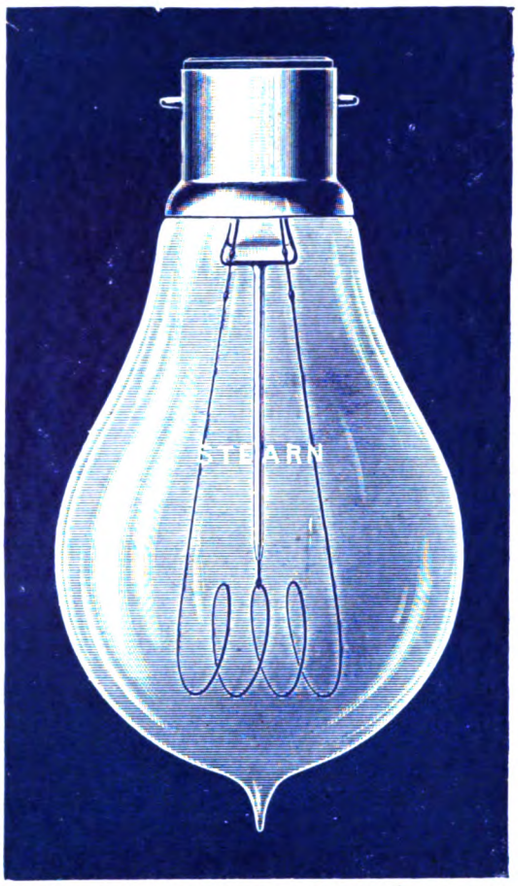
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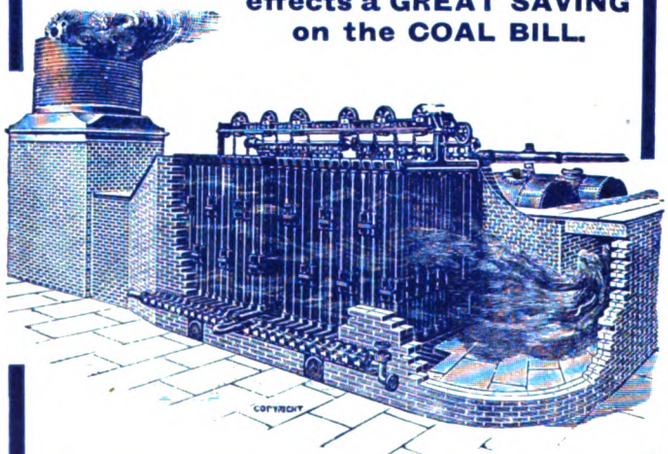
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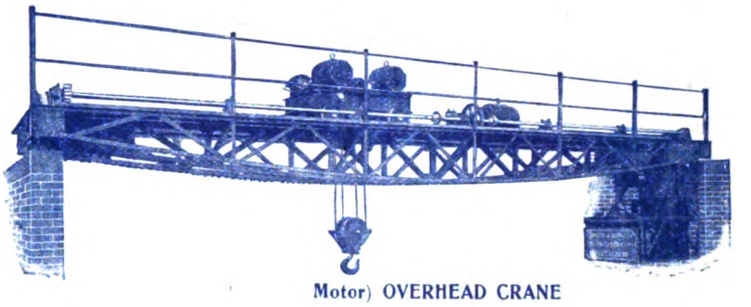
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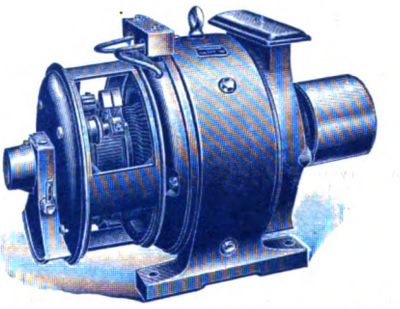
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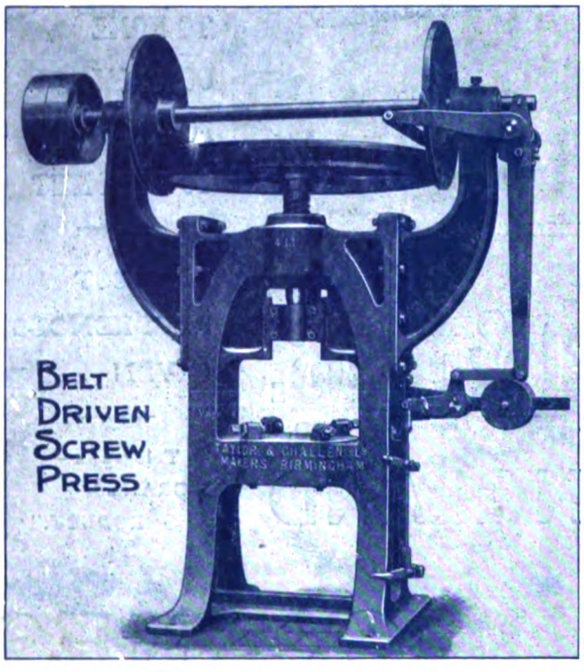
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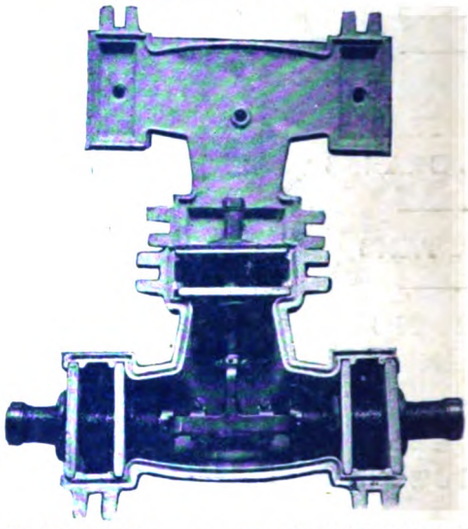
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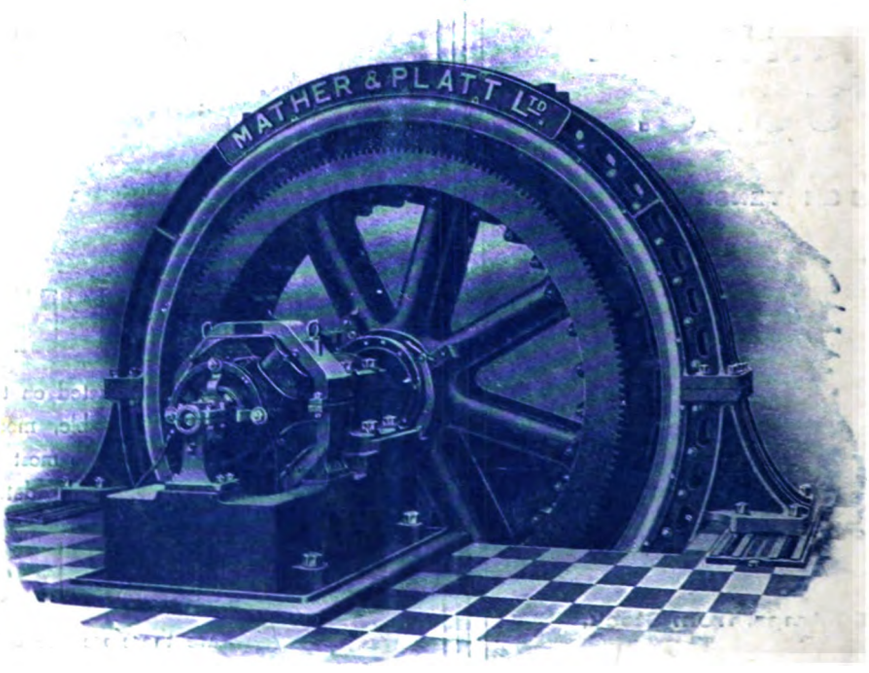
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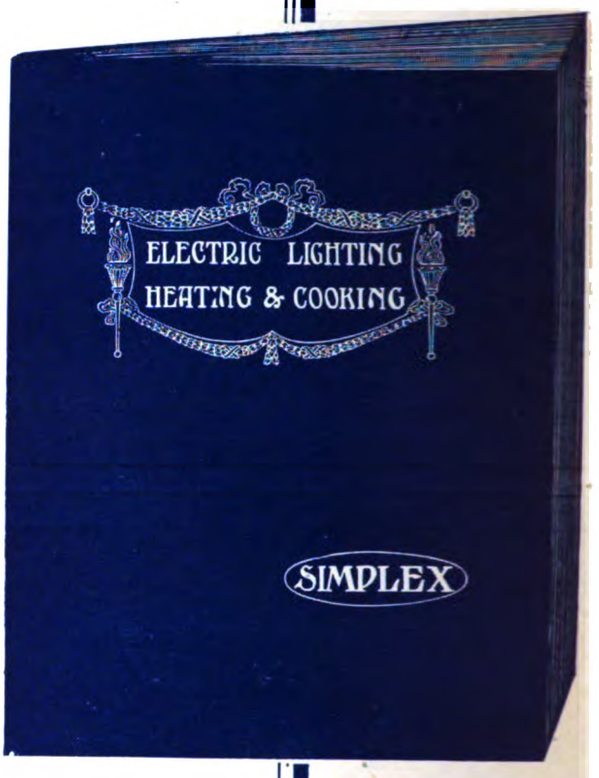
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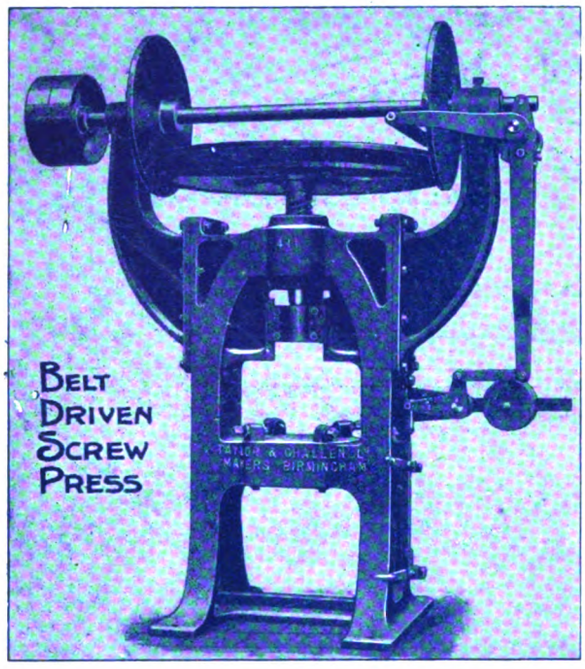
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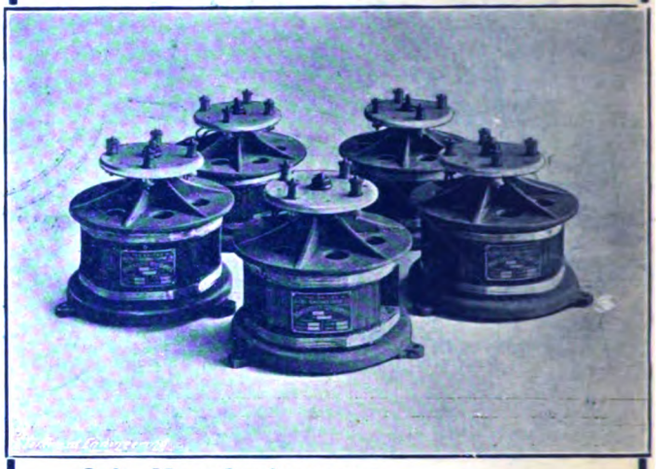
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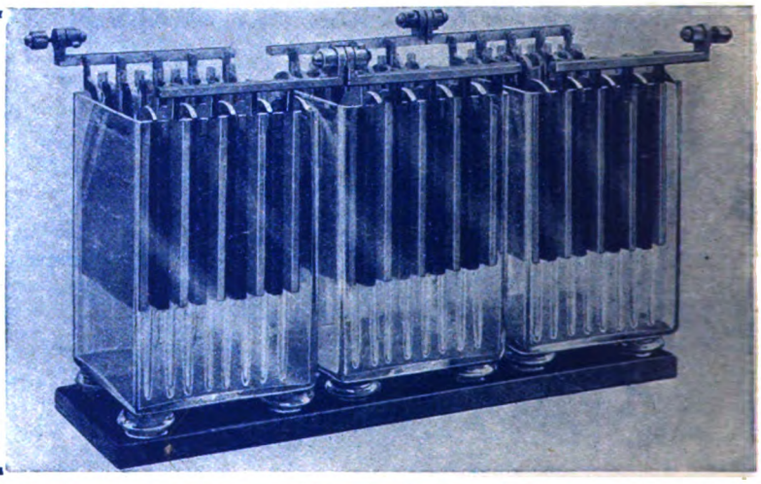
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